APPROACHES FOR SUSTAINABLE DEVELOPMENT OF HORTICULTURE

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Cover : Litchi in fruiting
Photo : Courtesy Dr. H.P. Singh

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J.N.L. Srivastava

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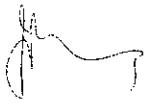
FOREWORD

The horticulture sector has emerged as economically rewarding and most viable option in diversification of agriculture. It offers a wide variety of crops suitable for cultivation under different agro-climatic conditions and terrain with possibility of multi-tier cropping system thus enhancing the returns per unit of land area, generating employment and providing food and nutritional security. The shift in the dietary patterns with preference to horticulture products, has resulted in increasing demand for intensification of efforts for the development of the sector. In economic terms, the horticulture sector contributes 24.5% to GDP of agriculture from less than 8.5 per cent of cultivated area.

The Ministry of Agriculture has been according very high priority for the development of horticulture in the country with its focused programme since the VIII Plan. Efforts have resulted in increased production and productivity of fruits, vegetables, root and tuber crops, mushroom, floriculture, medicinal & aromatic plants, coconut, cashewnut, cocoa etc. and their period of availability has increased. Technological infusion and programmes for infrastructural support have created a good impact, and a favourable environment for private sector investment has been created. In the global scenario India has acquired an enviable first position in the production of a number of products like mango, banana, cashewnut, cauliflower, coconut and a variety of spices and continue to have major share in global trade of spices and cashewnut.

The horticulture sector, however, is still in the transition stage, where the development of technology starting from production of planting material to value addition of produce is

taking place at an accelerated pace. The past experiences have resulted in prioritizing the programmes and its implementation in a regionally differentiated manner. With the idea of keeping the policy planners, scientists and the implementers of the programmes abreast with the recent developments, National Horticulture Conference (NHC) is organized each year. The last NHC held on 16-17 November, 2001 provided opportunity to discuss various issues confronting the development of the horticulture sector and develop strategies to address some of the issues. The Conference provided opportunity for reviewing the on going programmes of development in the country besides discussing the issues of importance. Based on the deliberations, I am happy to note that, a book entitled 'Approaches for Sustainable Development of Horticulture' has been brought out for wider dissemination. The articles contained in the book are of relevance for shaping the future development of horticulture for ushering a Golden Revolution. I compliment Dr. H.P. Singh, Horticulture Commissioner, Shri J.P. Negi, Managing Director, National Horticulture Board and Dr. Jose C. Samuel, Deputy Commissioner and their collegues for bringing out this publication which shall be of great interest for all those who are interested in development of horticulture. I am sure this publication will serve as reference book for sustainable development of horticulture in the country.



J.N.L. Srivastava

Date: 20th June, 2002

PREFACE

In the overall scenario of agricultural development, horticulture sector has a prominent place, as it contributes 24.5% of GDP in agriculture from 8.5% area and provides vast options for diversification. Initiation of efforts towards the planned development of horticulture in the Nineties by the Government has created ample awareness among the farmers about the positive role of horticulture in increasing returns per unit of area, providing on-farm and ex-farm livelihood and over all nutritional security. Technological infusion coupled with financial assistance has led to increased private sector investment in horticulture. We are passing through transition phase in development of horticulture and the growth achieved in the past has to be sustained.

Despite the favourable agroclimatic conditions, vast resources of manpower and infrastructure for research and development, the existing potential for horticulture has not been harnessed. Challenges ahead are much more to achieve the target of 265 million tonnes of horticulture produce with shrinking land and water resources. The challenges have further compounded in liberalized economy which needs to be converted into opportunity. The efforts have been successful in heralding a Golden Revolution, which needs to be sustained.

To deliberate on emerging issues, the Division of Horticulture has been organising National Horticulture Conference annually with the aim to develop strategies for achieving an accelerated growth in the horticulture sector commensurating with the demands of produce and meet the aspiration of the farmers. The National Horticulture Conference 2001 which was organised on 16-17 November 2001 provided us a wealth of information through presentation by Resource Speakers of renown. Essentially, the documentation of such valuable information is needed. In this book entitled *'Approaches for Sustainable Development of Horticulture'*, efforts have been made to compile and edit the information together. This publication is intended to disseminate the knowledge highlighting the advances made in different sectors of horticultural development. The Book has covered several aspects like research, development, export, WTO issues, crop related issues, quality standard, horticulture programmes, etc. and is expected to be of much help for all those interested in horticulture.

We take this opportunity to express our gratitude to Shri J.N.L. Srivastava, Secretary (A&C), who has been a constant source of inspiration for the development of horticulture. Our thanks are also due to Shri Hemendra Kumar, Special Secretary (A&C) who has been providing consistent guidance in planning and execution of programmes. We are equally indebted to all the Experts for their valuable contribution to bring out this book. Finally we express our gratefulness to all those who have, directly or indirectly, helped in bringing out this publication.

27th June 2002.

EDITORS

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APPROACHES FOR SUSTAINABLE GOLDEN REVOLUTION – THRUST DURING TENTH PLAN

H.P. Singh* and K.L. Chadha**

Role of horticulture in improving productivity of land, generating employments, improving economic conditions of farmers and entrepreneurs, enhancing exports and above all providing nutritional security to the people, has been well established. Horticulture sector comprises a wide variety of commodities like fruits, vegetables, roots and tubers, mushrooms, flowers, medical and aromatic plants, cashewnut, coconut, etc. This sector has emerged as a promising area for diversification in agriculture on account of high income generation per unit area and environment-friendly production systems besides providing better employment opportunity. The Government of India accorded high priority for the development of this sector, particularly since the Eighth Plan when the outlay for its developmental programmes was stepped up by more than 40 times from 24 crores during Seventh Plan to 1,000 crores in Eighth Plan. The impact of this investment has been visible in terms of increased production and productivity of horticultural crops. India has emerged as world leader in production of mango and banana, and is the second largest producer of fruits and vegetables. Besides, India has maintained its dominance in the production of coconut, cashewnut and a number of spices. It offers not only a wide range of options to the farmers for crop diversification, but also provides ample scope for sustaining a large number of agro-industries, which generate huge employment opportunities. At present, horticulture is contributing 24.5% of GDP from 8% land area. The rapid development in horticulture sector in the past decade has been described as a Golden Revolution by the Union Agriculture Minister at the National Horticulture Board (NHB), Gurgaon in October, 2001. This adds to the responsibility of the Nation to maintain the tempo and sustain the developmental efforts to meet the aspirations of the farmers.

With the approach of the culmination of the Ninth Plan, the Planning Commission constituted a Working Group on Horticulture for recommending the strategies for the development of horticulture during the Tenth Plan. The Working Group in turn constituted 13 Sub-groups comprising more than 200 Members to address the issues relating to different sectors of horticulture. The recommendations were presented before the Steering Committee of Planning Commission in June 2001. The recommendations form the framework of horticultural development during the Tenth Plan to sustain the Golden Revolution, along with approaches are presented.

RESEARCH AND DEVELOPMENT

Horticultural development was at very low ebb till the Third Five-Year Plan and received meagre attention even thereafter. However, the Plan investment in horticultural development increased significantly since the Eighth Five- Year Plan which resulted in considerable strengthening of horticultural development programmes in the country. The Plan allocation for research on horticultural crops by the Indian Council of Agricultural Research (ICAR) was first made in Fourth Plan with a modest allotment of Rs 34.8 million. This was enhanced to Rs 319.6, 1,102 and 2,130 million during

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Seventh, Eighth and Ninth Plans respectively. At present, about 10% of the total outlay for agricultural research made by the ICAR, is earmarked for horticulture research.

Starting with a meagre financial allocation of Rs 20.5 million for development in Fourth Plan, it rose to Rs 76.2 million in Fifth, Rs 146.4 million in Sixth, Rs 250 million in Seventh, Rs 10,000 million in Eighth (utilization Rs 7,890 million) and Rs 14, 530.6 million in Ninth Plans (Fig.1).

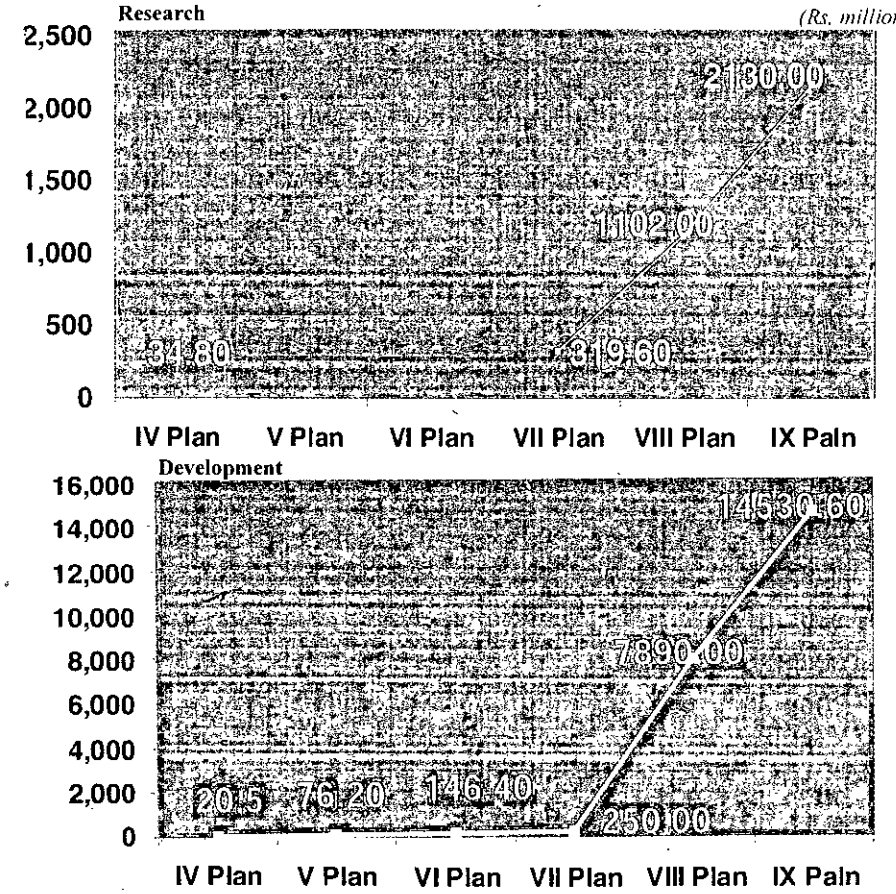


Fig. 1 Plan allocation for horticultural research and development

While the increase in budgetary allocation from Fourth Plan to Ninth Plan was 61 times for research, it was 584 times in respect of developmental programmes.

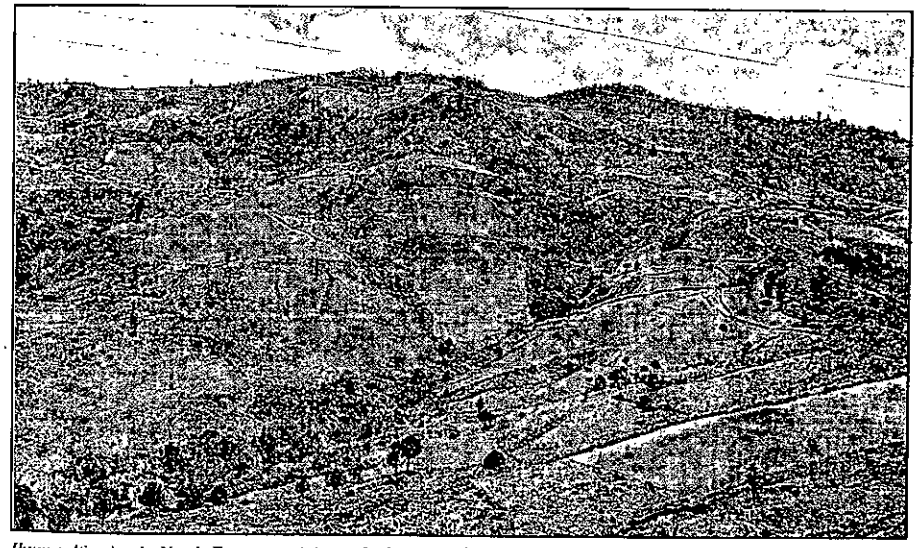
In addition, the Ministry of Commerce has been promoting research, development and exports of cardamom and spices through Spices Board and fresh as well as value added agricultural products through Agricultural Processed Food Prducts Export Development Authority (APEDA). Indirect organizational support for horticultural development is also being provided by National Cooperative

Development Corporation (NCDC) and National Agricultural Cooperative Marketing Federation (NAFED).

PROGRAMME INTERVENTIONS DURING NINTH PLAN

The thrust of the programme in the Ministry of Agriculture during the Ninth Plan was on improving the productivity of existing plantations through rejuvenation, plasticulture interventions, beekeeping and post-harvest management. Emphasis was laid on production of quality planting material as also on technology transfer. The schemes also provided opportunity for the promotion of new techniques such as tissue-culture, micropropagation of planting material, drip irrigation, greenhouse cultivation, grading, packing and storage of the produce. In tea, coffee and rubber, the thrust of programmes was similar, with more orientation towards export. Their Commodity Boards also addressed issues of research.

In general, the programmes in the Ninth Plan were only approved during the later part of 1999-2000. Thus, the existing programmes of Eighth Plan were continued. New initiatives like Human Resource Development, Integrated Development of Horticulture in Hill and Tribal Areas, Technology Mission for Integrated Development of Horticulture in North-Eastern Region, etc. were only initiated during fourth and last year of the Plan period. Overall impact of the programme in horticulture can be seen in terms of increased production and productivity. However, there was an overwhelming response to most of the programmes implemented during Ninth Plan, and their impact is also visible in terms of improved infrastructural facilities, human resource development, improvement in production of quality products etc.



Jhum cultivation in North-East, potential area for horticulture development

Another feature of the programmes of Ninth Plan has been amalgamation of most of the schemes in horticulture with the Centrally Sponsored Scheme on Macro Management in Agriculture-Supplementation/Complementation of State Efforts through Work Plan, a regionally differentiated

approach , which gives flexibility to States. Since the scheme has hardly been run for a year under this mode, its impact is yet to be assessed. However, one of the features which has been noted in the flow of funds from the Central Government to the State Finance Department, then to the Agriculture Department, and lastly to the Horticulture Department is that, there is increase in intermediaries and further delay in availability of funds to implementing agencies. Further, many of the States have separate Ministries for Agriculture and Horticulture. Under these circumstances, horticulture has not received much focussed attention in many of the states. Thus it is imperative that the impact is assessed so that the focus is not lost. Alternatively, it is advisable to have macro management mode applicable, if essentially required, separately for horticulture.

In North-Eastern region, to give a focussed attention to horticulture, the project on horticultural development has been taken up as Technology Mission under which all the issues on horticultural development in the region has been addressed. Faster flow of funds has been ensured to the implementing agencies. The scheme was approved for implementation during the financial year 2001-02. Hence its impact is not yet realised. There is, however, an overwhelming response to this programme. Thus the scheme needs to be continued with reforms, especially with strengthening of institutional support. The off take of the scheme on Human Resource Development and Integrated Development in Tribal/ Hill areas has resulted in an overwhelming response and excellent impact within a short time. These programmes need to be continued during the Tenth Plan after strengthening.

Two important factors in the tardy implementation of horticultural development programmes have been: (a) ill-equipped Departments of Horticulture in most states and chronic shortage of scientific manpower to handle the programmes, and (b) delay in release of funds to implementing agencies, leaving unspent balances, year-after-year, leaving little scope for release of additional funds to achieve higher targets. Any strategy for the development of horticulture in the region has to take into account these factors.

CURRENT STATUS

Area and Production

As a result of interventions made by the Government as well as the entrepreneurs and farmers, significant progress has been made in area expansion resulting in higher production. Besides, use of modern technologies has also brought about improvement in productivity. More than 50% increase in production is seen in many of the horticultural crops between 1991-92 and 1999-2000 (Table 1).

Table 1. Area and production of important horticultural crops in India

(Area '000 ha, Production '000 tonnes)

Crop	1991-92		1998-99		1999-2000		Increase over 1991-92	
	Area	Production	Area	Production	Area	Production	Area (%)	Production (%)
Fruits	2870	28630	3729	44042	3796.8	45496	32.29	58.91
Vegetables	5140	58530	5870	87530	5993.0	90830	16.60	55.19
Spices	2005	1900	2500	2907	2517	2911	25.54	58.21
Coconut	1530	6930	1910	10270	1777.7	8420	16.19	48.20
Cashew	530	300	730	460	686	520	29.43	73.33
Cocoa and others	226	247	263	1649	400	1750	77.0	608.5
Total	**12301**	**96537**	**15102**	**146858**	**151705**	**149927**	**23.33**	**55.30**

NA= Not available

During 1991-92 to 1999-2000, there has been a significant increase in area and production of various horticultural crops. The total area during 1999-2000 was 15.17 million ha with a production of 149.93 million tonnes. While the area under horticultural crops increased by 23.33% during 1991-92 to 1998-99, the production increased by 55.30 % indicating a boost in production due to increased productivity besides area expansion. The maximum increase in area took place under fruits followed by cashew. The increase in production was highest in cashew followed by fruits and vegetables. The impact of increased production of horticultural produce has been reflected both by gluts in crops like onion and potato and increased value of exports in several other commodities.

Exports

India is exporting fresh fruits, vegetables, processed products of fruits and vegetables, cut and dry flowers, medicinal and aromatic plants, seeds, spices, cashew kernels and their products. Total quantity exported increased from 0.80 to 1.22 million tonnes (52.5%).Total value of export increased from Rs 14110.78 million in 1991-92 to Rs 64400.80 million in 1999-2000 with an increase of 265.4%. Horticultural products account for more than 55% of the total value of exports of agricultural commodities from India.

High density planting of pineapple

There has been a significant increase in the export of fresh fruits and vegetables from Rs 2.934.5 million in 1991-92 to Rs 6472.2 million in 1999-2000 with an increase of 120.6%. Among fruits, mango was the main fruit while among vegetables onion has been the major crop exported from India. The value of total exports of processed fruits and vegetables from India was Rs 9936.4 million.

Although India's share in the export market of flowers is still insignificant, it has registered a sharp increase from Rs144.5 million in 1991-92 to Rs 1051.5 million in 1999-2000. The value of cut flower exports has shown a tremendous increase during the period from Rs 4 million to Rs 291.27 million. Export of dry flowers and floral products has been going on since 1985. Indian flower trade has crossed 10,000 tonnes, major markets being USA, Israel, Hongkong, Japan, Singapore and West European countries. The UK has been the largest importer of dry flowers from India, followed by Germany, Italy, Netherlands and Spain. The dry flower units are concentrated in Tuticorin in Tamil Nadu and Kolkata in West Bengal.

The potential for foreign exchange earning by India from the exports of medicinal and aromatic plants is estimated to be over US $ 3,000 million per annum. The demand for these plants is increasing both in developing and developed countries. The international market of medicinal plants related trade is estimated at US $ 60 billion per year having a growth rate of 7 % per annum. The annual exports of derivatives of medicinal and aromatic plants are to the tune of Rs 600-700 million. Major importing countries are USA, Europe and Japan.

Banana ready for consumption after long distance transporation

India has a long history of producing and exporting spices. Spices exports have been consistently moving up during the last decade with an increase of 210% in quantity and 622% in value. The country commands 46% in global trade in terms of quantity and 28% in value. Exports during 1999-2000 have been 2,36,142 tonnes valued at Rs 20,250.9 million. During 1999-2000, in the total spices export earnings, pepper contributed about 36.0% followed by spice oils and oleoresins (24.1%) and chilli (12.3%) of the total value. The value-added products in the export basket constitute 37% of the total value of exports.

While coconut as such is not exported, of late, the export of coconut products has increased considerably especially of coir products. The overall export of coconut and its products including coir increased from Rs 731.90 million during 1991-92 to Rs 3,121.53 million in 1998-99.

India is the leading producer, processor and exporter of cashew kernels in the world. The export earnings from cashew and allied products during 1991-92 was Rs 6,690.90 million which increased to Rs 24,514 million in 1999-2000 which is an alltime record. Cashew stood fourth in position among horticultural products exported from India, after tea, coffee and spices. The average growth in demand for cashew kernels for export and internal consumption is around 13 percent. Cashewnut shell liquid

(CNSL) is also an export item. While its export was 4,542 tonnes in 1991-92, it dropped to 1,912 tonnes in 1998-99, earning about Rs 42.1 million.

CONSTRAINTS IN DEVELOPMENT

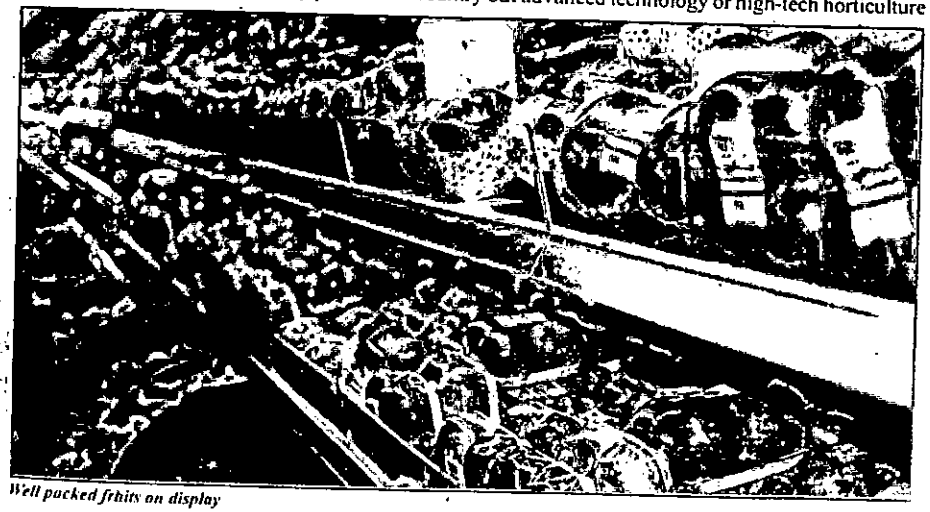
Over the years, productivity and quality of several horticultural crops have continued to remain much below the potential demonstrated in research trials. Productivity of many horticultural commodities continues to be low. There are various factors, which contribute to low productivity. These are:

1. One of the factors for low productivity of horticultural commodities is the poor quality of seeds and plants of improved cultivars. Although a large number of nurseries have been established and many seed companies are operative, there is an acute shortage of quality seeds and planting materials. Mechanism for assessing quality of seeds and plants is weak and farmers are also unaware about the risk in use of poor quality plants. Unlike the field crops, a large number of horticultural crops are propagated through vegetative methods. Although, vegetative methods of propagation help in multiplying true-to- type plants, there is high risk of transmission of virus diseases from one generation to other, if care is not taken for cleaning against virus. Sometime unscrupulous nurserymen even sell seedling plants in place of graft whenever demand is high. Similarly, quality seeds are also in short supply and quite often do not meet the growing requirements.

2. The low productivity of the perennial fruit and plantation crops is due to predominance of old and senile orchards, poor management practices and small average size of fruit orchards (0.21 to 0.79 ha). Apart from this, the poor condition of trees in most orchard plantations which suffer from infestation of insect pests and diseases and inadequate nutrition, is contributing to low yields.

3. In general, horticultural crops are not irrigated in many states. In many cases, excessive irrigation due to poor drainage also affects productivity. The situation has not changed much despite several developments taking place for efficient management of water through water harvesting, conservation and skillful application of technologies.

4. Horticultural crops are largely a subsistence cultivation. Technological advancement has improved the productivity in may parts of the country but advanced technology or high-tech horticulture



Well packed frhits on display

has been adopted on a very limited scale only in a few states. The situation is due to unawareness about the technology, poor capacity of farmers to invest and poor credit support coupled with problems of infrastructure.

5. Horticultural crops being highly perishable suffer losses due to poor post-harvest management, which makes the investment in these crops risky. In the absence of infrastructural facilities, production of these crops suffers from the crippling uncertainty and instability of market conditions. In view of poor risk bearing capacity of small and marginal farmers, their interest in production programmes is adversely affected.

Orchid, Dendrobium in flowering, ready for harvest

6. Marketing of perishable produce is a major component of the total production system and has a major role to play in making this system viable. Cooperative marketing is only successful in a few states. Thus, entire marketing is handled by commission agents. Fruits are mostly auctioned by orchard owners to pre-harvest contractors resulting in low returns, which do not encourage investment to achieve higher productivity. In absence of efficient marketing system coupled with seasonality and perishability high incidence of losses occurs.

7. The weak processing infrastructure also contributes towards keeping the production at low level. High production in season causes supply to be more than the demand and in absence of arrangement for processing, glut situation occurs which becomes a disincentive to the production.

8. Lack of sufficient processing units for processing of coconut, arecanut, cardamom, pepper, etc., is a major bottleneck for these crops. Lack of adequate standards for quality produce also hinder the export prospects of these crops. Lack of infrastructure like drying yard, etc., due to high capital investment, hinders effective utilization of raw materials.

9. The high capital cost involved in establishing an orchard / plantation as also setting up of required infrastructure is a serious constraint in expansion of area under many horticultural crops as well as improvement in existing orchards. Similarly, variable cost is also high for vegetable and flower

cultivation. The situation becomes all the more difficult in view of the large number of small holdings involved, owned by weaker sections, who have no means to invest, nor can afford to stand the burden of credit even if available. Added to this is the long gestation period that the perennial fruits and plantation crops take before coming to the economic bearing age. The farmers have to restrict their investment in maintenance of such plantations and raise alternate crops to make both the ends meet.

10. In view of the long gestation period, scientific management and high investment credit support to small and marginal farmers is crucial. There is a wide variation in the credit availability in different parts of the country, being highest in Kerala i.e. more than Rs 5000/ha of land compared to Rs 50/ha in Bihar. This imbalance in credit support is also one of the factors contributing to low productivity.

11. Agricultural Universities and other units of ICAR are operative in most of the states. But the existing system is not adequate to address the problems of horticultural crops. Investments for research on horticulture have always remained low despite the large number of crops it covers. This results in poor technological support. The extension system is also weak. The Department of Horticulture created in many states does not have adequate manpower and infrastructure to address the problems of horticulture. Further, horticultural crops not only suffer from weak extension support in physical terms, but also from absence of a well-tested and adaptable system for transfer of technology. Absence of such a system creates a major credibility gap in the viability of the technology developed at the research institutions, and, therefore, finds limited application.

12. For any planning process aimed at developing a particular sector, an authentic and up-to-date database is essential. In horticulture sector, database is very poor as collection of agricultural statistics covers only a few horticultural crops. The NHB is publishing database annually but its authenticity is always in question. Unless the database is made authentic and broader in its coverage, long-term planning for horticultural development will be difficult and unrealistic.

13. Risk management in horticultural crops is non-existent although crops like onion and potato are covered under National Agriculture Insurance Scheme. In the absence of yield data, it has been

Mite infested coconut

difficult to cover other horticultural crops. There is a need to cover risk in case of horticultural crops in a different manner, perhaps on the basis of potential production coverage instead of average yield. This would encourage higher investment to achieve higher productivity.

14. The thickly shaded mango orchards in the Malihabad areas of Uttar Pradesh, the seedling orchards of guava and cashew throughout the country and the disease affected pepper, cardamom and coconut plantations are commonly seen in large numbers in different parts of the country. These have brought down the average productivity of these crops drastically.

15. Presently, differential tax structure for diverse agricultural commodities is in existence in different states. This needs review and rationalization.

DEMAND PROJECTIONS

Despite emphasis made on horticultural crop production during Eighth and Ninth Plans, there is still a large gap between the demand and supply of several horticultural commodities. The demand is further expected to rise in the coming years on account of need to provide minimum per capita requirements of various horticultural commodities to increasing population to ensure nutrition-security. With emphasis on value addition, the demand of raw products of several commodities for the processing industry will increase. India has a great potential for improving its export of horticultural commodities. Change in dietary pattern and rise in average income are expected to accelerate demand for horticultural commodities. Changing scenario in living style will demand more processed and half cooked products (Table 2).

Table 2. Projected demand of horticulture produce (million tonnes)

Commodity	Production		Projection	
	1997-98	1998-99	2001-02	2007-08
Fruits	43.26	44.04	55.10	75.00
Vegetables	72.70	87.53	108.00	160.00
Spices	2.76	2.87	4.10	5.00
Coconut	8.75	10.27	12.50	18.00
Cashew nut	0.36	0.46	1.00	1.50
Cocoa, others	1.5	1.65	3.00	6.00
Total	**129.33**	**146.82**	**183.70**	**265.50**

The past growth in horticultural production has been a direct result of two major policy initiatives of the Government of India, namely, promotion of diversification of Indian agriculture and introduction of far reaching economic reforms. However, the emerging worldwide trend, which is also reflected in our country, indicates a paradigm shift in dietary needs of people. This means that the demand for horticultural produce will continue to rise with rise in income. The overall demand projection worked out for various horticultural crops is to the tune of 268.22 million tonnes by 2007-08, which do not include flowers, medicinal and aromatic plants and honey (as data on these crops are not adequate), as per details given in Table-2.

THRUSTS AND STRATEGIES

Horticultural crops have already demonstrated their role in terms of their potential in increasing income per unit area, generating additional employment opportunities, providing sustainable income to small, marginal and tribal farmers, and earning sizeable foreign exchange through exports and savings

through import substitution. The Eighth and Ninth Plan programmes have greatly helped the development of horticultural crops, resulting in a considerable increase in production, productivity, as well as export. Still there are several crops and areas which need strengthening, so that horticulture sector could be more competitive to face the present situation of global trade.

The development strategy for sustaining the Golden Revoulation through horticulture would address all the issues starting from the production activities to marketing of the final product. Thrust during the Tenth Plan would be on the integrated development of horticulture in Mission Mode to ensure adequate, appropriate, timely and concurrent attention to all the links in production, post-harvest and consumption chain which should maximize ecological and social benefit from investment and promise economically sustainable intensified production, ecologically desirable diversification and employment.

The following thrusts and strategies are proposed to achieve the above goals during the Tenth Five Year Plan.

- Improving production.
- Improving productivity.
- Reducing cost of production.
- Improving quality of products for exports.
- Value-addition.
- Marketing and export.
- Price stabilization.
- Strengthening of organizational support.
- Human Resource Development.
- Addressing relevant policy issues.

IMPROVING PRODUCTION

The demand of horticultural commodities, has been increasing over the years. To achieve the targets set for Tenth Plan and beyond, it would be necessary to increase production which has to be largely achieved through increase in productivity of various horticultural crops. The strategies that would be required for achieving the same are as follows:

- Utilizing available arable land by changing crop priorities.
- Promoting use of wastelands for growing suitable horticulture crops.
- Since dryland region accounts for more than 60% of area, stratetegies without focussed attention to these areas may not yield desired results. Thus, there is a need for infrastructural development of horticulture in dryland area in a Mission Mode.
- Emphasizing horticultural crop production in states having potential for area expansion.
- Promotion of cost-effective polyhouses in the arid temperate regions of Lahaul and Spiti, and Leh and Ladakh.
- Promote the production of off-season vegetables using greenhouse.
- Take technological advances to smaller plantation where potential for improvement is the largest.

- Better utilization of area through inter cropping/mixed cropping in existing orchards, through identification of synergic crops, e.g. growing of a crop in vacant space and growing of shade loving crops in grown up orchards. Some examples of inter/mixed cropping are given below:

Mango, cashew, sapota, jack fruit etc.	Inter cropping with suitable crops of the region
Coconut, arecanut and oil palm gardens	Cocoa, banana, pineapple, bush pepper, flowers, medicinal and aromatic plants, black pepper, tree spices, ginger and turmeric can be planted in inter spaces, and mixed farming of growing grasses and rearing animals can also be practised.
Coffee, tea and rubber	Black pepper, medicinal plants, pineapple, ginger, turmeric and bush pepper can be inter cropped.

- Adopting a Mission Mode approach for integrated development of medicinal and aromatic plants.
- Eastern and North-Eastern India have potential for horticultural development, which has not been utilised. Thus, integrated development of horticulture in North-Eastern and Eastern India need to be taken up in a Mission Mode.
- Giving special thrust to increase the production of raw cashew in the country, which is presently inadequate to meet the requirements of the processing capacity installed in the country.
- Giving special thrust to develop horticulture in island ecosystems.
- Laying emphasis on nut crop development in the North-Western Himalayas.

IMPROVING PRODUCTIVITY

The average productivity of most horticultural crops in India is low. A wide gap thus exists between yields obtained and potential yields with improved varieties and technologies. Programmes, therefore, need to be taken up to reduce the yield gap by improving productivity. The following strategies are suggested for this purpose during Tenth Plan:

- Production of disease-free, quality planting material of only released and recommended varieties/hybrids both in the public and private sectors.
- Improving orchards efficiency by gap filling and rejuvenation of old, unproductive, senile plantations through substitution of old varieties with improved high-yielding varieties in crops like mango, apple, cashew, rubber, tea and coconut.
- High-density planting by reduction in planting distance or use of plant growth inhibitors and dwarfing rootstocks as recommended in crops like mango, citrus and apple.
- Use of protected cultivation under controlled conditions using Hi-tech horticulture for growing fruits like strawberries, vegetables like cucumber, cabbage, capsicum, tomato and temperate vegetables in plain areas and high value cut flowers for domestic use and export.
- Promoting cultivation of crops, which produce higher biomass/unit area/unit time, e.g., banana, pineapple, papaya, potato, sweet potato, tapioca and elephant-foot yam in areas requiring poverty-alleviation and nutritional security.
- Use of plant growth regulators and chemicals for improving productivity. For example, by using of paclobutrazol for regular flower production in mango and by GA_3 for improving fruit size, shape and quality of grape.
- Application of frontier technologies (Hi-tech horticulture) e.g. micro-irrigation, fertigation, integrated nutrient management, etc. for improving productivity of high-value crops.
- Use of honeybees for pollination thus increasing fruit set and productivity in most of the cross-pollinated horticultural crops.

A view of green house growing gerbera

REDUCING COST OF PRODUCTION

In view of the global competition as a result of implementation of WTO provisions, reduction in unit cost of production, particularly of horticultural commodities, which are exported, has become inevitable. Further, there is a danger of large-scale imports of horticultural commodities from abroad if our local production costs are not lower/comparable. Appropriate programmes are therefore, required to be taken up during Tenth Plan to reduce cost of production. Some thrust areas are recommended. They are:

- Reducing cost of planting material by mass multiplication of horticultural crops using micropropagation, wherever feasible, e.g., banana, cardamom, vanilla, ornamental and medicinal plants.
- Reduction in cost of fertilizer by applying only required quantities through determination of plant needs as per leaf nutrient analysis.
- Efficient utillization and conservation of water and applied nutrients through drip/ microirrigation and fertigation, weed control, moisture conservation and solarization techniques.
- Integrated nutrient management through cover cropping with leguminous crop in perennial plantations and incorporating it in the soil to improve fertility, thus supplementing the fertilizer needs;
- Promotion of integrated pest and disease management thus reducing costs of chemical pesticides and fungicides.
- Reduction in post-harvest losses by proper pre-and post-harvest handling, proper packaging and creating suitable infrastructure, e.g. low-cost cold storage for fruits and vegetables, storage for potato and onion, cold chain transport and other technologies.
- Enhancing the shelf-life of fruits and vegetables such as mango, grape and litchi through use of pre-cooling units, controlled/modified atmosphere/refrigerated containers, particularly for transport by sea and reducing transport losses.

IMPROVING QUALITY OF PRODUCTS FOR EXPORTS

In the post liberalization period, the main thrusts should be on improving quality of various horticultural crops, so as to make our produce competitive in the world market. At present, various products being produced in India do not conform to standards prescribed by major importing countries. The strategy recommended for improving quality of the produce is:

- Popularization of improved agro-technique as well as improved implements, e.g, mango harvester, seed/fertilizer drill etc.
- Due emphasis on cultivation of specific varieties for table, processing and export purpose should be given.
- Emphasis needs to be laid on harvesting horticultural produce at optimum maturity.
- Setting up of quality control laboratories to help exporters ensure that commodities being exported meet international quality standards.
- International quality standards for various commodities should be made known widely to ensure quality produce both for domestic and export markets.
- Although India's share in the export market of flowers is still insignificant, it has registered a sharp increase. The cut flower exports have shown a tremendous increase during 1991-92 to 1998-99 from Rs 40 lakhs to Rs 25.3 crores. This has come about with the establishment of a large number of export-oriented cut flower units around Bangalore, Pune, Delhi and Hyderabad during the last 5 years. Hence, quality parameters for various flowers need to be standardized and popularized.

VALUE - ADDITION

Value-added products like oleochemicals, oleoresins and essential oils have more of export market. Hence development of new value-added products in spices, coconut, cashew, tea and coffee will go a long way in export promotion. Newer technologies need to be developed. Similarly, newer processed fruits, vegetables, ready-to-serve food items need to be developed and popularized. Further, following aspects also need immediate attention:

- Processing capacity of exisiting units needs to be augmented.
- Existing facilities need to be modernized.
- Products diversification needs to be encouraged.
- The prescribed international and domestic SPA standards should be disseminated and adhered to.

MARKETING AND EXPORT

If Indian horticulture has to make a mark both in the domestic and export markets, due emphasis will be required to be given to some thrust areas. They are:

- Promoting introduction and commercial cultivation of varieties having established export value.
- Better understanding of the domestic and export trade, and to identify potential areas of marketing. All major towns/*mandis* dealing with marketing of horticultural commodities need to be linked through Market Information Service, preferably through the internet.
- Creation of infrastructure facilities like cold chain, e.g. pre-cooling units, grading and packing sheds, cold storage, refrigerated trucks and wagons, refrigerated containers, adequate cargo space both through sea and air at appropriate places like APMCs and ports of despatch.
- Establishment of plant clinics in the private sector for soil, water and tissue analysis; identification of pests, diseases and nutrient status and for suggesting control/remedial measures. Providing financial assistance for the same.
- Promotion of organic farming in selected export-oriented commodities. To achieve this, adoption of vermiculture, use of bio-fertilizers, use of mycorrhizae and farmyard manure/ compost/enriched compost need to be promoted. An agency for accelerating certification for organic farming for different crops needs to be established.
- Concept of alternate market, having backward and forward linkages which is being tested on pilot scale should be promoted vigorously.
- The potential for export and earning foreign exhange from medicinal and aromatic plants is estimated to be over US $ 3000 million per annum. Since, India is one of the richest sources of medicinal plants as well as traditional systems of medicines, it is necessary to make sustainable use and export of such plants or plant products in which India has the competitive advantage.

- The increase in value of exports of tea between 1991-92 and 1998-99 indicates a decline in export volume to the extent of 24.24 million kg and export earnings has only been marginal. The Indian share in global tea exports has got a set back when the share of 18.5% in 1990-91 declined to 14.3% in 1998-99. Efforts need to be focused to regain the lost position in case of tea.
- Prices of coconut and its products are greatly influenced by price of coconut oil. There is an urgent need for product diversification and value-addition so that there should be shift in the marketing of coconuts. Tender nut sales promotion is yet another area which needs popularization in an organized manner.
- While a wide variety of germplasm is available in most of the horticultural commodities, varieties most suited for exports have not been adequately identified in several crops. Similarly many well-known varieties having demand in the international market have not been introduced and tried. Arrangements have to be made to identify the items and importing the same into the country on priority basis either on exchange basis or outright purchase basis.

PRICE STABILIZATION

Horticultural crops suffer price fluctuations due to overproduction, underproduction, fluctuation in exports, lack of short-and long-term storage facilities and lack of market intelligence besides inadequate database. The following strategy is suggested.

- Collection of reliable database in horticultural crops.
- Developing a long-range export policy.
- Timely introduction of Market Intervention Scheme (MIS), Minimum Support Price (MSP) and Creation of Price Stabilization fund needs to be considered.

STRENGTHENING OF ORGANIZATIONAL SUPPORT

Eventhough a lot of initiatives have been taken to strengthen the organizational support for horticultural development, e.g. creation of National Horticulture Board, Coconut Development Board,, etc., there is scope to further supplementing organizational changes in case fullest potential of horticulture has to be exploited. The following specific recommendations are made:

- New Directorate of Fruits, Directorate of Vegetables with regional stations, Directorate of Medicinal Plants on the lines of Directorates of Arecanut and Spices, and Cashew and Cocoa, need to be created for monitoring the integrated development of these commodities.
- The post of Director in Directorates of Cashew & Cocoa and Arecanut & Spices and the post of Chief Coconut Development Officer in Coconut Developmnet Board need to be made equivalent to the post of Director existing at the headquarters of the Ministry of Agriculture.
- The Coconut Development Board needs to be reorganised as Palms Board to take care of development of all the palms namely coconut, arecanut, oil palm and palmyra palm.

- A Horticulture Planting Material Regulatory Authority needs to be constituted to ensure production and sale of healthy, disease free planting material of elite varieties by various public and private nurseries. Also to channelize import/export of all horticulture sector planting materials.
- The National Horticulture Board needs to be strengthened to enable it to play an important role in marketing of fruits, vegetables and flowers by creating suitable infrastructure.
- In many of States, Directorates of Horticulture have been created but they do not have adequate manpower and infrastructure to support the development of horticulture. In the absence of adequate manpower, neither programme implementation nor technical support could meet the pace of development. Therefore, strengthening of Department of Horticulture in the State, in terms of manpower and infrastructure is vital. Model of Department of Horticulture in Karnataka should be replicated with financial support to the State Government for an initial period of five years.
- Hi-tech horticulture, wherein plasticulture intervention has to play an increasing role i.e. fertigation, protected cultivation etc. Precision farming, which aims at efficient utilization of inputs and time have major components of plastics. National Committee on Plasticulture Applications in Horticulture has played a significant role in the promotion of plasticulture technology in the country. Therefore, this Committee may be replaced with a Board or Society with autonomy to provide institutional support for the development of high-tech horticulture.
- A National Committee for product and process standards should be formulated under the umbrella of Ministry of Agriculture. The role of this committee would be to formulate different subject-wise sub-committees namely Sub-Committee on Fresh Fruits and Vegetables, Sub-Committee on Processed Products and creation of mandatory standards and inspection bodies for strict adoption of standards.

HUMAN RESOURCE DEVELOPMENT

Emphasis on human resource development to ensure efficient transfer of technologies on some lines are suggested. They are:

- Development of strong database in horticultural crops.
- Organizing management training programmes for plantation managers at suitable horticultural and plantation crops institutes.
- Organizing study tours for small and marginal farmers.
- Organizing training programmes on modern aspects of horticulture crops production and post-harvest management.
- Setting up of large/compact block demonstrations adopting latest technologies on various horticulture crops.

- Conducting integrated training for horticultural producers for some identified fruits such as grape, mango, litchi and kinnow in selected regions where farmers will be provided training in integrated pre- and post-harvest management practices for better handling of the produce both for domestic and export markets.

ADDRESSING POLICY ISSUES

The following policy issues need to be considered for implementation during Tenth Plan period for fully exploiting potential of horticultural crops which are earning valuable foreign exchange and also providing livelihood security to the vast population of the country. They are:

- Create facilities for enhancing shelf-life of mango, grape and litchi through the use of controlled/modified atmosphere/refrigerated containers.

On farm training of farmers

- Horticultural produce should also be included under Hazard Analysis Critical Control Points (HACCP) Certification Programme.
- Spices exports have been consistently moving up during the last one-decade with an increase of 210% in quantity and 622% in value during this period. However, the export has shown a decrease of 10% in volume. During 1998-99, in the total spices export earnings, pepper contributed about 36.3%, followed by spice oils and oleoresins in terms of value. The value-added products in the export basket constitute 37% of the total. More emphasis should be laid on export of value-added spice products in which India has competitive advantage.

- The basic principles of WTO agreement are, non-discrimination, reciprocity, market access and fair competition. Since, India is signatory to WTO agreement, it has to fulfil certain agreements under WTO regime. Hence, there is need for creating awareness on the implications of WTO regime among horticultural entrepreneurs as well as small and marginal farmers.
- As per the agreement of agriculture, the gain or loss of a country as a result of liberatlization will largely depend on achieving the market accessibility through providing the green box subsidies, which can be allowed under the agreement. In the case of manufacturing products, there are serious problems relating to high cost, inefficiency in production, outdated technology, and problems related to delivery schedule and prodct specification. As a long-term measure, focused attention needs to be paid to efficient horticultural cropping zones not only to achieve cost efficiency in production but also to attain international quality standards prescribed by various importing countries.
- Sanitary and phyto-sanitary standards already available in India for fresh horticultural produce should be immediately harmonized with the international guidelines and if higher level of measures is required, the scientific justification for the same should be documented at the earliest.
- Japan, Australia and China have banned imports of mango and grape from India on account of presence of certain fruit flies. China has imposed a ban on grape import for a species of fruit fly that does not even exists in India. Australia desires to have complete details about pest management practices in India and the ban can only be lifted after signing of a MoU on mutual recognition of pest management practices. US rules governing import of fresch fruits and vegetables are very stringent. USDA gives clearance only after detailed tests involving inspection of the production areas. Efforts should be made to resolve such issues with mutual consultations.
- Various chemicals and their residue levels have been prescribed which differ from country to country within the EU with the result that there are no harmonized regulations in this regard and no intra-EU trade exists for horticultral commodities like gherkins. This is restricting free flow of trade in horticultural products. Such non-tariff barriers are required to be resolved.
- The EU has prescribed maximum levels of pesticide residues in honey and these are required to be tested before exports to the EU. This is practically difficult keeping the Indian conditions in mind where honey is required to be collected from different sources before being packed. One may not be surprised if India sees a ban on exports of honey to the EU sooner than later. Such issues need to be suitably resolved so that export requirements are met.
- In the context or removal of quantitative restrictions and WTO regime there are a number of factors, which govern the competitiveness in the global trade. They are lack of range

of varieties and pre-harvest practices to control post-harvest losses; loss of produce at the primary level; lack of adherence to maturity indices; lack of facilities for physical and chemical treatment after harvesting; lack of post-harvest infrastructure and logistics.

- Lack of data and awareness of such factors greatly hamper the process of withstanding global competition in terms of price and quality of horticultural produce. Efforts are, therefore, needed to document the data and create awareness on these issues.

Vermi compost making in coconut garden

- New opportunities like organic farming, import substitution, import information system and the products, which have edge in international market, need to be promoted for sustained advantage and profit.

- Indian standards in the agriculture sector have been framed by various organizations of the Government, most of which are under Ministry of Agriculture and Commerce. These organizations are responsible not only for production and product standards, but also for their inspection and quality control. Some of the major organizations involved are; Directorate of Marketing Inspection (Agmark); Directorate of Plant Protection, Quarantine and Storage; State Seed Certification Agencies (SCA). Food Products Order (FPO), Department of Food Processing Industries (DFPI); Bureau of Indian Standards (BIS) and Agricultural and Processed Food Export Development Authority (APEDA). The standards developed under these organizations for various products need to be harmonized to meet the standards of importing countries under one authority with wider participation.

- There is also multiplicity of standards in several horticultural products. There is, therefore, an urgent need not only to rationalize standards fixed by various organizations but also to harmonize this with ISO standards for different commodities. Standards for growing

and packaging requirements of international markets are also not available in a large number of commodities. The standards developed by Directorate of Marketing and Inspection are old and outdated. There is, therefore, an urgent need to harmonise the standards to promtoe domestic as well as international trade in agricultural/horticultural commodities.

- In the present scenario of globalization, it has become important to understand the implications of the IPR. As a result, many of the foreign nurseries do not encourage the supply of horticultural crop varieties to India since their rights are not fully protected. Thus, India does not have access to many useful materials due to non-protection of plant breeders' right. For accelerated growth of horticulture industry it is necessary to give emphasis to IPR in the context of WTO regime and competition.

- The strength of Indian horticulture needs to be capitalised to provide leadership for overall development of horticulture in the region with the involvement of other countries and organizations like FAO.

RECOMMENDED OUTLAY

The overall requirement of funds for the development of horticulture during Tenth Plan as identified by the Working Group on Horticulture is to the tune of Rs 1,22,869.00 million. However, based on the availability of funds, an outlay of Rs 2000.00 crores have been earmarked for the development of horticulture during the Tenth Plan, including an outlay of about Rs 2500.00 crores to be spent under macro management scheme on horticulture.

GENERAL ISSUES NEEDING FOCUS

- The Macro Management mode of implementation of developmental programmes, although provides flexibility to the state governments to prioritize their programmes, the sectors of national interest and development of crops having export potential tend to get diluted. Therefore, it would be necessary to adopt specific schemes in core areas and for crops like cashew, medicinal and aromatic plants, coconut and programmes like hi-tech horticulture and apiculture.

- High interest rates from the lending institutions make investments in the horticulture sector non-viable. Hence, it would be necessary to reduce the interest rates or develop mechanism to reduce cost on capital.

- The involvement of the private sector for meeting the demands of horticultural produce for the community and also ensuring quality produce would be crucial keeping in view the open market under WTO regime.

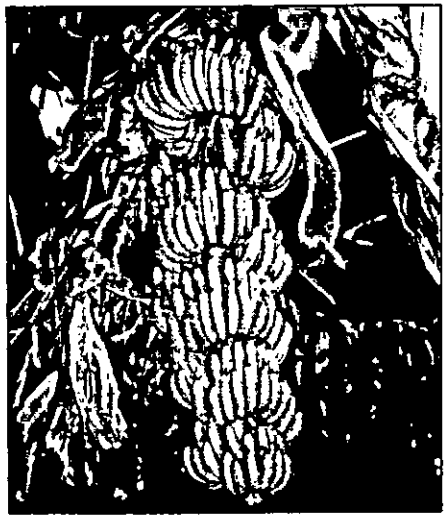
- The small farmers also will have to be reached in an effective manner to ensure the development of horticulture in all parts of the country.

- Review of enactment / enforcement of law on land ceiling and lease of land, tenancy Act, nursery Act, contract farming and release of wastelands, would be essential for the development of horticulture in general and cultivation of tree crops like fruits, cashew, cocoa, coconut etc. in particular.
- Under the WTO regime of free trade, it would be necessary to protect the interest of the farmers by keeping a vigil on the imports and by imposing appropriate tariffs.
- Horticultural activities should be considered as agricultural activity and the rates for electricity for greenhouses, tissue culture units etc. should be charged as being levied for agriculture.
- Credit support for horticultural development needs to be liberalized and loans need to be made available based upon the seasonal demand of the crop.
- The current ban on recruitment needs to be liberalized, particularly in the horticulture sector to cater to the needs of this fast emerging sector.
- Crop insurance scheme needs to be extended to all horticultural crops.
- Minimum support price programme needs to be introduced for selected horticultural crops.
- The programmes being implemented by other Departments, which have a bearing on the horticultural development need to be integrated.
- The programmes need to be devised in such a manner that the benefits reach the end user.
- A comprehensive crop insurance coverage should be given in the floriculture sector.

CROP-SPECIFIC ISSUES

Fruits

The average productivity of fruits has been of the order of 11.80 tonnes/ha during 1998-99. The productivity will have to be increased to the level of 15 tonnes/ha by the end of the Tenth Plan through measures like production and distribution of improved seeds and planting material, rejuvenation of senile orchards, judicious use of natural resources like land, water and light, integrated pest management, mechanization of farm operations, disease surveillance, plant health clinics etc. Assistance for these activities will have to be extended to the public as well as private sector.



Hi-tech production of banana using fertigation & invitro plants

Vegetables

Vegetables are rich sources of phytonutrients which have protective and disease preventing properties, like antioxidants, anticarcinogenic and cardiovascular protection. These include vitamins (A, B_6, C, E, etc.), carotenoids (beta carotene), glucosinolates, allylic sulfides, terpenes, phytosterols, phenols, isoflavones, flavanoids, thiols and indoles. Hence these need to be developed on commercial scale.

Jack fruit in fruiting

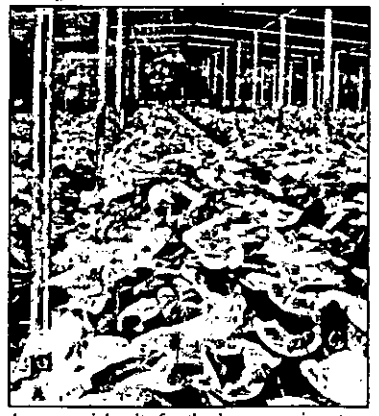
Floriculture

Proper research support in the areas of i) identification of native and novelty flowers and cut foliage plants from indigenous flora for commercialization, ii) post-harvest technology, iii) indigenization of greenhouse technology and iv) standardization of agro-techniques for exotic and domestic flowers. Product diversification/value-addition like extraction of pigments, essential oils, production of dry flowers, flower crafts etc. should be carried out.

Orchids in shade of net house

Calla lily under green house

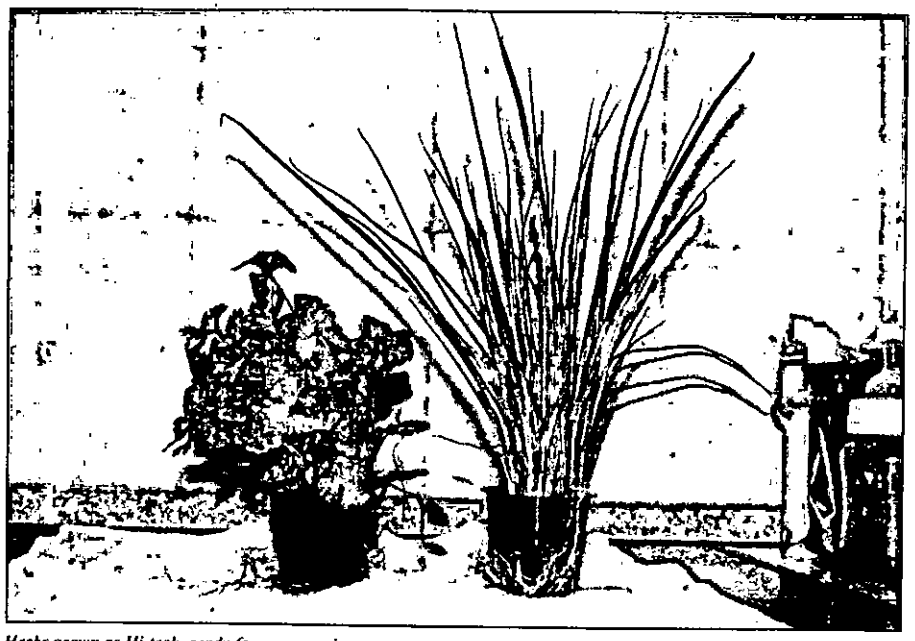
Hi-tech production of capsicum under green house



A commercial unit of anthurium grown in pots

Medicinal and Aromatic Plants

There is a vast potential for exploiting the wealth of medicinal and aromatic plants in India. Most of the demand from the medicinal and aromatic plants is met from natural ecosystems, thereby creating pressure on the natural resources base. There is an urgent need to launch developmental programmes in a mission-mode approach for overall development of this sector.



Herbs grown as Hi-tech, ready for consumption

Spices

Herbal spices need to be given additional support for meeting the domestic as well as export demands. Incidence of viral diseases in black pepper has been noticed in a rampant which need to be appropriately tackled to sustain the production, in which India has the competitive advantage. To be competive quality and competitive price have to be ensured.

Coconut

No other tree crop bestows so much benefit to the inhabitants of the coconut-growing states. Coconut is a significant source of dietary energy, cooking fuel, shelter and cash income. Intensified production system, product diversification and market promotion are to be taken up to tap the internal and export market of coconut products.

Ginger, a major source of income in NE State

Cashewnut and Cocoa

Steps will have to be taken to increase the production to bridge the gap of the local industrial demand of 1 million MT. The qualitative aspects of processing also will have to change with modern trends, consumer preference and the demand for branded packages. Cocoa need to be promoted as an intercrop in coconut and arecanut plantations.

Arecanut

Area expansion in arecanut has been discouraged on a priority basis and efforts should be focused on productivity improvement of the existing areas. In order to minimize the harmful effects of arecanut consumption in the form of pan masala, pan parag, gutkha etc. the industry involved in the manufacture of these items should be taxed substantially. They should also display statutory warning on their products as in case of cigarette and alcohol. The farmers should be made aware of the limited scope for the crop on a long run so that they can slowly shift to equally remunerative and socially beneficial perennial / annual crops on a competitive advantage basis in the context of trade liberalization and WTO regime.

PROGRAMME FOR TENTH PLAN

Based on the availability of financial resources in the Ministry of Agriculture the programme for development during the Tenth Plan would cover the following activities:

ONGOING PROGRAMMES

Technology Mission for Horticulture Development in North-Eastern and Eastern India

The Technology Mission for North-Eastern India including Sikkim was introduced during the Ninth Plan with effect from the year 2001-02. The mission-mode approach was conceived particularly

for the North-Eastern States of the country on account of the vast potential for horticultural development in the region and lack of infrastructure facilities. The analogy would apply to other states of the Eastern India including Bihar, Jharkhand, Orissa and West Bengal. The Technology Mission would comprise of 4 Mini Missions covering research, development, post-harvest management and marketing. The Mission would encompass the development of all horticultural crops, which have potential in the region. Existing programme under the Technology Mission in North-Eastern states is being continued with the outlay of Rs 600.00 crores.

Integrated Development of Coconut including technology mission

Coconut is the most important horticultural crop which provides all required amenities for human life, which include food, drink, beverage, medicine, fibre and a variety of raw materials for production of an array of products of commercial importance. It is a traditional plantation crop grown in India for centuries, and holds the longest history of cultivation in the country. Coconut is grown in 17 States and 3 Union Territories. Since a decade back its cultivation was confined to 10-12 States and

Coconut ready for harvest

3 Union Territories in India. The crop was considered as a coastal one and the concept has been shifted when the crop was introduced and expanded in non- coastal areas and the interior tracts of the country like Madhya Pradesh, Bihar and North-Eastern states. The programme for development of coconut was implemented during the Ninth Plan with an outlay of Rs 105.00 crores through the Coconut Development Board. In the Tenth Plan allocation for the Board is Rs 150.00 crores. The programme shall address availability of quality planting material, productivity enhancement, transfer of technology, product diversification, market research and market promotion.

Horticultural Development in Tribal/Hilly Areas

Tribal areas are "Scheduled Areas" defined in the Indian Constitution. The tribal/hilly areas in Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Gujarat, Maharashtra, Orissa, Bihar, Rajasthan, North-

Eastern States and North-Western Hill region offer vast potential for growing horticultural crops, such as, fruits, vegetables, tuber crops, spices, medicinal plants, floriculture, plantation crops, etc. However, in view of the fragile ecological balance, the strategy for development in these areas, has to be sustainable with development and environment becoming mutually supportive and reinforcing. In order to fully exploit country's limited land resources and favourable agroclimatic situations and also to promote balanced regional growth by providing growth opportunities in tribal and hilly areas, Government of India has launched a Central Sector Scheme on "Integrated Development of Horticulture in Tribal/ Hilly Areas" during IX Plan with an outlay of Rs 10.00 crores covering 6 districts. The programme would be continued during the Tenth Plan also to cover more of such areas. The outlay for the programme is Rs 50 crores.

Macro-management in Horticulture

All the programme of horticulture which have been run with Work Plan shall be continued. The innovative approach, provides flexibility for regionally differentiated programmes. Within the Macro-management in Agriculure an outlay of 30 per cent of allocation has to be spent on horticulture to give thrust on horticulture.

Commercial Horticulture and Post-harvest Management (Programmes of NHB)

Due to highly perishable nature of most of the horticultural produce, adequate infrastructure for pre-and post-harvest management of the produce is highly essential. Hitherto, this aspect has been tackled by the NHB. During Ninth Plan, NHB launched various programmes with an outlay of Rs 263.00 crores. The innovative scheme on modernization and establishment of cold storages launched by the NHB during Ninth Plan has been well received and need to be extended further. During Tenth Plan, investments for development of infrastructure would include construction/modernization of cold storage, establishment of collection centres, ripening chamber, evaporatively-cooled chamber, retail outlets, special transport vehicles, and primary processing equipment. The programme shall be continued with an allocation of Rs 650 crore during the 10th Plan.

NEW PROGRAMMES

High-Tech Horticulture and Precision Farming

The promising gains of horticulture will have to be sustained in the coming years to meet the aspirations of the growing population. This would be possible only through deployment of modern hi-tech applications and precision farming methods. Hi-tech horticulture is the deployment of modern technology, which is capital intensive, less environment dependent, having capacity to improve the productivity and quality of produce. Similarly, precision farming involves the application of technologies and principles to manage spatial and temporal variability associated with all aspects of horticulture production for improving crop performance and environment quality. This would call for efficient management of resources through location specific hi-tech interventions.

A step towards promoting precision farming was taken by re-designating the Plasticulture Development Centres (PDC) as Precision Farming Development Centres (PFDC) during the meeting of the National Committee on Plasticulture Applications in Horticulture (NCPAH) held under the Chairmanship of Union Agriculture Minister on 20th September, 2001. With a view to introduce the

concepts of hi-tech horticulture, a new scheme on High-Tech Horticulture & Precision Farming has been included during the Tenth Plan, with an outlay of Rs.350.00 crores. The scheme will promote all aspects of hi-tech horticulture covering technology dissemination as well as application in the farmers' field.

The interventions would include high-tech production of planting material, fertigation, chemigation, micro-irrigation, green food, seedless culture, etc. Besides, it would involve the use of Remote Sensing and Geographic Information System (GIS), technological refinement, dissemination and adoption. The list of interventions proposed under the Scheme is given in Table - 3.

Table-3: Interventions of Hi-tech Horticulture & Precision Farming during X Plan

Sl. No.	Item
A.	Hi-Tech Horticulture
1.	Technology Development & Refinement in Hi-Tech Horticulture
2.	Technology adoption in Hi-tech Horticulture
	i) Cultivation of micro propagated plants
	ii) Hi-tech nursery
	iii) High density planting
	iv) Fertigation
	v) Hi-tech green house
	vi) *In situ* moisture conservation through mulching
	vii) Hi-tech mechanization in horticulture
	viii) Green food production
	ix) Recycling of horticulture waste for environment quality improvement
	x) Biological control
3.	Technology Dissemination in Hi-tech Horticulture
B.	Precision Farming
1.	Technology development & refinement in PF
2.	Precision farming adoption
3.	Precision farming technology dissemination
	Training
	Seminars/workshops
C.	Support for Precision Farming Development Centres (PFDC)
D.	Support for National Council for Precision Farming
E.	Media Support & IT
F.	Emergent Requirement
G.	External Evaluation, Technical Support, Consultancy Cell at HQ

The hi-tech and precision farming interventions would require the support from a number of agencies / organisations such as National Remote Sensing Agency (NRSA), State Remote Sensing Centres (SRSC), State Agricultural Universities (SAU), ICAR Institutes, State Development Departments of Horticulture/Agriculture, National Informatics Centre (NIC), Precision Farming Development Centres (PFDC) etc. Monitoring and implementation of the Scheme would be through the National Committee on Plasticulture Applications in Horticulture (NCPAH), which is proposed to be renamed as National Council for Precision Farming (NCPF).

The states that would be participating in the programme would identify an agency to implement the programme. The Agency could be a Public Sector Undertaking or a State Implementing Agency (SIA) who would be in a position to operate the central assistance directly by opening a separate bank account. Besides, it is proposed to support Common Facility Providers, who would generate data needed for taking up precision farming in the farmers' field.

Sustainable Development of Horticulture through Technological Interventions

Sustainable development of horticulture would involve the interaction of a number of agencies and a number of components. The efforts initiated during the Ninth Plan through different Schemes and later through Macro Management Scheme has helped in creating infrastructure for developing quality planting material of horticultural crops; facilities for training of farmers, entrepreneurs, supervisors and gardeners; dissemination of technology, etc. During the X Plan, it is proposed to integrate the activities under the Central Sector Scheme on Sustainable Development of Horticulture Through Technological Interventions with an outlay of Rs.250.00 crores. The main objectives of the Scheme are:

- To facilitate capacity building for manpower development in horticulture
- To ensure delivery of technology to all those engaged in horticulture development through demonstration, training & awareness campaign and media support
- To facilitate research institutes and organisations other than state government departments to play a supportive role in terms of technology refinement, supply of nucleus material, etc. for horticulture development
- To fill gaps in existing programmes through institutional support
- To ensure quality assurance mechanism

The Scheme would also address new issues like development of horticulture in island ecosystems, promoting Indian horticulture in the international arena, setting up of price stabilisation fund and risk management in horticulture.

CONCLUSION

The horticulture sector has, over the years, emerged as a key sector in the overall development of agriculture in the country. The sector offers a variety of choices to the farmers in terms of short as well as long gestation crops having potential for increasing the returns per unit of land area. Focused attention to horticultural research and development which was given since the Eighth Plan had a positive impact among the farming community and has helped in increasing the production to bridge the gap between demand and supply of horticultural products to some extent. The increasing production has been to the tune of 55% till 1999-2000 as compared to 1991-92. The rapid development of horticulture has been described as ushering of a Golden Revolution. A number of factors covering from planting material to marketing have been hindering the growth of horticulture to harness the available potential. The estimated demand of horticultural products by the end of Tenth Plan is 265.5 million tonnes as compared to 149.93 million tonnes during 1999-2000. A number of strategies have been evolved to address the issues during the Tenth Plan through Plan investment and policy intervention to sustain the Golden Revolution. The outlay for horticulture during the Tenth Plan is estimated to be about Rs. 4500 crores. Ongoing programme on horticulture development such as Technology Mission for NE, Scheme on Tribal/Hilly Areas, Coconut Development Board's programmes including Technology Mission on Coconut and National Horticulture Board's programmes are planned to be implemented with vigour. The new intervention would include Hi-tech Horticulture and Precision Farming and Sustainable Development of Horticulture through Technological Interventions.

RESEARCH SUPPORT FOR MEETING CLIENT NEEDS IN EMERGING SCENARIO OF HORTICULTURAL DEVELOPMENT IN INDIA

G. Kalloo* and P. S. Bhatnagar**

Horticultural development in India continues to make a steady progress with a total annual horticultural production of 149.2 million tonnes during 1999-2000. Today, India is a leading producer of fruits (46 million tonnes) and vegetables (91 million tonnes). Our share in the world production is about 10 % in fruits and 14% in vegetables. The horticultural crops covering 9 % of the total area under cultivation, contribute 24.5% of gross agricultural output in the country. India produces about 44% of the world mangoes, 29% of bananas, 35% of cauliflower and 11% of onions. India stands first in production of mango, banana, sapota, litchi, cauliflower and peas in the world and is a leading producer of coconut, cashew nut and spices. The overall productivity of fruits is 12 tonnes/ha and of vegetables 15.2 tonnes/ha. The productivity has over the time gone up 3 times in banana and 2.5 times in potato. In the new millennium, technology adoption in both traditional horticultural enterprise as well as commercial horticulture sectors will need focused attention. The pattern of consumption of fresh and processed fruits and vegetables may also undergo a substantial change in the 21st century.

RESEARCH INFRASTRUCTURE

Horticultural research in India is about 4 decades old. The research agenda is designed relevant to national plans and priorities for the horticultural development. Under the aegis of the ICAR, 10 each central research institutes, and national research centers (NRCs), and 15 all India coordinated research projects are providing research support to horticultural needs in the country, besides 7 multi-disciplinary ICAR institutes, a full-fledged University of Horticulture and 25 State Agricultural Universities (SAUs) (Annexure 1). In addition, there are 5 network projects on hybrid research on vegetables, drip irrigation, protected cultivation, phytophthora disease and post-harvest loss assessment in fruits and vegetables. The ICAR is also participating in the international programmes such as SAVERNET, UTFANET, COGRANT, CIP and IPGRI. A large number of AP Cess fund supported schemes are in operation. The horticultural research system is geared to provide necessary technological support to the expanding horticulture industry.

TECHNOLOGY GENERATION

As a result of concerted research efforts on varietal development/ improvement, quality seed and planting material generation, agro-techniques and post-harvest management, a number of technologies have been generated for wider adoption as well as improving production and productivity of horticultural crops in the country. Salient technologies are:

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Improved Varieties and Hybrids of Horticulture Crops : Large number of cultivars and hybrids developed are given in table 1.

Table-list of cultivars and varieties develop

Crop	Varieties/Hybrids
Fruit Crops	
Mango	Mallika (coming up well in Karnataka), Amrapali (showing promise in eastern India), CISH M2, Arka Puneet, Arka Aruna, Arka Anmol, Arka Neelkiran, Ratna (canned slices), Sindhu (pulp making), Dashehari 51 (regular-bearing, high- yielding)
Banana	FHIA-01, FHIA-03, Co-1, H-1and H-2
Grape	Arkavati, Arka Kanchan, Arka Hans, Arka Shyam, Arka Neelmani, Tas-e-Ganesh, Sharad Seedless and Dilkush
Acid lime	Pramalni, Vikram and PKM-1
Guava	CISH-G-1, CISH-G-2, CISH-G-3, Arka Mridula and Arka Amulya
Papaya	H-39, CP-81, Co-1 to Co-7, Surya, Pusa Delicious and Pusa Nanha
Pomegranate	Hybrid Ruby, Ganesh, Jyoti (red arils) and Arakta
Pineapple	PKM-1
Ber	Gohah Kirti, Umran, Gola and Kaithalli
Aonla	Chakaiya, Krishna, Kanchan, NA-7 and NA-10
Bael	NB-5 and NB-9
Apple	Red Delicious, Royal Delicious, Oregon Spur, Red Spur and Red Fuji
Custard apple	Arka Sahan
Sapota	Kalipatti, Guthi, Cricket Ball, PKM and DHS
Kiwifruit	Abbnott, Allison, Brune, Hayward and Monty
Plum	Black champa, Sweet early and Burbank Elephant Heart
Peach	Shan-e-Punjab and Flordasun (low-chilling)
Pear	Clappers Favourite and Bertlette
Almond	California Paper Shell, Pranyaj, Nikitiskij and Primonskij
Vegetable Crops	
Tomato	Arka Abha, Arka Alok, Pant Bahar, LE-79 and BT-1 (resistant to bacterail wilt); Sel 120 (resistant to root-knot nematode); F_1 Hybrids – Pusa Hyb-1, Pusa Hyb-2, MTH-6, Arka Vardan, Pant Hybrid 1 and 2, Pusa Sheetal (cold set), Pusa Hybrid-1 (Hot set) and BRH-2
Brinjal	F_1 Hybrids : Arka Navneet, Pusa Ankur, Pusa Hyb-6, Pusa Hyb-5, Azad Hybrid, ARBH-201, NDBH-1, ABH-1, MHB-10 and MHB-39,KKM(KSM-107); Pusa Purple Long, BWR, Pusa Purple Cluster, Ritu Raj, SM-6-7 and Pant Samrat (resistant to bacterial wilt)
Capsicum	Arka Mohni, Arka Gaurav, Arka Basant, KT-F 1 hybrid and Arka Gaurav (tolerant to bacterial wilt)

Chili	Arka Lohit (bright red retentive pigment); Pusa Jwala (resistant to leaf curl, CMV and PVY disease), PLR-1, Jawahar Mirch 283 and Gujarat Chilli-2
Okra	Arka Anamika, Parbhani Kranti, Pb. Padminj, Sel-2 (YVMV resistant), Co3 (Hybrid-8) and Arka Abhey
Onion	Arka Niketan, Arka Kalyan, Pusa Madhvi, Pusa Ratnar, Pusa Red (red varieties); Pusa White Flat, Pusa White Round (white varieties); Arka Bindu (small red round bulbs – good for export); F_1 hybrid : Arka Pitamber, Arka Kirtiman (yellow skin – good for export); N-53 (suitable for *kharif* cultivation in north India); Arka Nihar and Kalyan (resistant to purple blotch)
Garlic	G-50, G-1 and G-41 and Yamuna Safed-3
Carrot	Pusa Yamdagni and Ooty-1
Cabbage	Pusa Mukta (Resistant to balck red disease); Pusa Synthetic, Kinner Red; F_1 hybrids: Shri Ganesh Gol and Nath 401
Cauliflower	Pusa Early Synthetic, Pusa Synthetic (early and mid season); F_1 hybrid : Pusa Hybrid –2 (mid season); Pusa Subhra, Pusa Snowball, K-1 (resistant to black rot)
Pea	Arkel (early pea variety); PM-2, PRS-4, FC-1, JP-83 (resistant to pow dery mildew); JP-4 (resistant to both powdery mildew and rust)
French bean	VL Boni, Arka Komal, Pant Anupama and Yarcaud-1
Cowpea	Pusa Komal (resistant to bacterial blight); Birsa Sweta (suitable for Bihar)
Dolichos	Deepaliwal, Co-8 and Co-9 (bush type), Kalyanpur T-2 and Rajni (pole type)
Watermelon	Arka Manik (suitable for Southern states, resistant to multiple diseases), Durgapur Meetha, Sugar Baby (Northern and Eastern States), Arka Jyoti F_1
Muskmelon	Hara Madhu, Punjab Sharbati, Arka Jeet, Gujarat Muskmelon 1 and 2, MHY-3, Arka Rajhans (resistant to powder mildew), Punjab Hybrid and Pusa Rasraj (hybrid)
Bottle gourd	Co-1, Kalyanpur Long Green, Punjab Long and Pant Shankar Lauki-1; F_1 Hybrids: Pusa Meghdoot and Pusa Manjari
Cucumber	Kalyanpur Green and Pusa Sanjog F_1
Pumpkin	Arka Chandan, Arka Suryāmukhi, CM-14, Pusa Viswas and Arka Chandan (high carotene content)
Potato and Tuber Crops	
Potato	Kufri Jyoti, Kufri, Badshah, Kufri Bahar, Kufri Sindhuri, Kufri Lalima; Kufri Chipsona-1 and Kufri Chipsona-2 (Processing varieties); Kufri Jyoti, Kufri Megha, Kufri Giriraj (Resistant to late Blight); Kufri Sherpa and Kufri Kanchan (Resistant to wart disease); Kufri Swarna (resistant to golden nematode and late blight); Kufri Pukhraj (early-maturing).

Cassava	Sree Jaya, Sree Vijaya, Sree Visakham, Shree Harsha and H165
Sweet potato	Gouri, Sankar, Sree Bhadra, Sree Ratna, H41, H42 and H268
Elephant-foot yam	AM-15
Plantation Crops	
Coconut	Pratap, Hybrids, CODXWCT, WCTXCOD and LOXCOD
Arecanut	Mangla, Sumangla, Sreemangla and Mohitnagar
Cashew	Goa-1
Spices	
Black pepper	Panniyur 1-5, Sreekara and Palode-2
Cardamom	Mudigere 1-2, PV-1and ICRI 1-3
Ginger	Suprabha, Surbhi and IISR Varada
Turmeric	Sungandham, Suvarna, Rasmi and Ranga
Cinnamon	IISR Navashree and IISR Nithyashree
Cashew	BPP 1-8, NRCC Sel.1, V 1-7 and VRI 1-3
Medicinal and Aromatic Plants	
Opium	Jawahar Aphim-1, Chetak Aphim and Trishna
Isabgol	Gujarat Isabgol1-2, Selection 10 and Haryana Isabgol
Asgandh	Jawahar Asgandh, WS-90-134, WS-90-100
Sarpagandha	PG-7 and RSI (R)
Senna	AFLT-2
Betelvine	Ghangatte
Ornamentals	
Rose	Sonia, Raktagandha, Dr G.S.Randhawa, Arjun and Mohini
Gladiolus	Shagun, Shringarika, Chirag, Mayur, Sagar, Dhiraj and Urmil
Chrysanthemum	Diana, Chandrika, Neelima, Red Gold and Rakhee
Bougainvillea Hibiscus	Dr. H.B.Singh, Jawaharlala Nehru, Usha, Purple Wonder and Vishakha Anuradha, Bharat Sundari, Geetanjai and Tribal Queen
Orchids	IIHR-154 and IIHR-38

PRODUCTION TECHNOLOGIES

Fruit Crops

- In mango, soft-wood grafting standardized for mass production of planting material.
- In mango, soil application of Paclobutrazol (cultar) @ 5 g/tree for regular flowering and fruiting commercially adopted in coastal Maharashtra.

- In mango, spraying of NAA @ 200 ppm in October recommended for the control of malformation.
- In banana, micropropagation through tissue culture has been standardized for commercial production. Large areas have been brought under tissue culture plants with good scope for productivity increase.
- In banana, drip irrigation technique standardized resulting improved water-use efficiency (60-70%), production gain and 40-50 days early harvesting.
- In banana, high-density planting (4,550 plants/ha) given yield up to 174 tonnes/ha. Adoption of improved technology helped Maharashtra in achieving fruit yield as high as 52 tonnes/ha.
- In grape, water-use efficiency increased by 11% through drip irrigation.
- In grape, use of gibberellic acid (20 ppm) recommended for quality improvement. Application of Dormexc for early budbreak successful.
- In grape, grape guard and pre-colling employed to extend storage life.
- In grape, micropropagation technology for large-scale production of salt tolerant grape rootstock 'Dogridge' and grape variety 'Arka Neelmani' developed.
- Rangpur lime rootstock ha been found supefior to sweet oranges and mandarins.
- In citrus, biological control of Phytophthora pathogen through Trichoderma isolates advanced.
- In guava, application of neem-coated urea (800 g/plant) gives substantial yield increase.
- In papaya, closer spacing of 1.4m ↔ 1.4 m recommended for high yield.
- In papaya, ring spot disease can be minimized by adjusting the time of planting and balanced nutrition.
- In pomegranate, high-density planting and drip irrigation system developed. Drip irrigation could save 35% of irrigation water as compared to basin irrigation.
- In ber, propagation techniques standardized for mass production of planting material.
- In ber, identification of suitable varieties made ber cultivation in south India commercially viable extending fruit availability season from November to March.
- In aonla, standardized vegetative propagation technique made large-scale multiplication of improved varieties possible thus enabling fast extension of area with HYV.
- In bael, propagation techniques standardized.
- In jackfruit, superior clones identified. Early fruiting (3-4 years) with vegetatively propagated plants of improved varieties possible.
- In jackfruit, propagation techniques standardized. Patch budding and softwood grafting are successful. Tissue culture protocols also developed.
- In apple, spray schedule for control of scab has been worked out and a disease warning system developed.
- In custard apple, propagation techniques standardized. Patch budding or veneer grafting in March successful.

- In sapota, softwood grafting standardized and commercially adopted in Maharashtra, Tamil Nadu and Karnataka.
- In kiwifruit, propagation technique standardized. Commercial kiwi production is viable.
- Low-chilling peach varieties suitable for subtropical climate identified.

Vegetables Crops

- Identification of onion N-53 and appropriate technology for *kharif* cultivation in northern India to get 2 crops of annually.
- Development of cauliflower 'Pusa Early Synthetic' for cultivation even in warmer south India.
- Multiple disease resistant 'Arka Manik' watermelon has saturated southern states.
- Radish and tomato can now be grown all the year round due to availability of suitable varieties.
- Potato hybrid Kufri Ashoka, maturing in 75 days, can fit well in rice-wheat cropping system in Indo-Gangetic plains.
- 'Seed Plot Technique' for production of disease-free potato seed in the plains has been standardized and widely adopted by farmers.
- In potato, micro-tuber production technology standardized. Potato-based cropping system developed and potato intercropping in sugarcane found remunerative in Maharashtra.
- High-yielding strains of button mushroom identified and production technology standardized.

Tuber Crops

- Development of cassava starch-based biodegradable plastics is one of the most significant achievements. The technology has been patented and its know-how has been transferred to commercial establishments in India.
- The technique for nursery planting of newly-released cassava varieties has been standardized for mass multiplication. The NPK application (75:50:100 kg/ha) is recommended for cassava CI 649 in rice-based cropping system.
- Intercropping of *Colocasia*-cowpea at Ranchi, *Colocasia*-radish at Navasari, and *Colocasia*-chilli at Faizabad are profitable crop combinations. For effective weed management in *Colocasia* and sweet potato, application of Isoproturan (1 kg/ha) is recommended on post-emergence of weed, followed by hand-weeding 30 and 45 days after planting.
- Biological control of sweet potato weevil is recommended by using *Rhaconotus menippus* (10 pairs/ m^2) and *Metarhizium enisopliae* (3 x $10^9/m^2$) 50 days after planting followed by re-ridging 65 days after planting.
- Treating cassava chips or impregnating their bags with Azadirachtin is effective in controlling insect infestation during storage. Infestation by *Lasioderma serricone*, an important pest of cassava products, can be reduced significantly by storing cassava chips at low temperature (<20°C) and relative humidity (<50°).

Plantation Crops

- In coconut, production of seedlings raised in polybags with a potting mixture of red earth + sand + cowdung in equal proportion expressed higher vigour and better recovery than conventional field nursery.
- Based on the field trials for management of eriophyid mite, spraying of triazophos, carbosulfan and endosulfan (0.05%) on affected bunches controls the infestation. Wettable sulfur (0.4%) and Azadirachtin (0.004%) are found at par with the chemical pesticides.

Oil Palm

- The treatment containing soil + farmyard manure + neem cake + rock phosphate + vermiculture gives maximum height, number of leaves and girth.
- A small unit (FFB capacity 200 kg/hr) for palm oil extraction has been developed. It is suitable for 10 ha oil palm plantation. A horizontal type sterilizer has been developed to sterilize FFB (capacity 200 kg/batch) at a steam pressure of 2.3 - 2.6 kg/cm^2 for 45-60 minutes. A mechanical bunch stripper has been developed to loosen fruits from 200 kg sterilized bunches in about 5 minutes.

Cashew

- High-density planting (500 trees/ha) gives a cumulative yield of 2,627 kg/ha from 7 harvests as compared to 721.5 kg/ha from recommended spacing (156 trees/ha). Application of NPK and poultry manure (500 g + 125 g + 125 g + 10 kg/tree) increases yield 2-6 times.
- A working model of raw cashew nut grader consisting of gravity separator and oscillating sieve separator has been fabricated. Database on processing aspects of cashew industries has been established. Cashew kernel flour compares well/better regarding water and oil absorption capacity, foaming capacity and foaming stability.

Spices

- Drenching of black pepper vines, affected by mealy bugs with Chlorpyriphos (0.1%) or Quinalphos (0.1%) is effective for management of mealy bugs. Integrated disease management schedules involving Phytophthora tolerant pepper lines, biocontrol and chemical control measures have been standardized for pure as well as mixed cropping systems. Potassium phosphate in combination with *Trichoderma is* quite effective to control foot rot.

POST-HARVEST MANAGEMENT OF FRUITS AND VEGETABLES

Pre-harvest Factors and Harvesting Techniques

- Post-harvest diseases like anthracnose and stem-end rot of mango could be controlled by spraying of Topsin-M (0.1%) or Bavistin (0.1%) thrice at 15 days interval before harvesting. The economics of Bavistin spraying has also been worked out and a net benefit after deducting spraying cost comes to Rs 4,350/ha.
- Three sprays of Benlate or Topsin-M or Bavistin 0.1% at 15- day interval before harvesting control post-harvest decay in Nagpur mandarins.
- Three pre-harvest sprays of Difolatan (0.2%) at 10-day interval before harvesting are effective to control post-harvest diseases of tomato and onion.

- Pre-harvest spraying of maleic hydrazide (2000 ppm) in combination with Difolatan (0.25%) 15-day before harvesting reduces storage loss of onion under Bangalore conditions.
- Pre-harvest spraying of GA applied at marketable stage of fruits delays ripening in both mango and guava, which retained better quality and increased vitamin-C. Gibberellic acid (10-15 ppm) application before harvesting at green stage in Nagpur mandarins delays colour break and on-tree storage by delaying maturity.
- Application of $CaCl_2$ (0.6%) 20 days and 10 days before harvesting is useful to check senescence, improving storage life, marketability and colour development in mango and guava.
- Harvesting of banana around 115-120 days after fruit set with less angularity and dull green colour results in good quality fruits with better shelf-life.
- The best appearance and marketability of guava are observed in fruits of specific gravity less than 1.00 followed by the fruits of specific gravity between 1.00 and 1.02.
- The optimum harvest maturity of mango (Alphonso and Pairi) is attained when fruits show a specific gravity of 1.00-1.20, while in Dashehari specific gravity is found to be less than 1.00.
- Tomato harvested at breaker stage had good quality, better shelf-life and proper development of colour.
- The irrigation should be discontinued 10-15 days before harvesting of onion for obtaining bulbs having maximum storage life.
- The mango fruits harvested with stalks impart better shelf-life with reduced decay and improved marketability.
- Tomato fruits harvested during evening under Bangalore condition have longest shelf-life, uniform ripening and better quality.
- Curing of onion in perforated plastic crates for 15 days is found to be most effective for better removal of moisture during curing and reduction of losses due to rotting in storage. In potato, when curing is done in perforated plastic crates for 15 days at room temperature, the rotting is minimum at the end of 75 days of storage.

Cold Storage of Fruits and Vegetables

- Precooling of mango to 12-15°C with 500 ppm Bavistin increases their shelf-life. In Alphonso, it also reduces the incidence of spongy tissue. Significant reduction in respiration rate, slow rate of ripening and good surface colour of fruits in mango is achieved by hydrocooling coupled with Bavistin.
- Post-harvest application of Bavistin (0.1%) and Topsin-M (0.1%) is most effective to control storage diseases in mango. However, hot-water treatment with Bavistin (0.1%) is more effective.
- Use of Topsin-M (0.1%), Imazalil (0.1%), Bavistin (0.1%) and Benlate (0.1%) is most effective in reducing storage losses of Nagpur mandarins.

Zero Energy Cool Chamber: An on-farm, low- cost, environment-friendly cool chamber has been developed using locally available materials. The double-walled chamber, constructed with bricks, sand and bamboo, is soaked with water and maintained in that condition. The principle of evaporative cooling reduces inside temperature by as much as 17-18 °C and keep its relative humidity above 90% during peak summer. The cool chamber is useful in extending the shelf-life of fruits and vegetables.

Technology Suitable for Processing at Farm Level

- **Raisin making** : Methods for raisin making in grape have been standardized. Raisins can be made from white seedless grape varieties like Arkavathi and Thompson Seedless by dipping prepared bunches in 0.3% boiling sodium hydroxide solution for 3 seconds followed by sulphuring with 3 g/kg of grapes and shade-drying. Storage temperature should be 3-5°C.
- **Bulk preservation of mango pulp:** Methods for bulk preservation of mango pulp without microbial spoilage using a combination of potassium metabisulphite (250 ppm) and heat (85-90°) have been developed. Food grade high-density polyethylene (HDPE) containers are felts substitute than glass carbuoy for storing pulp. Alphonso, Langra, Totapuri, Arka Puneet, Arka Anmol and Hybrid 51 are good for canned mango juice..
- **Tomato processing:** Tomato cultivars Arka Ashish and Arka Ahuti are suitable for processing into products like juice, ketchup and puree. Crushed whole tomato for culinary purpose can be preserved by concentrating to one-third of its volume and adding potassium metabisulphite (400 ppm), sodium benzoate (200 ppm) and glacial acetic acid (5 ml/kg of product). White HDPE containers and wide-mouthed glass bottles are suitable for packaging.
- **Vinegar making:** It can be taken up in rural areas with advantage. Various carbohydrate sources and fruit culls, which at present are not fully utilized, can be converted into vinegar. Raw material like cane juice, jaggery, mango, apple, grape, pineapple, cashew apple, mahua flowers, jamun and other fruit wastes can be used.
- **Raw mango slice for pickling:** Raw mango slices are generally preserved in bulk by dry salting method for subsequent use in pickling. A method for preservation of raw mango slices in brine has been developed which minimizes loss of colour, texture of slices for more than 6 months.
- **Utilization of indigenous fruits and vegetables:** Many indigenous fruits such as phalsa, jamun, bael, aonla, ber, pomergrnate, karonda, kokum etc. are utilized for preparation of value -added products. RTS beverages, preserve, pickles, chutneys, carbonated drinks etc.
- **Carbonated beverages from fruit juices:** Process for preparation of carbonated beverages from many fruit juices such as lime, grape, guava, ber, phalsa and jamum have been standardized.
- **Biogas from fruit and vegetable waste:** As enough of cowdung is not available for biogas production, fruit and vegetable waste can be utilized to replace 25-50% of cowdung in the digestion for optimum gas production. For acidic fruit waste, acidity has to be neutralized for optimum gas production.

Development of Machinery

- **Mango harvester:** It harvests fruits with pedicels of 1-2 cm in length. This stops sap bleeding and reduces latent infection and increases shelf-life of fruits by 2-4 days. Its harvesting capacity is 51-177 kg/hr and cost of harvesting comes to Rs 40-130/tonne for different cultivars, compared to manual harvesting capacity of 27-138 kg/hr and cost of harvesting of Rs 77-245/ tonne. The fruits are held in the frame of the harvester.They are harvested with the required length of pedicel by shearing action of the harvesting blade. The cost of harvester is Rs 50/ unit.
- **Raw mango peeler:** A continuous type raw mango peeler has been developed for pickle, chutney and amchoor (dry-mango powder) making industries. The peeler consists of a concave revolving at 250 rpm, guide revolving at 2 rpm, inlet and outlet for mangoes along with necessary casing, speed reductions and 2 hp electric motor. The concave has semi-elliptical

cavity along its periphery with a width of 7.0 cm and depth of 8.5 cm. The concave is provided with sharp projects of 2 mm around its internal surface. The mangoes are enclosed in cavity formed by concave and guide and get peeled by the rotation of concave. The rotation of guide maintains the continuous feeding and output from the peeler. Peeler has a capacity of 200 kg/hr with 90 cm diameter concave. The size and number of concaves can be increased to increase the capacity. The size of the cavity can vary to peel different sizes of mangoes. The peeler can be integrated with grader. Its capacity becomes 1 tonne/hr with 3 concaves of 180 cm diameter.

- **Mango stone decorticator:** Manually, hard cover of 10-15 kg stones only can be processed by hand. A mango stone decorticator has been developed which can decorticate two quintals of dry material in an hour. The kernels can be utilized for extraction of fat, starch or animal feed.
- **Aril separating machine:** A useful machine has been developed for preparation of Anardana from wild pomegranates.
- **Cassava chipping machine:** It has been developed for the preparation of chips from cassava.
- **Indian gooseberry pricker:** Hand, pedal and electrically operated pricking machines for Indian gooseberry have been developed for preserved preparation. It can be used for pricking karonda and apple also.

EMERGING ISSUES AND STRATEGIES

Horticulture will continue to form an integral part of food and nutritional security in the country. On research front, a good progress has been made in generating relevant technologies for enhancing productivity and production of different horticultural crops. However, there are a number of unresolved problems and new challenges arisen due to globalization of agriculture. For genetic resource management and safeguarding under IPR registration of varieties and finalization of material transfer arrangements need to be institutionalized. There is a strong need for shift from commodity/discipline- oriented research to system-based research. In production system research major thrust should be for integrated water management, integrated nutrient management and integrated pest and disease management. Large tracts of low and unproductive orchards/plantations need replacement with improved genetic stocks. Old plantations need rejuvenation. Inadequate supply of quality planting material at reasonable rate is a major constraint. Improving the availability of hybrid seeds and healthy planting materials of improved varieties, supported by a network of regional nurseries/seed farms equipped with distribution outfits will go a long way for scientific horticulture. Export promotional research covering quality enhancement programmes, development of bulk handling and sea transport protocols for various fruits and vegetables and disinfestation technology for export commodities is important. Similarly, specification of quality standards for export of indigenous fruits and vegetables need to be developed. The private sector investment in terms of contract research, collaborative research, consultancy and other forms may be needed. The public funded research system may have to continue to provide quality research input to large unorganized small land holding sector to improve productivity of horticultural crops and quality of horticultural commodities in the years to come.

On the development front, tempo generated in the recent past has enabled the farmers and entrepreneurs in adopting modern hi-tech programmes, thereby resulting in improvement of horticultural production and availability of horticultural produce to the consumer. In the new Millennium, this tempo is required not only to be maintained for better nutritional security of our masses but for achieving a respectable place in the global trade markets. Focussed efforts will be needed for creating infrastructural facilities for enhancing shelf-life/quality standards of perishable produce and minimizing post-harvest losses, and disease forecasting besides ensuring availability of quality planting materials.

Annexure I. Horticultural Research Institutions in India

Institutes Under Horticulture Division of ICAR

- Indian Institute of Horticultural Research (IIHR), Bangalore
- Central Institute of Subtropical Horticulture (CISH), Lucknow
- Central Institute for Arid Horticulture (CIAH), Bikaner
- Central Institute of Temperate Horticulture (CITH), Srinagar
- Central Potato Research Institute (CPRI), Shimla
- Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram
- Central Plantation Crops Research Institute (CPCRI), Kasaragod
- Indian Institute of Spice Research (IISR), Calicut
- Indian Institute of Vegetable Research (IIVR), Varanasi
- Central Agricultural Research Institute, Port Blair
- National Research Centre for Citrus, Nagpur
- National Research Centre for Banana, Tiruchirapalli
- National Research Centre for Grapes, Pune
- National Research Centre for Onion and Garlic, Rajgurunagar
- National Research Centre for Mushroom, Solan
- National Research Centre for Orchids, Gangtok
- National Research Centre for Oil Palm, Eluru
- National Research Centre for Cashew, Puttur
- National Research Centre for Medicinal and Aromatic Plants, Anand
- National Research Centre for Seed Spices, Ajmer

Institutes Under other Divisions of ICAR

- Indian Agricultural Research Institute, New Delhi
- ICAR Complex for NEH Region, Barapani
- Central Arid Zone Research Institute, Jodhpur
- Central Soil Water Conservation Research and Training Institute, Dehradun
- ICAR Research Complex for Goa, Ela, Old Goa
- Central Research Institute for Dryland Agriculture, Hyderabad
- Central Institute for Post Harvest Engineering and Technology, Ludhiana
- Central Institute for Agricultural Engineering, Bhopal.

Agricultural Universities

- Dr YS Parmar University of Horticulture and Forestry, Solan.
- State Agricultural Universities with separate Horticulture Department/Division (25).

POLICY REFORMS FOR DEVELOPMENT OF COMMERCIAL HORTICULTURE

J.P. Negi*

Horticulture includes propagation and scientific handling of fruits, vegetables, flowers, tuber crops, mushroom, honey, spices, medicinal and aromatic plants, nuts etc. It has established its credibility in improving land use, promoting crop diversification, generating employment and above all providing nutritional security to the people besides supplementing to their income. Apart from these, the horticultural crops help in maintaining ecological balance and produce increased biomass per unit of area. In all the advanced countries, horticulture sector has established itself and is treated as an industry. But in India, it has yet to find its rightful place.

At present, the area under total operational holdings in agriculture in India is 1.655 lakh ha and total cultivable wasteland is 138 lakh ha. The production of horticultural crops is about 149 million tonnes out of which share of fruits and vegetables is 137 million tonnes. Small and marginal farmers constitute more than 80 per cent. Despite being the second largest producer of fruits and vegetables in the world, the per capita consumption of fruits and vegetables of our over one billion population is very low. About 21% of the total population and 53% of children are undernourished.

The value of horticulture export is Rs 6,485.70 crores which is very low, i.e. meagerly 1% in the world trade. In total exports, the maximum share is of tea, coffee and spices. The import value of horticultural produces is Rs 1,450.10 crores of which maximum share is of nuts and processed fruits and vegetables (APEDA, 1999-2000).

INDIAN HORTICULTURE

Strength

- Wide product base, high volume of production
- Tropical, subtropical and temperate produce round the year
- Strategic geographical location
- High domestic demand
- Abundant sunlight
- Easy availability of labour at comparatively low cost

Weakness

- >80% small farmers with fragmented holdings (average 1.6 ha)
- Multiple products in small quantities with heavy wastages
- Farmers' organizations either non-existent or disorganized, as against unionized traders
- Exploitation by commission agents

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- Farm-gate price only 25% of retail price compared to 70% in advanced countries
- Glut situation with distress sale, followed by scarcities and vacuum in the market
- Poor per hectare yields and limited varietal rootstocks compared to international standards
- Lack of convergence horticulture with various developmental agencies/schemes
- Archaic Laws (Excise, Forest, Narcotic Drugs and Psychotropic Substances Act and APMC Acts)
  - Regulatory in nature
  - Not conducive to boost horticulture industry

Marketing Bottlenecks

In India too many intermediary channels increase the cost of handling of horticultural products manifold, whereas producer's share is negligible compared to advanced countries.

- **Sale of produce**: About 75% of the farmers sell their produce at the farm level to village merchants, retailers, big producers or pre-harvest contractors. They cannot afford to transport their produce to distant "mandies" on account of non-availability of transport facilities, expensive transportation cost, malpractices in the market such as heavy deductions, free sample of the produce etc.
- **Market distortions** : There are market distortions. Some of thems are: high and unjust market charges levied on producer-sellers, delayed payments, pooling by traders and lack of open bid system. Malpractices are rampant and the national market operates in a highly segmented manner.
- **Bargaining power** : Small growers are un-orgainzed and lack group action and bargaining power. As a result the traders exploit these farmers.
- **Banking facilities** : Bank branches may be located in the market area but their mode of operation is similar to other banks and they are not giving any preference to such farmers. In addition, there is no organized concessional credit available to these farmers.
- **Market intelligence** Information regarding demand, supply, price, market outlook, knowledge of consumers' preference, marketing channels and practices are important for marketing of produce, which is not available at the moment. At present, farmers lack knowledge and equipment for grading and packaging of fruits and vegetables.
- **Exploitation by commission agents/traders** The small and marginal farmers are not attended to properly by the commission agents. They have to wait for a long period for auction of their produce.

INDIAN HORTICULTURE—OPPORTUNITIES

Value-addition and product formulation

- There is a need to create value-addition and product formulation for table consumption, liquids, beverages (alcoholic and non-alcoholic).
- Health drinks, pulp and other semi-liquids, culinary products, pharmaceuticals, oleoresins, cosmetics, perfumery and confectioneries, and recycling of horticultural wastes.

In India, entire emphasis has been for popularizing the varieties meant for table consumption.

whereas in advanced countries, more than 70% of produce is processed compared to 1% in India. Therefore, there is an urgent need to introduce processable varieties to give boost to processing industry.

The above mentioned horticulture scenario broadly highlights some issues. They are:

- mismatch of demand and supply position,
- inadequate raw material resourcing to the industry,
- lack of value-addition to the horticultural produce,
- heavy wastages, and
- need for introduction of maximum number of varietal rootstocks, seeds and planting material from world over which are adaptable to our conditions.

To address these issues, some of the laws require a fresh look which will help in creating conducive environment for the healthy growth of horticulture sector in the country.

Cold Storage Scheme

The scheme of National Horticulture Board for construction/expansion/ modernization of cold storages and storages is being implemented successfully because of the abolition of Cold Storage Rent Control Order by various states. So far, 351 projects have been established creating a capacity of 17 lakh tonnes with private investment of Rs 472 crores. The NHB has also released back-ended capital investment subsidy to the tune of Rs 103 crores

ISSUES ON LAWS AND ACTS

Punjab Excise Act 1914 – Section 4 (2) Foreign liquor means:

- All liquor imported by sea into India on which customs duty is leviable. All liquor manufactured in India (other than rectified spirit, denatured) spirit, and perfumed spirit, on which duty at a rate higher than that levied on Country liquor is leviable
- All beer (including ale, porter and stout) manufactured in India or abroad and
- All sacramental wine prepared from pure dried grapes by a process of fermentation only without the addition of alcohol or any other ingredient.

Indian Excise laws place wines, beer, and IMFL at par. These laws are also probing injurious to public health. Therefore, there is a need to amend these Excise Laws and delink Wines and Beer from IMFL and declare such products as light alcoholic beverages not injurious to public health (as in all the advanced countries). Even the Ayurvedic formulations allow use of alcohol up to 11%.

Indian Forest Act 1927– Chapter-I, Clause 2(4):

"forest produce" include :

- The following whether found in, or brought from, a forest or not, that is to say bark, lac, mahua flowers, mahua seeds, [kuth] and myrabolams
- The following when found in, or brought from a forest that is to say trees and leaves, flowers and fruits and all other parts or prodce not hereinbefore mentioned, of trees .....plants not being trees (including grass, creepers, reeds and moss), and all parts or produce of such plants: ..... silk, cocoons, honey and wax
- "tree" includes palms, bamboos, skumps, brush-wood and canes

Clause 26 of the Act says, any person who makes any fresh clearing prohibited by section 5 or ..... (g) subject to any manufacturing process or removes any forest produce..... shall be punishable with imprisonment for a term which may extend to 6 months or with fine. *Red Data Book*

Ministry of Forest and Environment have identified 9,500 species of herbal, medicinal and aromatic plants growing in forests. Unfortunately, thousands of such species are at the verge of extinction which have been included in the 5 volumes of Red Data Book and thus placed under the banned list for commercial use. These species have also been placed under the Negative List of Exports. For example, *Taxus baccata* – a wonder plant for the treatment of cancer is included in such a category.

These species have been declared as endangered and threatened due to excessive exploitation by the petty forest contractors. Some of the State Governments have even decided to empower Village Panchayats to exploit the minor forest produce.

The responsibility of Ministry of Forest and Environment is to conserve the forest wealth and commercial propagation of such a forest wealth should be left with the horticulture sector. And, therefore, there is a need to exclude horticultural produce from the purview of "forest produce" and allow scientific propagation of such produce on private lands/wastelands through horticulture sector.

Narcotic Drugs & Psychotropic Substances Act

The Act restricts substances for ayurvedic and other drug formulations, e.g. Cannabis is proving to be a "wonder drug" after successful trials by the British Government and Government will bow to public pressure and legalise the cultiation of cannabis for medical purposes by 2002 (*Hindustan Times*, 11.9.2001 and *Tribune*, 7.11.2001).

APMC Acts

In the APMC Acts also, there are restrictive legal provisions such as "all agricultural produce brought into or processed in market area shall pass through the principal market yard or sub market yard and shall not be bought or sold at any other place within the market area". The AMA is separately looking into such issues.

Land Ceiling Acts

Encourage higher acreage for "plantation crops" only. Fruits, medicinal and aromatic plants and all horticultural crops should also be permissible with higher land ceilings. Therefore amendments are also required to be carried out in the said Acts. The total cultivable wasteland of 138 lakh ha should be allowed to be converted under horticultural crops with higher land ceilings.

Plantation Crops

The focus on plantation crops has been given boost to commodities like tea, coffee, spices, rubber, cashewnut etc. through their respective Commodity Boards. There is a need to have a balanced growth of every horticultural commodity with the assistance from National Horticulture Board.

Contract Farming

There is a need to amend the existing labour laws to encourage contract farming.

Constitutional and other provisions with respect to the amendments

The 7th Schedule to Constitution and provisions of the Indian Forest Act mentions as under :-

Union List, Clause 84 - Duties of excise of tobacco and other goods manufactured or produced in India except:

a) alcoholic liquors for human consumption

b) opium, Indian hemp and other narcotic drugs and narcotics, but including medicinal and toilet preparations containing alcohol or any substance.

State List, Clause 8 – Intoxicating liquors, that is to say, production, manufacture, possession, transport, purchase and sale of intoxicating liquors.

State List, Clause 51 – Duties of excise on the following goods manufactured or produced in the State and countervailing duties at the same or lower rates on similar goods manufactured or produced elsewhere in India:-

a) alcoholic liquors for human consumption.

b) opium, Indian hemp and other narcotic drugs and narcotics, but including medicinal and toilet preparations containing alcohol or any substance.

Concurrent List, Clause 19 – Drugs and poisons, subject to the provisions of entry 59 of List I with respect to opium.

Indian Forest Act 1927

State/Central Government

Labour laws

Union List, Clause 55 - Regulation of labour and safety in mines and oil fields

Concurrent List, Clause 24 – Welfare of labour including conditions of work, provident funds, employers' liability, workmen's compensation, invalidity and old age pensions and maternity benefits

Land Ceiling Laws

State List, Clause 18 – Land, that is to say, right in or over land, land tenures including the relation of landlord and tenant, and the collection of rents, transfer and alienation of agricultural land; land improvement and agricultural loans; colonization

The above mentioned provisions make it amply clear that the onus of initiating the proposed amendments primarily rests with the State Governments.

OBJECTIVES OF NHB

The objectives of NHB have been made more broad-based to encourage the healthy growth of commercial horticulture which aims at to:

- develop high-quality horticultural farms in identified belts and make such areas vibrant with horticultural activity which in turn will act as hubs for developing commercial horticulture.
- develop post-harvest management and cold chain infrastructure.

- strengthen Market Information System and horticultural database.
- assist R&D programmes to develop products suited for specific varieties with improved methods and horticultural technology.

SCHEME OF NHB

The NHB, Gurgaon, has launched a set of innovative and entrepreneur-driven schemes during 2000 for boosting horticulture sector in the country. These schemes are aimed at achieving the desired objectives. Therefore, the schemes cover every segment of this industry. The main emphasis has been given to the commercial horticulture and cold chain management for horticultural produce. The salient features of the scheme are as under :-

Back-ended capital investment subsidy schemes:

Development of Commercial Horticulture through Production and Post-Harvest Management

Scheme/ project	Components	Pattern of assistance
Production related	• High quality commercial horticultural crops • Indigenous crops/produce, herbs • Aromatic and medicinal plants • Seed and nursery • Biotechnology, tissue culture • Bio-pesticides • Organic foods • Primary processing of products • Establishing hort. health clinics/ laboratory(for agri/horti unemployed graduates) • Consultancy services • Beekeeping.	• Back-ended capital subsidy not exceeding 20% of the project cost with a maximum limit of Rs 25 lakhs per project. For the North-Eastern/ Tribal/Hilly Areas, maximum limit of subsidy would be Rs 30.00 lakhs per project • The subsidy to be released to the leading participating financial institution on the completion of project as in the case of cold storage projects approved by the Government. • For projects in the cooperative sector funded by NCDC, the subsidy would be through NCDC.
PHM/ processing related	• Grading/ washing/sorting/ drying/ packing centres • Pre-cooling unit/cool stores • Refrigerated van/containers • Special transport vehicle • Retail outlets • Auction platform • Ripening curing chamber • Marketyard/rope ways • Processing unit/ radiation unit/ VHT unit • Horticultural ancilliary industry, e.g. tools, equipment, plastics, packaging etc. • Crates, cartons, aseptic packaging and nets (50% subsidy)	

Capital-investment subsidy for construction/expansion/ modernization of cold storage/ storages for horticultural produce: ***Components and Pattern of Assistance***

- Projects up to a capacity of 5,000 tonnes with an average cost of Rs 2 crore (Rs 4,000/tonne) would be promoted for wider dispersal, which includes expansion of existing capacity (including CA/M.A. stores/pre-cooling units).
- In case of modernization and rehabilitation, subsidy @ 25% of the capital cost will be determined @ Rs 1,000/tonne capacity created.
- For other storages, subsidy @ 25% of the capital cost is to be determined @ Rs 2,000/tonne capacity to be created.
- 25% promoter's contribution.
- 50% term loan by banks at PLR+1% through NABARD refinance. Banks not availing refinance may also finance such projects with the overall operational guidelines of Govt. of India.
- 25% back-ended capital investment subsidy by NHB not exceeding Rs 50 lakh per project, for North-Eastern States, maximum subsidy admissible would be @ 33.1 % up to Rs 60 lakhs.
- The subsidy would flow from NHB and operated by NABARD, through commercial/ cooperative banks, and by NCDC where cooperatives seek loan from NCDC.
- Wherever term loans are not raised from institutional sources and the promoters fund projects entirely through internal resource generation, NHB would provide subsidy directly.

The emphasis shall be laid on the following points:

- Reducing PHM losses with multi-chamber and multi-product facilities.
- Modern Design/Technology and Energy Saving Equipments/ Devices to be adopted to avoid obsolescence of machinery, etc.
- Improvement in technology like shifting from Diffuser system to Gravity Cooling System/ Fincoil System, etc.
- This scheme will be implemented only in those States/UTs/areas which do not control rentals for cold storages.
- The respective Banks/FIs/NCDC/NABARD, etc. will adhere to their own appraisal norms.

Benefits

- Impetus to the farmers to grow more
- Shelf -life of the produce will increase
- Losses shall be reduced
- Consumer shall be able to relish the produce in a "Farm-Fresh" state.

Promotional Schemes

Technology Development and Transfer	
• Introduction of new technologies	• 100% financial assistance up to Rs 10 lakhs/project for production related and up to Rs 25 lakhs to R&D efforts
• Visit of progressive farmers	• Second class sleeper rail/ ordinary bus fare and Rs 100/day/farmer for a group of 30 farmers
• Experts' Services from India/abroad	• Actual basis
• Technology awareness	• Up to Rs 50,000/seminar
• Organizing/participation in seminars, etc.	• Up to Rs 3.00 lakhs for state, Rs 5.00 lakhs for national event and Rs 10 lakhs for international event
• Udyan Pandit	• Rs 1.50 lakhs
• Publicity	• On merit
• Observation-cum-study tours abroad	• On actual basis
• Honorarium to scientists for effective transfer of technology.	• Up to Rs 20,000 for each expert, up to 5 experts/ project
Market Information Service for Horticultural Crop	
• Generate information on wholesale prices, arrivals and trends in various markets for horticultural produce and dissemination of information through media and publications.	• To assist farmers, exporters, dealers, research organisations, etc.
Establishment of Nutritional Gardens in Rural Areas	
• Distribution of fruit plants and vegetable seeds in minikits	• Rs 250/minikit/family
• Zero energy cool chambers	• Rs2,500/zero energy cool chamber per school/ village in a panchayat selected for the demonstration
• Demonstration	• Up to Rs 5,000 per school/ panchayat selected for demonstration.

Horticultural Promotion Service • Techno-economic feasibility studies to review the present status of horticultural development in particular area/ state • Identify constraints and suggest remedial measures • Develop short-term and long-term strategies • Provide consultancy services	• Studies through professional consultants • 100% financial assistance

ELIGIBLE ORGANIZATIONS

The eligible promoters under the above schemes shall include NGOs, Association of Growers, individuals, Partnership/Proprietary Firms, Companies, Corporations, Cooperatives, Agricultural Produce Marketing Committees, Marketing Boards/Committees, Municipal Corporations/Committees, Agro-Industries Corporations, SAUs and other R&D organizations concerned. However individuals, SAUs and other R&D organizations concerned are not eligible for the cold storage capital subsidy scheme.

PERSPECTIVES FOR HORTICULTURAL DEVELOPMENT IN INDIA

Gopi N. Ghosh*

Agriculture sector is very important to India in ensuring food security and poverty alleviation. It provides employment to 70% of the people and contributes 30% of GDP. About 142 million ha of land is under cultivation with a cropping intensity of nearly 130%. Foodgrain production in India quadrupled to 200 million tonnes since Independence. Similar growth in oilseeds, livestock and fishery products has been achieved. After passing through the traditional phase of low-input, low-technology mode of production in the early years of Independence, India moved on to the "green revolution" phase 3 decades ago. The country is now in the third phase of agricultural development where it is paying more attention to agricultural diversification and productivity enhancement.

HORTICULTURAL DEVELOPMENT IN INDIA

The existence of a great variety of agroclimates from cold temperate to hot and humid tropical conditions make growing of a large number of crops, fruits and vegetables possible in India. Horticultural crops though account for only 6-7% of the total area (176.4 million ha), it provides 18.8% of total agricultural production and 52% of the total agricultural exports. Horticulture sector provides immense employment potential that can bring about significant changes in the food security and poverty alleviation in the rural areas. Horticulture is also important for environmental conservation and export earnings. India occupies, top position in fruit production as well as in the production of several individual crops like mango, banana and second position in world vegetable production next only to China.

The current thrust on horticulture and their impact on agrarian environment, are all the more important from several considerations. Indian agriculture critically needs diversification to improve farm efficiency and farmers' income, to cater to the changing dietary pattern and also to benefit from emerging global integration. This has also got an important bearing on food and nutritional security of the nation. And there is ample indication that horticultural crops would increasingly occupy a significant place in the lives of the poor people and help in qualitatively improving the nutritional status of their diet.

Horticultural development however, requires serious attention on many fronts. Except a few crops, the productivity of horticultural crops in India is quite poor compared to those of other countries. Many improvements are required in enhancing the qualitative aspects as well. Generation of proper technology especially the biotechnology, development of improved variety and adoption of good farm and plantation management techniques, are key to successful horticultural development in the country. Again, as the post-harvest losses are reported to be staggering, proper post-harvest management and processing activity need urgent attention. Key element, in the post WTO scenario is the marketing strategy to boost the income of the farming communities. All these would necessarily require larger investment in infrastructure, research in post-harvest facilities as well as in processing, marketing and exports.

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HORTICULTURAL DEVELOPMENT BY FAO

FAO has been active since long in enhancing the agricultural production capacity and improving food security scenario of its member nations. Horticulture occupies a special place in FAO and the Horticultural Crops Group has as its main objective towards the intensification and diversification to horticultural crops. Primarily, the aim is to increase the availability of high quality and safe horticultural produce (fruits, vegetables, roots and tubers, mushrooms and ornamentals) by developing improved crop management practices for sustainable and environment-friendly horticultural crop production systems. FAO strives to promote neglected and high-value horticultural crops as possible diversification options, according to their economic interest of nutritive value, and to make the best use of available germplasm and biodiversity within distinct agro-ecological zones.

Within these overall goals, the Horticulture Group in FAO Headquarters works for the following programme areas:

Rural Household Horticulture

FAO supports to promote horticulture-based and subsistence-oriented production systems for household food security and improved nutrition mainly for rural families. This programme aims at guiding the development of national policies and strategies to improve the output, quality and quantity of subsistence horticultural production, particularly in poor and remote regions. Particular attention is paid to carrying out integrated programmes for improving small-hold horticultural food production, particularly at household level. These are based on the cultivation of improved lines of traditional crops of high nutritive value, and the use of sustainable growing systems which ensure year-round harvesting of fruits, vegetables and horticultural staples.

Urban and Peri-Urban Horticulture (UPH)

Intensification of UPH production system aims to secure year-round market supply of fresh horticultural produce and promote rural employment and income. As almost 50% of the world population live in urban areas, this trend is expected to continue and even to accentuate especially in Africa and Asia. This phenomenon has given birth to an increased demand for fresh fruits and vegetables which is to be met by new production areas combined with more intensified crop management in order to raise the productivity per unit of land and water. The available land area on the hand, is shrinking to accommodate growing population and their dwelling and other economic as well as livelihood needs. It has also been mentioned that the uncontrolled growth of the cities will lead to poverty and malnutrition for more than 600 million people by the year 2025. Horticulture within and around the cities is already a referred activity for many of the unskilled migrants. Individual households are gardening on small plots, roadsides, rail track sides, terraces and patios - both to feed the family and also to sell through street vendors.

City farmers have developed small-and medium-sized market gardens specializing in the production of vegetables, fruits and root crops for sale on city markets. This activity is becoming more and more popular as it provides employment and income for women and young farmers. However, in most cases, city farming initiatives lack planning, supervision and guidance and are expanding in a haphazard fashion and with farmers squatting on any available piece of land. Moreover, uncontrolled use of agro-chemicals and doubtful irrigation water have on several occasions led to public health problems. Consequently, UPH is considered by some as a high-risk activity. Recognizing the important role of UPH as a contribution to improved food security, nutrition and livelihood (jobs and income), it is essential that "adequate" steps be taken to safeguard UPH and to ensure its orderly and "safe" development for the benefit of the population and the environment.

The UPH project needs critical support and research inputs which will assist in specializing and diversifying urban and peri-urban production systems through sustainable intensification of natural resource use and by strengthening decision support systems.

Crop-specific and Large Scale Horticulture

There are attempts to achieve the full agronomic and economic potential of principal horticultural crops in distinct agro-ecological conditions and to improve large-scale horticultural production system. Key activities under this programme are to assist member governments in: a) formulating policies, national strategies and technical guidelines for horticultural development master plans to be incorporated into the overall agricultural development planning process: b) organizing workshops and diffusing training materials on Integrated Production and Protection Management (IPP): c) assisting pilot projects and field demonstrations: and d) developing information exchange platform, supporting regional and global networks for inter country cooperation.

HORTICULTURAL MARKETING

Marketing is the process by which the space between the producer and the consumer is bridged. In horticultural farming, where prices are rarely regulated, commodities are perishable, financial gain depends as much upon business and marketing skills as on the farmer's technical expertise. It is high-value crops which are often a crucial component of viability for small farms.

In subsistence agriculture a farmer will mainly be feeding himself and his neighbours. The local community's taste and requirements are well understood. Transport and post-harvest losses are not serious problems. As the populations of the cities expand, farmers have the added responsibility of feeding not only the rural market but the growing distant urban markets. The farmer therefore has to take on substantive commercial and marketing skills.

Marketing essentially involves finding out what your customers want and supplying it to them at a profit. This stresses the two crucial points that govern marketing: Firstly, that the whole marketing process has to be customer oriented. Production must supply customers with what they want or need. Secondly, that marketing is a commercial process and is only sustainable if it provides all the participants with a profit.

Horticultural products are mainly sold fresh; some are eaten raw while others are cooked. Some horticultural products have traditionally been processed when no other form of storage was available, e.g. dried fruits and jams. As society develops and becomes more affluent, the market for processed and prepared horticultural products develops. A market also develops for horticultural products such as flowers and house and garden plants which are sold for purely aesthetic reasons. Increased wealth also brings with it an increased demand for product diversity in the form of new crops, off-season supplies and different flavours.

Important characteristics of horticultural crops are:

- They are mainly eaten for their contribution to the flavour and interest of food and for the supply of minor but essential nutrients, especially vitamins;
- They are not basic food commodities; people will put off buying if the price is too high;
- Consumption levels vary, depending on the selling price and the income of the buyer.
- Many of the crops are not traded in large volumes and there is a limited market;
- The products are perishable, which means there is always a reduction in quality if they are not sold immediately, usually leading to a fall in value;

- There is a wide range and variety of horticultural products. If one product is too highly priced the consumer will generally buy another;
- The products are normally traded in a very free market where price is primarily determined by supply and demand.

All these factors contribute to the crucial and reoccurring fact about horticultural crops: that prices, especially the prices the farmers obtain, are variable and difficult to predict. Therefore, some of the key strategies of successful horticultural marketing would include:

- reducing unit cost of production to become competitive in the market;
- improving the quality and presentation of the produce as per consumer preferences;
- identifying the highest price buyer, thereby, stress on effective market information;
- negotiating from strength, especially collective/cooperative activities to give benefits to small producers.
- maximizing earning by scheduling production when there is limited availability taking resource to off-season cultivation.

Helping farmers to minimize risks would also be essential perhaps through selling a proportion of produce at firm contract prices; growing a crop range which includes a mix of high and low risk products; and investing in technology which increases yield stability and therefore income stability.

With increased distances between the area of production and the points of consumption, systems and infrastructure will have to be set up to deliver produce regularly and reliably to the market, and provide a feedback of information between the market and the growers so that production can be constantly oriented towards consumer demand.

FAO's special programme on food security also highlights some issues to promote horticultural production. They are to :

- identifying commercial suppliers of farm inputs and the best way for farmers to deal with those suppliers;
- assessing the market for new or additional production;
- identifying the best ways of marketing the produce taking into account the benefits of group action;
- ensuring effective post-harvest handling to reduce losses and increase sales value;
- selecting options to ensure effective processing to add value when this is possible;
- strengthening extension skills in marketing and post-harvest handling.

FAO'S HORTICULTURAL DEVELOPMENT ACTIVITY IN INDIA

FAO's assistance to development of horticulture in India was well-recognized as early as in 1970s when with UNDP/FAO assistance, Centres of Advanced Studies for Post Graduate Education and Research in Horticulture were established in tropical horticulture jointly at the Indian Institute of Horticultural Research and University of Agricultural Sciences at Bangalore and for Temperate Horticulture at the University of Forestry and Horticulture at Solan. Besides meeting country's demand for highly qualified professionals in these areas, these initiatives also assisted in developing and introducing new varieties of fruit crops, vegetables, plantation crops, as also the post-harvest management

research. Release of improved varieties and standardization of production continue to help the farmers in improving productivity and quality of the produce.

FAO also assisted in developing packages for greenhouse floriculture technology for small growers in modern commercial floriculture production in locations, such as Maharashtra, Karnataka, Jammu and Kashmir. Jammu and Kashmir has also been assisted by FAO in vegetative propagation of walnuts by establishing mother and progeny orchards by providing technical assistance to the Department of Horticulture, State Extension Service and Agricultural University of Shalimar. This project is likely to be extended for walnut development in Northern Hill Regions. FAO has also approved a TCP project to provide assistance to improve production of banana plantations for small scale growers in Assam and Andhra Pradesh.

Even the small scale farmers based Tele.Food projects also got horticulture oriented by setting up of a greenhouse for walnut development in Uttaranchal, establishing Horticulture Garden to Reduce Malnutrition of Poor Backward Community in Gurgaon, a lime orchard and also a mushroom demonstration-cum-production center in Jammu and Kashmir, a vegetable nursery in Kumaon, a polyhouse agro technology nursery in Himachal Pradesh, as also a school vegetable orchard in Delhi. Through various training activities, frontier technologies such as tissue culture, cryopreservation, in-vitro conservation etc., are also being disseminated to improve horticultural production processes.

FAO has given required impetus to improve the productivity, quality and post-harvest efficiency of horticultural crops in tune with Govt. of India's priority to the sector. It is providing consultancy support to NDDB for the development of an ambitious wholesale fruits and vegetables market in Bangalore. A plan for a comprehensive horticultural development strategy in Madhya Pradesh and a proposal for the Lychee improvement project in Bihar, Uttar Pradesh and Uttaranchal are under consideration. FAO is also considering to assist Horticultural Department of Himachal Pradesh in solving their problems relating to fall in productivity of apple plantations which covers over 42% of the total area under horticultural crops.

CONCLUSION

Addressing the problems of sustained quality and high productivity in fruits and vegetables should set the agenda for future research in the country. Despite large production base, the export potential of many fruits and vegetables is not being actualized. Lack of quality output and poor post-harvest management are areas that need to be addressed. Processing could be a potent solution for reducing gluts, stabilizing prices and making products available during scarce period. The post-harvest infrastructure is urgently required to be built to bring in expected gains in marketing and export. FAO would like to see India in the forefront of global horticultural production, productivity and exports.

WTO AGREEMENT ON AGRICULTURE AND ITS IMPACT ON INDIA

Rajiv Mehta*

The emergence of World Trade Organization (WTO) in January 1995, succeeding the General Agreement on Tariff and Trade (GATT) was a landmark event in the annals of global trade reforms. It offered a set of Agreements offering a framework of rules for multilateral trading system. The Agreement on Agriculture (AoA) was also reached by the member countries for the first time with the objective to establish a fair and market-oriented trading system and that a reform process should be initiated through the negotiation of commitments on support and protection and through the establishment of strengthened and more operationally effective GATT rules and disciplines. The Preamble of AoA states that commitments under the reform programme for trade in agriculture should be made in an equitable way among all members, having regard to non-trade concerns, including food security. Article 20 of the Agreement, which mandates negotiations for continuation of the reform process, also recognizes that non-trade concerns, such as food security should be taken into account in the negotiations.

THE AGREEMENT ON AGRICULTURE : SALIENT FEATURES

The AoA forms a part of the Final Act of the Uruguay Round of Multilateral Trade Negotiations. The AoA was signed by the member countries in April 1994 at Marrakesh, Morocco and came into force on the 1st January 1995. The long-term objective of the Agreement is "to establish a fair and market-oriented agricultural trading system and that a reform process should be initiated through the negotiation of commitments on support and protection and through the establishment of strengthened and more operationally effective GATT rules and disciplines". It has been further stated that "the long-term objective is to provide for substantial progressive reductions in agricultural support and protection sustained over an agreed period of time, resulting in correcting and preventing restrictions and distortions in world agricultural markets".

The Agreement incorporates 3 broad areas of commitments from member states. They are:

- market access, i.e. the disciplines on import restraints and tariffs
- domestic support, i.e. subsidies by Governments to domestic producers
- export subsidies.

Market Access

On market access, the Agreement primarily envisages tariffication of all non-tariff barriers. In other words, non-tariff barriers such as, quantitative restrictions (quota, import restrictions through permits, import licensing, etc.) are to be replaced by tariffs to provide the same level of protection and then progressive reduction of the tariff levels is to be made.

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The reduction commitments on import tariffs are as under:

Tariffs (Base: 1986-88)	Developed Countries (1995-2000)	Developing Countries (1995-2004)
Average cut for all agri products	36%	24%
Minimum cut per product line	15%	10%

Domestic Support

Provisions of the Agreement on **domestic support** measures have 2 main objectives.They are to:

- identify acceptable measures of support to farmers and
- discipline trade distorting support to farmers.

These commitments regarding domestic support are primarily aimed at containing high levels of domestic agricultural support in developed countries. This objective is to be achieved by quantification of domestic support, that is, the Aggregate Measure of Support (AMS) and then by progressive reduction of the AMS.

There are 3 categories of support measures that are **not subject to reduction** under the Agreement. These categories of exempt support measures are:

"Green Box" Measures - which have a minimum impact on trade. These include the following types of assistance:

- Government assistance on general services like research , pest and disease control, training, extension, and advisory services.
- public stock holding for food security purposes.
- domestic food aid.
- direct payment to producers, such as, governmental financial participation in income insurance and safety nets, relief from natural disasters, and payments under environmental assistance programmes.
- de-coupled income support.
- Government financial participation in income insurance and income safety-net programmes.
- payments (made either directly or by way of governmental financial participation in crop insurance schemes) for relief from natural disasters.
- structural adjustment assistance provided through producer retirement programmes; resource retirement programmes; and investment aids.
- payments under environmental programmes.
- payments under regional assistance programmes.

"Blue Box" measures – representing direct payments under production limiting programme. These are relevant from the point of view of developed countries alone.

Special and Differential Treatment for Developing Countries :

i. investment subsidies which are generally available to agriculture in developing countries. and

ii. agricultural input services generally available to 'low income and resource-poor producers' in developing countries.

The AMS (also called Amber Box) consists of 2 parts. They are:

- product specific subsidies, that is, the difference between the administered prices (minimum support prices in India) and external reference prices (c.i.f prices of imports and f.o.b. prices of exports), times the quantity of production which gets such support.
- non-product-specific subsidies, that is, subsidies on inputs such as fertilizers, electricity, irrigation etc.

The AMS net of exempted categories of support measures is subject to reduction commitments as under:

Domestic support (Base 1986-88)	Developed countries (1995-2000)	Developing countries (1995-2004
AMS	20%	13%

Domestic support given to agriculture sector within the specified *de minimis level*, that is , up to 10% of the total value of agricultural produce in developing countries and 5%in developed countries is allowed. In other words, AMS within this limit is not subject to any reduction commitment.

Export Subsidies

The export subsidies are also subject to reduction commitments as under :

Export subsidies (Base 1986-90)	Developed countries (1995-2000)	Developing countries (1995-2004)
Subsidy value	36%	24%
Subsidised quantities	21%	13%

Export subsidies of the kind listed in the Agreement which attract reduction commitments are non existent in India.

INDIA'S COMMITMENTS

Being under a balance of payments cover, India had been maintaining Quantitative Restrictions (QRs) and had not undertaken any commitment with regard to market access and this has been clearly stated in our schedule filed in WTO. The only commitment India had undertaken was to bind its ***primary agricultural products at 100%; processed foods at 150% and edible oils at 300%.*** However, there are a few tariff lines, which had been bound at lower tariff levels in the earlier rounds of negotiations. Of these tariff lines, the bound levels of 15 tariff lines, which include milk, skimmed milk powder, spelt wheat, maize, rice, millet, sorghum, rape, colza or mustard oil, were raised through successful negotiations under GATT Article XXVIII in December 1999.

India does not provide any product-specific support other than market price support. During the reference period (1986-89), the total product specific AMS was (-) Rs 24, 442 crores. Since product

specific AMS is calculated by subtracting the international price (fixed at 1986-88 levels) from the domestic price and then multiplying the resultant figure by the quantity of production eligible to receive the support, a negative figure would arise if international prices were higher than domestic prices. During the base period, except for tobacco and sugarcane, international prices of all products were higher than the domestic prices, hence the negative figures of AMS.

Non-product-specific subsidy is calculated by taking into account subsidies given for fertilizers, water, seeds, credit and electricity. During the reference period, the total non-product-specific AMS came to Rs 4,581 crores.

Since the total Product-Specific AMS is negative, and that too by a huge magnitude, and the Non-Product Specific AMS is also well within the *de minimis* level, India has no reduction commitments to meet. Even the calculations for the marketing year 1995-96 show the product-specific AMS figure as (-) 38.47% and non-product-specific AMS as 7.52% of the Agri GDP. This still keeps our aggregate AMS well below the *de minimis* level of 10%. Moreover, the explanatory note to the AMS notifications also indicated that non-product-specific support figures did not exclude the input subsidies given to low-income-and resource-poor farmers, which India is entitled to exclude from AMS calculations under Article 6.2 of AoA. Therefore, India is under no obligation to reduce domestic support currently extended to the agriculture sector.

In India, exporters of agricultural commodities do not get any direct subsidy. The only subsidies available to them are in the form of exemption of export profit from income tax under section 80-HHC of the Income Tax Act which is also not one of the listed subsidies (even normal agricultural income is non taxable in India); and subsidies on cost of freight on export shipments of certain products like fruits, vegetables and floricultural products.

The AoA does not in any way, require India to reduce its existing subsidies for research, pest and disease control, marketing and promotional services and various infrastructural support services. It does not in any way affect the existing PDS. India has not taken any obligation for providing market access opportunities to other trading partners. India is free to follow her own agricultural policy and various domestic support programmes for the farmers.

EXPERIENCE OF IMPLEMENTATION OF AOA

Experience during the last 6 years shows that the AoA has not brought about the anticipated deepening of world trade in agriculture or spatial re-distribution of agriculture production or improved returns to farmers in developing countries or greater transparency in agricultural trade. It is evident that a good number of provisions of the AoA lack the required degree of rigor or contain ambiguities leading to the possibilities of varying interpretations. It is well-known that the advantage of the lack of vigour and ambiguities in the Agreement have been accruing to those very Members who are mainly responsible for the distortions in the international trade in agriculture. For example, tariffs continue to be quite high on products of interest to developing countries like sugar, rice or dairy products, because commitments under the AoA require reductions only on an un-weighted average basis.

India's Agricultural Trade

Despite being an agrarian economy, where the agriculture sector provides employment to approximately 65% of the population and contributes 25% to the GDP of the country, India has remained a marginal player in world agricultural trade. Currently, it has a share of less than 2% of the world market in agriculture. India is an importer of pulses, oilseeds and edible oils. The share of agricultural products including coffee, tea and fisheries in the total exports of India was around 14.6% in 1999-2000.

The post-Uruguay Round experience has been a mixed one for agricultural trade in India. While in certain cases, exports have increased in others a decline has been registered. However, these cannot be attributed solely to the impact of the Agreement on Agriculture. An increase in traditional export items is largely due to the comparative advantage that India enjoys in production of certain items and because of a large number of ethnic Indians living abroad who have a preference for Indian products. The traditional items, which have registered an increase, are rice, sesame seed, oil meals, etc. Other factors, which are acknowledged to have limited our exports, are infrastructural inadequacies as well as ad-hoc domestic and trade policies. Meeting the sanitary and phytosanitary requirements of most trading partners also call for substantial investment in developing quality standards and developing adequate infrastructural facilities.

Ever since, there have been apprehensions that removal of QRs would open the floodgates of imports, but these fears appear to be unfounded. Actual empirical data reveals that at the aggregate macro level, the removal of QRs has not altered either the overall rate of growth of imports or even their composition. The non-oil imports have so far (April-January 2001) witnessed a negative growth of 8.16%.

Another emerging area, which poses a challenge, is trade in genetically modified agricultural products. While it is viewed by some as a panacea for food security problems of the country, others feel that we may be led into uncharted territory, which is fraught with serious implications for health.

Trade Defence Measures

The time gap in the collection of import data, which used to be about 10 months in the DGCI&S office, has been brought down to less than 3 months and efforts are being made to ensure that import data is available within a period of less than 30 days. Continuous monitoring of import of about 300 sensitive items and monitoring of the impact of QR removal is done and corrective measures are initiated. The imports are being closely monitored and in cases where any injury has been caused to the domestic producer or any serious injury has been apprehended due to unfair trade practices by the foreign exporters or due to import surge, anti-dumping action or safeguard action have been taken as provided in various WTO agreements to give necessary protection to the domestic producers.

With a view to see that domestic producers do not have to face unfair competition and a level playing field is created, in addition to tariff protection, all imports are subjected to domestic laws, rules, regulations, procedures, technical and sanitary and phytosanitary standards applicable to the domestic industry. In this connection, DGFT had issued orders in November 2000 that all packaged imported products will have to indicate the maximum retail price as per the provisions of the Weights and Measures Act and also for the 131 items for which the Bureau of Indian Standards (BIS) certification is compulsory, the foreign exporters will have to get themselves accredited with BIS.

Further, following notifications are being issued by DGFT to create a level playing field for the domestic industry/ domestic producers:

- Import of tea waste is to be allowed only subject to fulfilment of conditions of the provisions of the Tea Waste (Control) Order 1959.
- The import of alcoholic beverages will be subject to the compliance of various mandatory requirements as might have been stipulated by various state governments.
- Import of all edible and food products as regards their quality and packaging requirements shall be subject to the conditions and the standards as might have been fixed under Prevention of Food Adulteration Act 1954.

- All meat and poultry products will have to comply with the conditions regarding manufacture, slaughter, packing, labelling and quality conditions as laid down under Meat Food Products Order 1973.
- Import of various edible products will be subject to the compliance of quality specifications, norms for packing, limits of poisonous metals in fruit products and restrictions regarding use of food colours, preservatives and salts as have been prescribed in "Fruit Products Order 1955.
- Besides for items such as sugar where the domestic producer has to give a particular percentage of levy to FCI or Government at a fixed price, the same requirement will have to be met in the case of imported items.

Besides, Agriculture Ministry will make use of the provisions of the Plants, Fruits and Seeds (Regulation of Imports into India) Order 1989, for ensuring that the foreign imported agricultural goods do not carry any pests or create any risks to human or animal life or plant health.

Some mechanisms are available to the Government for giving protection to domestic producers. They are:

- Anti-dumping, anti-subsidy countervailing duty or safeguard action as provided under various WTO agreements can be taken under certain circumstances.
- Article XX or XXI of GATT providing for general exception and on national security considerations respectively can be invoked to put QRs on any item as could be justified under these Articles of GATT.
- Department of Commerce have also strengthened its Designated Authority for Anti-Dumping and Countervailing Duties. In the last few months, preliminary anti-dumping duties have been imposed with a gap of only about 75 - 80 days from the date of investigation as against the statutory minimum period of 60 days.

EXIM POLICY 2001

The EXIM Policy 2001 has particularly focussed on agricultural trade, highlighted as under :

- Primacy to promotion of agricultural exports as the ongoing negotiations on agriculture as the WTO presents opportunities for farmers.
- Supplements the efforts of State Governments in facilitating agri exports based on specific products and specific geographical areas.
- Concerted efforts to fill in the gaps with regard to information on prices, demand, quality standards etc. to enable the farmers to respond to the international situation.
- The EXIM Policy schemes like Duty Exemption Scheme and the Export Promotion Capital Goods Scheme (EPCG) have been made applicable to the agro-sector also.

The farm-to-port approach in the Agri-Economic Zones and the proposed Agri-Export Policy are expected to give a boost to agricultural exports.

Negotiations on Agreement on Agriculture:

As mandated under Article 20 of the AoA, the negotiations for further progressive liberalization to establish a fair and market-oriented agricultural trading system have begun from 1st January 2000.

These discussions are taking place in Special Sessions of the WTO Committee on Agriculture. Till end of March 2001, 47 proposals have been filed by various countries/groups of countries in the WTO.

India's Proposals for Negotiations

Based on the inputs received from the consultations held with various stakeholders, India's objectives in the negotiations are:

- To protect its food and livelihood security concerns and to protect all domestic policy measures taken for poverty alleviation, rural development and rural employment.
- To create opportunities for expansion of agricultural exports by securing meaningful market access in developed countries.

Indian proposals submitted to WTO on 15 January 2001 can broadly be classified into following 2 categories:

- Increasing the flexibility enjoyed by developing countries for providing domestic support to the agriculture sector under the special and differential provisions as also further strengthening of trade defence mechanisms with a view to ensuring the food security and to take care of livelihood concerns.
- Demanding of substantial and meaningful reductions in tariffs including elimination of peak tariff and tariff escalation, substantial reductions in domestic support and elimination of export subsidies by the developed countries so as to get meaningful market access opportunities.

COPING STRATEGIES

It is expected that the trade liberalization as a result of WTO Agreement on Agriculture would bring about a structural change in the global agricultural trade and a less distorted trading regime in which more efficient agricultural producers would stand to benefit. The National Agriculture Policy has identified various thrust areas primarily for accelerated sustainable growth of agriculture. This in turn addresses the issue of long-term efficiency of Indian agriculture. Enhancement of efficiency of Indian agriculture would improve competitiveness in the International market resulting in greater market access for our agricultural produce. This would necessitate a focused agenda for reforms and enhancing efficiency of Indian agriculture. The salient aspects of the same are :

- Support in the areas of research extension, water and land management, infrastructure, post-harvest management, rural credit and agricultural risk management to sustain the growth and attain competitiveness.
- Investment in irrigation, watershed development, power and rural infrastructure.
- Reorganize production and export efforts on the basis of specific products in identified geographical areas with the tenet of comparative advantage, encompass all areas from production to post-harvest management, quality standards, processing, storage, transport and marketing activities. Setting up of grading and sorting facilities and other post-harvest technologies.
- Convert India's low use of agro chemicals into an opportunity.
- Compliance with international quality including hygiene and safety standards.

- Standards by Codex Alementarius Identification and declaration of pest-free areas for export.
- Education and training on post-harvest management and exportability of products.
- Establish a credible system of registration of accredited laboratories for quality certification.
- Redefining role of APMC in a more competitive environment, integrate existing agricultural markets through information access, reduce the price spread , reduce trade barriers.
- Better network of existing institutions using more affordable technology, with priority on coverage and local participation.
- Rationalisation of statutory levies.
- Improve credit, insurance and cooperative institutions.

Policy Thrust for Structural Reform, National Agriculture Policy

- Enhance comparative advantage.
- Productivity acceleration.
- Efficient use of inputs and their assured availability.
- Diversification.
- Land reforms.
- Risk management.
- Information access and dissemination.

ROLE OF NABARD IN CREDIT SUPPORT FOR DEVELOPMENT OF HORTICULTURE

M.R. Sharma*

Agriculture contributes nearly 30% to GDP, providing livelihood to more than 70% of the population of the country. Thus, it forms an important sector of the Indian economy. The share of agriculture exports is around 15% of all-India exports. Horticulture, as an important sub-sector of India's agriculture, contributes 18% of the gross value of agricultural output and 52% of export earnings from agriculture (Table 1). Horticulture makes significant contribution particularly in providing employment opportunities, higher incomes to farmers, earning foreign exchange, ecological development and nutritional needs of human beings.

In spite of its prominent position in socio-economic, ecological and nutritional scene of the nation, the progress of horticulture sector is not commensurate with the actual available potential. In fact, India's horticultural progress is yet to come to its full bloom. Nevertheless, achievements of the country in this sector is undoubtedly significant particularly in fruits and vegetables production. As per the data available, India produces 44.04 million tonnes of fruits and 87.53 million tonnes of vegetables from an area of 3.73 million ha and 5.87 million ha, respectively. India ranks second next to China in world production of fruits and vegetables. About 65% of the world mangoes and 11% of the worlds banana is produced in India.

However, India's per capita consumption of vegetables is only 130 g/day as against the requirement of 280 g/day. As such, there is an imperative need for increasing the production and productivity of vegetables.

Apart from meeting the domestic market requirements, the needs of the processing industry for producing items for home consumption and exports, following fruits, vegetables, flowers and plantation produces have a lot of export market potential.

Fruits	Mango, grape, banana, citrus, litchi, sapota, ber, pomengranate and custard-apple.
Vegetables	Onion, potato, okra, bitter gourd, asparagus, celery, bell pepper, sweet corn and baby corn, green and lima beans.
Flowers	Rose, carnation, orchids, gladiolus, chrysanthemum, ornamental plants and foliage, bulbs and seeds and tissue culture material.
Plantation crops	Tea, coffee, cashew, black pepper, cardamom and arecanut.

Horticultural export earning constitutes 52% of the total export earnings from agriculture. There has been an increase in export earnings from plantation and horticulture products except a decline during 1998-99 which can be observed from Table 1.

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Table 1. Export of horticultural products of India (1996-99)

Year	Quantity ('000 tonnes)	Value (Rs. crore)
1996-97	897.08	1,163.84
1997-98	871.68	1,483.91
1998-99	650.85	1,404.84

Keeping in view the vast potential available, both in respect of exports and domestic consumption of horticultural products, a quantum jump can be achieved provided necessary support including credit is provided to the entrepreneurs on liberal terms. Besides, a remedy-malady analysis of horticultural and allied activities in India clearly points out immediate need for proper blending of technology, credit and scientific management to ensure an accelerated growth of this important sector.

CREDIT SUPPORT

Like any other developments, horticultural development essentially requires credit as a crucial component for production, post-harvest management, including marketing and above all, creation of necessary infrastructure which inter alia include connectivity, strong and suitable transport systems, storages etc. The development of plantation and horticultural crops involves long gestation period (mango, apple, coconut, cashewnut, tea, coffee etc.) and high investments (growing of vegetables / flower cultivation under greenhouse conditions, growing of mushrooms under controlled conditions, etc). Therefore, credit needs of the sector is not only of high volume but also for longer duration extending up to 15 years.

Direct credit support for horticultural development is provided to the individuals, groups of individuals, cooperatives, companies, etc. by various financial institutions like Commercial Banks (CBs), Cooperative Banks, Regional Rural Banks (RRBs), Industrial Development Bank of India (IDBI), National Bank for Agriculture and Rural Development (NABARD) and some private sector banks.

ROLE OF NABARD

The NABARD, since its inception, has played an important role to facilitate the smooth credit flow by way of creating adequate awareness among the concerned agencies, formulating guidelines, model schemes, working out cost structures, providing concessional refinance through banks and lately direct credit to State Governments to create necessary infrastructure like roads, irrigation facilities etc. Plantation and horticulture sector, on an average, contributes nearly 5% of the refinance assistance sanctioned by NABARD. There are more than 50 activities covered under this sector which comprises fruits crops, plantation crops, vegetables, floriculture, mushroom, betelvine, sericulture, bee-keeping, tissue culture, post-harvest technology, fruit and vegetable processing etc.

The business in plantation and horticulture is thus more challenging task as compared to other sectors. Due to multiplicity of crops under varying agroclimatic conditions, the quality and quantity of technical inputs required are of a high order. The long-term nature of crops will demand careful planning for development. The disbursement of refinance, under schematic lending, from NABARD with respect to plantation and horticulture was merely Rs 28 crores during 1982-83 which rose commendably to the extent of Rs 246.02 crores during 2000-01. A cumulative amount of Rs 2,128.90 crores from 1982-83

to 2000-01 of refinance been disbursed by NABARD under Plantation and Horticulture sector. The annual average growth rate achieved during last 16 years (1982-83 to 1997-98) was 11.47%. The major portion of refinance disbursement in all the years (more than 50 - 60%) was availed by southern states (south zone). Among crops/activities of the sector, plantation crops were provided major share (36.74%) of refinance followed by fruit crops (33.79%).

The NABARD has also played a very important role to make the credit available for hi-tech horticulture. As on date 234 schemes on hi-tech horticulture which includes agro-processing, floriculture, tissue culture, mushroom, etc. have been sanctioned with a total financial outlay of Rs 907.59 crores. Of which, a total amount of Rs 135.78 crores has been disbursed.

Vision of NABARD

The vision of NABARD is :

- Achieving the nutritional security of the citizens of India.
- Generation of rural employment.
- Increasing agri-export.
- Diversification in agriculture.
- Promoting agro-based industries by increasing raw material supply.
- Environmental sustainability.
- Increasing the productivity and quality standards of horticultural products like fruits, vegetables, flowers, spices etc.
- Dissemination of scientific technologies in hi-tech areas of horticulture.

Strategies

Several steps are taken by NABARD to boost the production and productivity level of horticultural crops in the country. They are :

- Publication of model schemes for the benefit of banks/farmers.
- Preparation of area development schemes.
- Training bank officers in various training centres on development of P/H activities.
- Development of database on plantation/horticulture sector.
- Collection of research highlights of various research organizations of India related to P/H sector.
- Supporting R&D activities connected with improvement of production, productivity and quality of P&H activities.
- Guidance to the farmers / entrepreneurs.
- Suggesting improvements in technical input of PLPs.
- Encouraging technology transfer through innovative schemes.
- Coordination with development departments of GOI, Commodity Boards etc.
- Involving in planning process for development of P/H crops by closely following the Ninth Plan proposals of GOI and various other institutions related to development of P/H sector etc.
- Extending faculty support to various Bankers' training college.
- Organizing/participating in the seminar/symposium on various sub-sectors of plantation and horticulture.
- Holding meetings with state horticulture dept./commodity boards to chalk out the strategies for the development of the sector.

Sectoral Issues and Strategies to Overcome Bottlenecks

- The extension wings of State Horticulture Department are to be strengthened to enable them to educate the farmers about latest research findings (lab to land) periodically.
- The state governments concerned are being suggested during our discussion with the state governments to follow the successful cooperative marketing structure as prevailing in Karnataka. Further, they are also being requested to initiate starting separate regulated marketyards for horticultural crops with the required infrastructure for perishable horticultural produce.
- Government/Commodity Boards/National Horticulture Board are being requested to route their subsidies, if any, through the financing banks to implement the scheme more effectively.
- During monitoring studies, the farmers are being educated to adhere to the spacing norms to get the maximum benefit from the crops. The extension staff of the department is being advised to educate the farmers about the importance to adhere to the recommended spacing norms.
- In various meetings with the GOI and development departments, emphasis on coordinated approach for integrated development of the plantation and horticulture sector is being emphasized. NABARD is being invited by all the development departments concerned during the discussions on development of this sector.
- Farmers may be educated about the concept of inter cropping by the Extension wing of State Horticulture Department. NABARD has made provision to capitalize the cost of raising the inter crops during the first year, in the investment cost (unit cost) of the horticultural crops, to encourage the farmers to raise short-duration crops during the gestation period.
- NABARD has been stressing the need for building up of database in respect of plantation and horticultural crops in various meetings of the relevant development departments, to enable all the concerned departments to use the data for proper planning for development of this important sector.

Further, NABARD has been advocating identification of a "nodal department for horticulture / plantation sector database" to act as the source department for all the database for all the development departments.

- The State Horticulture Departments are being requested to provide adequate/competent manpower to cater to the technological needs of the farming community.
- The State Horticulture Departments are being advised to supply adequate quality planting

material so as to improve the productivity. They are being advised to open more nurseries in the potential areas and also increase the production of planting material of existing nurseries.

- The State Governments are also being requested to amend Nursery Act, to prevent the supply of poor quality planting material by some private nurseries.
- The above issues are being taken up regularly with the State Governments concerned, by NABARD during their discussions with various State Governments.

THRUST AREAS

To increase the production and productivity level of horticultural crops, following are the thrust areas of NABARD :

- Production of genuine quality planting material.
- Mass production of quality planting material by tissue culture.
- Developing indigenous production and processing technology for commercial horticulture for domestic and export market.
- Area-specific package of practices for optimization of productivity.
- Promotion of dryland and wasteland development through horticultural schemes
- Stress on water management in horticultural crops through use of drip and sprinkler irrigation systems.
- Encourage captive contract farming for the benefit of producers and processors
- Finding a permanent solution to the perennial problems of important crops like mango malformation, spongy tissue of mango, bunchy top of banana, katte disease of cardamom, root wilt of coconut, etc.
- Development of horticultural infrastructure for automation of technology right from the planting, production, harvesting, processing and marketing till the produce reaches the final consumer at a comparable price and better quality.
- Encourage biological control for pests and diseases, organic farming for better sustainable development for protecting ecology and environment.
- Support transfer of technology and its adoption.
- Identifying crop/activity-specific thrust areas and working on them to achieve the desired targets.
- Plasticulture.
- Improving productivity and quality of produce from the existing area under horticultural crops
- Development of reliable database necessary for proper planning for horticultural development.
- Product diversification and improving consumption.
- Enhancement of exports.

- Human resource development.
- Strengthening infrastructure for programme implementation and database.
- Emphasis on off-season fruits, flowers and vegetables production.
- Emphasis on low-volume high-value crops.
- Promotion of Apiculture.
- Publicity and extension for "growers-cum-marketing cooperatives" for collection, grading, marketing, etc. of horticultural produce.
- Integration of horticultural crops in the overall land-use pattern.
- Strengthening the backward and forward linkages.

ROLE OF NCDC IN DEVELOPMENT OF HORTICULTURE

P.K. MISHRA*

India is the second largest producer of fruits and vegetables in the world, producing 46.8 and 90.85 million tonnes respectively accounting for 10 and 14% of the total world's production. About 20 million tonnes of root and tuber crops are also produced. It is estimated that 20-25% of the horticultural produce goes waste due to improper post- harvest management which reduces the growers share. In the present marketing arrangements, the grower is getting hardly 25-35 paise of a consumer rupee. There is, therefore, a need to evolve a marketing system where growers and consumers both may be benefited.

NCDC IN HORTICULTURAL DEVELOPMENT

The National Cooperative Development Corporation (NCDC) supports fruits and vegetables marketing and processing cooperatives. It is a unique organization which not only plays a developmental role but also provides financial assistance for creating infrastructure for marketing, processing and storage of horticultural produce in the cooperative sector. It extends financial assistance in all the areas of post-harvest management. The schemes of NCDC which provide financial assistance are:

Strengthening of Share Capital Base of Fruit and Vegetable Cooperatives

Under this scheme, an assistance up to Rs10 lakhs is provided for increasing the capital base of the beneficiary cooperative societies for improving their marketing operations.

Margin Money Assistance for Raising Working Capital.

This scheme provides an assistance to enable raising working capital from banks for increasing business operations. This assistance is available to State Federations, District-Level Federations and Commodity Marketing Societies.

Assistance for Purchase of Transport Vehicles

The Corporation provides assistance to the beneficiary societies to purchase transport vehicles for moving stocks from growing areas to consuming centres.

Construction of Packing and Grading Sheds and Godowns

Under this scheme, an assistance is provided to cooperatives at primary as well as *mandi* level, for construction of godowns and sheds.

Construction of Cold Storages

Assistance under this scheme is provided to cooperatives, mainly in potato and fruit growing areas, for setting up of cold storages.

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Creation of Marketing Infrastructure

Assistance is provided to create marketing infrastructure including retailing.

The Corporation has, so far, assisted 424 projects in the country to enable cooperatives to market fruits and vegetables. An assistance of Rs 54.24 crores has been sanctioned for these projects. This includes 32 projects for setting up of pre-cooling and cold storage units for marketing and export of grape and other fruits.

The NCDC has cumulatively assisted setting up of 262 cold storages with a capacity of 8.69 lakh tonnes as on 31 March 2001. Of these, 252 cold storages, with a capacity of 7.89 lakh tonnes, have been completed. The Corporation has, so far, provided about Rs 111.78 crores for establishment of cold storages. The assisted cold storages are mainly for storage of potatoes, though fruits, tamarind, spices, milk products etc. are also being stored.

The NCDC also assists fruit and vegetable cooperatives for establishment of fruit and vegetable processing units. Assistance is provided for setting up spice, honey and tapioca processing units also. So far (as on 31 March 2001), 43 cooperative fruit and vegetable processing units have been sanctioned. Of which, 37 have been installed. The Corporation has sanctioned Rs 20.68 crores for establishing such units. During 2000-2001, two assisted units in Punjab and Maharashtra have exported their products: The MARKFED Canneries, Jullandhar, Punjab exported canned food worth Rs 226.00 lakhs. Similarly, 100% export-oriented units (EOUs) of Shree Warana Agricultural Goods Processing Cooperative Society Ltd, Maharashtra, exported 1972 tonnes of banana puree and mango pulp valued at Rs 540 lakhs to the Netherlands.

ELIGIBILITY CRITERIA FOR AVAILING FINANCIAL ASSISTANCE

Some conditions govern the availability of assistance from NCDC for establishment of fruit and vegetable projects. They are: the project should be technically-feasible and economically-viable. Most of the raw material requirement should be available from within the area of operation of the society. The cooperative character of the unit should be maintained. And the society should have firm arrangements for marketing of fruit and vegetable items.

ROLE OF COOPERATIVES

Cooperatives continue to play an important role in marketing operations of fresh fruits and vegetables. During 2000-2001, the value of fruits and vegetables marketed by cooperatives was around Rs 369.12 crores against Rs 337.25 crores during 1999-2000. Besides, domestic marketing, cooperatives also export fresh fruits. During 2000-2001, Mahagrapes, Pune and other cooperative(s) exported fresh fruits, grape and pomegranate, worth Rs 6.51 crores.

CONSTRAINTS

Cooperatives are facing some constraints. They are :

- Cooperatives mostly engaged in providing services like credit, supply of agricultural inputs including fertilizers, seeds etc. Cooperatives have weak forward and horizontal linkages. Therefore, cooperative societies are not equipped to competitive in marketing of horticultural produce.
- Due to non-availability of qualified professionals in cooperatives at village level. Cooperatives are not able to formulate business plans/proposals: strategies that are to

be adopted in procuring the produce from its members on most competitive prices as also in its marketing in the present scenario and develop forecasting techniques.

- The cooperatives are unable to use the database as provided by many institutions.
- Weak capital base and poor knowledge and expertise in marketing of fruits and vegetables. Cooperatives are not able to venture in setting up of better handling and preservation systems. This aggravate high levels of wastage and low returns to the member farmers.
- The cooperatives could not make significant impact in the processing of fruits and vegetables mainly on account of their limited expertise and marketing tie-up of.
- Cooperative cold storage normally do not undertake marketing/trading activities on account of non-availability of institutional arrangements for marketing of potato and other fruits and vegetables.
- Many old cold storage are having diffuser cooling system and therefore incur high expenditure on electricity. This increases the operational cost and affect viability.

SOME SUCCESSFUL COOPERATIVES

Hopcoms, Lalbagh, Bangalore

It retails about 140 tonnes of fruits and vegetables a day in Bangalore and 5 other towns, providing about 70% of the consumer price to the growers. The cooperative directly retails the produce of its members through about 365 retail outlets in Bangalore. The society has marketing outlets in 7 districts, viz. Bangalore, Mysore, Mangalore, Mandya, Kolar, Tumkur and Hassan. The cooperative has benefitted growers and consumers to a large extent. Its total turnover is around Rs 38.00 crores. During 2000-2001, the society marketed fruits and vegetables worth Rs 30.83 crores.

Mahagrapes, Pune, Maharashtra

The NCDC has assisted 32 export-oriented units comprising pre-cooling and cold storage in Maharashtra for undertaking export of grape, pomogrante and other fruits. The NCDC has sanctioned an amount of Rs 17.06 crores for these units. The Mahagrapes is a partnership cooperative of grape growers, exporting grape. During 2000-2001, it exported 543.12 tonnes of grape and pomegranate valued at Rs 6.51 crores.

Lahoul Potato Growers Cooperative Marketing Society Ltd, Manali, (LPS) Himachal Pradesh

It is engaged in marketing of seed potato, handling about 60% of the total produce of Lahoul Valley. Its total business is around Rs 10 crores/annum. During 2000-2001, the society marketed potato, and fruits and vegetables worth Rs 2.73 crores.

Himachal Pradesh Cooperative Marketing and Consumers' Federation ltd., (HIMFED), Shimla

During 2000-2001, HIMFED, Shimla, has marketed 925 tonnes of horticultural produce comprising apple and citrus fruits worth Rs 9.19 crores.

Regional Fruits and Vegetables Producers Cooperative Society Ltd, (VEGCO), Thaliparamba, Kerala

The society marketed 2854 tonnes of fruits and vegetables worth Rs 2.08 crores during 1999-2000.

NAFED, New Delhi

During 2000-2001, NAFED exported 1,82,962 tonnes of onions valued at Rs 159.71 crores and 1,450 tonnes of potato worth Rs 1.78 crores. In the domestic market, NAFED marketed fruits and vegetables worth Rs 5.14 crores. Besides, under the market intervention scheme of Govt. of India, the society marketed apples worth Rs 1.16 crores.

Cooperative Cold Storage, Rao, District Indore, Madhya Pradesh

The cooperative cold storages assisted by NCDC in Madhya Pradesh, particularly in Indore district are showing good performance and running in profit. To exemplify, the NCDC's assisted cooperative cold storage Rao, Indore, Madhya Pradesh, is performing optimally on consistent basis and regular by attaining a capacity utilization of 100%. The capacity of the cold storage has now increased from 2,000 tonnes during 1982-83 to 15,600 tonnes. The unit has not only repaid the loan but also redeemed its share capital to the State Government.

Uttar 24 Parganas Krishi Samabay Himghar Samity Ltd, District 24 Parganas, West Bengal

In West Bengal also, most of the cold storages have been utilizing their full capacity despite rental ceilings. Further, cold storages are now being used as multipurpose cold storages.

The UTTAR 24 Parganas Krishi Samabay Himghar Samity Ltd. commissioned a 4,000 tonnes cold storage plant in April 1987 with NCDC's assistance under NCDC II World Bank Project. The cold storage is running in profit. During 1999-2000, it utilized its capacity to the extent of 106.05%. The society subsequently added 15 TPD Ice Plant with NCDC assistance and also changed the cooling system from diffuser to vertical grid system. The society is also operating a milk chilling unit. The society has increased its cold storage capacity by 6,000 tonnes with financial assistance from the NCDC during 1999-2000.

Strategy for Development of Cold Storage

The Government of India, on the recommendations of a High-Level Expert Committee (HLEC) on Cold Storage and Storage, has provided back-ended capital subsidy under the Capital Investment Subsidy Scheme (CIS) for creation of additional cold storage capacity of 12 lakh tonnes, besides rehabilitation, modernization and technology upgradation of existing cold stores in Nineth Plan period. The Cooperative Sector would create around 10% of the above targetted capacity. The other recommendations of HLEC are :

- Withdrawal of excise duty on refrigeration plant and machinery and import duty on raw material used for insulation.
- Withdrawal of sales tax on refrigeration equipment.
- Total repeal of Cold Storage Acts in the states and rental ceiling as also concessional power tariff to cold stores. Also broadening of insurance coverage.
- The committee also made recommendations relating to uninterrupted power supply, in-plant training for the cold storage personnel with a thrust on extension and data collection of horticultural crops.
- Vide letter No.NCDC:9-1/98-P(F&V) dated 7.3.2000 the NCDC has circulated details of Capital Investment Subsidy Scheme for construction/expansion/ modernization of cold storages and storages for horticultural produce. The schemes provides for Back

- Ended Subsidy (BES) to the extent of 25% of the project subject to a maximum of Rs 50 lakhs and @ 33.33% of the project cost subject to a maximum of Rs 60 lakhs in North-Eastern State for a 5,000 tonnes capacity cold storage. With the introduction of CIS, the soft loan assistance available under NHB scheme as well as grant-in-aid available under the DFPI scheme have been discontinued.

Initially, the amount of subsidy would also be sanctioned as a loan to the State Govt. for which a separate account would be maintained by the State Govt. No interest on such loan would be charged by NCDC till the completion of the unit in stipulated period of 18 months. On completion, this loan will be converted into subsidy.

FUTURE THRUST OF NCDC

The NCDC's endeavour is to, among others, develop fruit and vegetable cooperatives and enable them to market and process horticultural produce in an efficient manner. The NCDC is assisting fruit and vegetable cooperatives for practically all aspects of post- harvest operations. The cooperatives are being encouraged to set up modern facilities for marketing and export of fruits and vegetables. Emphasis has been laid in organiszing cooperative marketing projects in and around medium and large towns.

TECHNOLOGICAL DEVELOPMENT AND ADOPTION OF COOL CHAIN MANAGEMENT IN HORTICULTURAL PRODUCE

J. P. Negi*

There has been a significant increase in consumption of fresh fruits and vegetables, mainly due to health concerns. These changes have made it necessary to develop modern technologies to preserve perishable food items. A well-organized cold-chain is a prerequisite in India to guarantee the supply of high-quality fresh horticultural products for domestic and export markets. Ideally managed, a cold-chain requires to start at the farmer level and cover up to the consumer or at least to the retail level. The enhanced range of cold-chain services assures that quality and organizational demands that are placed upon the Indian perishable horticultural product sector by export markets can be met. More efficient use and implementation of latest technologies in cold-chain management cannot only reduce the wastages in handling and transportation of perishable produce in India but also generate a significant export stream.

Temperature and relative humidity control are most important post-harvest techniques for the preservation of fresh horticultural crops. It is referred to as "Maintaining the Cold Chain" during post-harvest handling and marketing.

Pre-cooling of Perishable Produce

Pre-cooling or rapid cooling is the rapid removal of field heat and starting point for cold-chain management. It reduces respiration (for less perishability), transpiration (less water loss and shriveling), ethylene production, activity of microorganisms and ripening and also increases resistance to ethylene action. The speed for pre-cooling varies from 1-24 hours depending on perishable nature of the produce. The popular pre-cooling methods includes: room cooling, forced (pressure) air cooling, hydrocooling, vacuum/hydro-vacuum cooling, evaporative cooling, contact/package/topicing etc.

Room cooling, the conventional method, has lower cost but may not be very effective for very perishable products. The product (packaged or not) is exposed to cold air in normal cold store with air velocity of 60-129 m/min. and the cooling rate is comparatively low. Adequate packages/stacking is required for better cold air flow.

Forced-air cooling method creates a pressure gradient on opposite ends, and thus forces air through stacks and a large volume of cold air has to be used with an increased air velocity. Cooling in this method is 4 -10 times faster than room cooling but the initial cost is higher. Perishable crops that are not water tolerant can be cooled using this method.

Hydrocooling method uses cold water for cooling and is characterized by rapid cooling (faster than air) and causes less water loss from commodities. Water needs to be disinfected and cleaned regularly to avoid contamination and products and packages has to be water tolerant.

Vacuum cooling involves boiling off some water in the commodity at low pressure. When water loss is excessive hydrovacuum cooling is utilized. Rate of cooling is dependant on the surface/volume ratio of the produce. It is fast in products with high surface/volume ratio and very low in products with low surface/volume ratio. Initial cost for this method is also very high.

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Evaporative cooling method does not use any mechanical refrigeration system and cools with the evaporative cooler and cooling is obtained with humidified cold air or misting. The cooling rate in this method is limited and involves low energy cost. This method is more suitable for regions with low relative humidity (<65%) and good quality water supply. This method is mostly adapted for chilling sensitive crops.

Finely crushed ice or ice slurry containing liquid ice with 40% water, 60% ice and 0.1% salt can also do cooling. This method is commonly used during transit but results in slow and limited cooling. But this method is mostly recommended as a supplement to other pre-cooling methods.

Cold storages for refrigeration

Conventional cold storages are commonly constructed with concrete blocks. However, steel buildings are now used for modern cold stores, especially for refrigerated CA rooms. Selection of thermal insulation is important to provide adequate temperature control. Cold rooms operating in warm areas are designed with higher thermal insulation values (R). Higher R values (resistance to heat flow) indicate greater resistance to heat flow and better insulating characteristics.

Vapor barriers are important to prevent moisture accumulation that deteriorates thermal insulation and even causes structural damages due to rotting and rusting. Materials like 0.001-inch polyethylene is commonly installed, especially at the warmer side of the cold room as vapor barriers.

Most storage facilities use mechanical refrigeration to control storage temperature. This system utilizes the fact that a liquid absorbs heat as it changes to a gas. Simplest method to do this is to allow a controlled release of liquid nitrogen or liquid carbon dioxide in the storage area. However, this method requires a constant outside supply of refrigerant and is only used to a limited extent with highway vans, rail cars or air cargo ships. The more common mechanical refrigeration systems use a refrigerant such as ammonia or a variety of halide fluids (sometimes referred to by the trade name of "freon") whose vapor can be easily recaptured by a compressor and heat exchanger.

Heat from inside the cold room is absorbed due to the change of phase of the refrigerant used. The liquid refrigerant is accumulated in a receiving tank (usually located outside the room) at high pressure and flows as needed and boils in the evaporator (usually inside the room) under low pressure. The heat is then absorbed by the evaporating refrigerant resulting in cooling the air in the room, and thus the stored commodities. The cold low-pressure vapor is compressed and (compressor usually outside the room) and the hot compressed vapor is condensed and converted to liquid again, which is accumulated again in the receiving tank to flow when needed.

Small mechanical refrigeration systems are controlled by the expansion valve, which regulates the pressure of the refrigeration in the evaporator. Low pressure causes the liquid refrigerant to evaporate at low temperatures. The valve also controls the flow of refrigerant, which affects the amount of refrigeration capacity available. Capillary tubes and thermostatic expansion valves are the most common types of expansion valves. Large refrigeration systems commonly use an evaporator coil that is designed to always have liquid refrigerant in it, called a flooded coil. It has a greater heat transfer efficiency than a non-flooded coil of equal size. Refrigerant flow is controlled primarily with a float control that ensures a constant level of refrigerant in the coil. The float control also operates in parallel with a thermostatic expansion valve. Other controls such as suction pressure regulators are also used in conjunction with float controls to maintain the highest possible evaporator coil temperature to maintain high humidity in the storage room.

Modern cold storages usually use finned tube evaporators. Air from the storage is forced past

the tubes by fans, which are a part of a complete evaporator unit. Evaporators operating near 0°C build-up frost that must be removed to maintain good heat transfer efficiency. Defrosting is done by periodically flooding the coils with water, by electric heaters, by directing hot refrigerant gas to the evaporators, or by continuously defrosting with a brine or glycol solution.

The most common types of refrigeration compressors are reciprocating (piston) and rotary screw. Reciprocating compressors some in a wide range of sizes and can be set up to operate efficiently at varying refrigerant flow rates. The main disadvantage of reciprocating compressors is their fairly high maintenance costs. Rotary screw compressors have low maintenance costs but are not available in smaller sizes and they operate efficiently only at near-maximum refrigerant flow-rates. It is a common practice to use screw compressors for base load refrigeration needs and reciprocating compressors for the portion of the load that varies significantly during the day.

Condensers are categorized as air-cooled or water-cooled. Small systems usually use an air-cooled unit and large condensers are likely water-cooled. As water is a better heat conductor than air, water-cooled condensers are smaller than forced-air units of equal capacity. Water-cooled units, however, require large quantities of water, which might be expensive to obtain and dispose off. Evaporative condensers are able to reduce water consumption by recycling the heated condenser water, but they require continuous and close monitoring.

Basically two types of refrigerants are commonly used in cold stores: ammonia and halide fluids. Halide refrigerants are more expensive than ammonia and some of them are also suspected to harm the environmental balance. Both types of refrigerants have some restrictions also like ammonia cannot be used with metals that contain copper and halide refrigerants cannot be used with magnesium and might damage plastic materials too.

Most horticultural crops require high relative humidity during storage and transport. High RH in store is established by maintaining the least temperature difference between the outlet and inlet of the evaporator. In a cold room operating at 0°C a temperature difference of 1°F provides a relative humidity (RH) of 95.8%, a difference of 3°F provides a RH of 87.1% and a difference of 10°F provides a RH of 62.7%. Increasing humidity in the store is also effective with the use of humidifiers.

Transport of Perishable Commodities

Refrigerated transport is a vital link in the cold chain and several technologies have developed to improve the handling of fresh horticultural crops during transportation. Reefer or intermodal refrigerated containers and refrigerated vehicles have become an integral part of managing the cold chain.

Reefer or intermodal containers are specialized forms of transportation. Normally these are of a standard size of 8 (width) X 8.5 (height) ft cross-section and 10, 20, 30, or 40 feet long. Refrigeration of the container is either independently powered electrically by the container vessel (integral containers), or provided entirely by the vessel system (porthole containers). Most containers for fresh fruits and vegetables are constructed with bottom air delivery. Reefer containers have several advantages attached such as loadability at packinghouses, reduction in handling losses, independent temperature control, possibility for the use of modified and controlled atmosphere systems.

Truck refrigeration units are compact systems with automatic; self protected mechanisms for constant temperature control. Refrigerated containers are mounted on trucks and have insulated bodies with reinforced plates all around. The overcab refrigeration units consist of mechanisms for temperature control, defrosting system, evaporator and automatic controls for optimum efficiency. Thermostats

control the cooling and heating system, the defrost mechanism and fans. Temperature monitoring devices are also located in return-air and discharge-air channels. Air circulation is also an important factor to maintain uniform temperature, to avoid build-up of heated spots and also to avoid build up of are gases and volatiles. Two types of air circulation are most commonly used: top/horizontal air delivery (common in road transport vehicles) and bottom/vertical air delivery (used in marine containers).

Technological Advancements in Transport of Perishables: Transportation in MA/CA

Transportation in MA/CA encourages the use of sea transport and it is beneficial as the costs incurred are much lower. Atmospheres for transport can be developed passively, semi-actively or actively. Passive systems are MA regimes where the atmosphere is modified by fruit respiration and the permeability of a barrier material. In the semi-active systems, one or more gas(s) is/are added or withdrawn, most commonly at the beginning, but no strict control is carried out. Active systems imply a strict control of the atmosphere during the entire transport period. The semi-active systems are the most commonly used one for being cheaper as compared to the active systems. The use of CA technology for food transport is also a practical reality today. A CA container has the same features as that of a refrigerated container, in addition to a higher level of gas tightness: O_2 and CO_2 control systems, and systems for control of ethylene and relative humidity (RH). CA systems for transport are used when transport periods are longer and food/product is highly perishable.

Modern Cold Storage Technologies: Modified (MA) / Controlled Atmosphere (CA)

Controlled Atmospheres (CA/MA), used as a supplement to proper temperature and relative humidity management, can contribute significantly in extending post-harvest life and maintaining quality of many perishable products. Controlled atmospheres usually involve reduction of oxygen (O_2) and/or elevation of carbon dioxide (CO_2) concentrations to achieve an atmospheric composition around the product that is different than normal air (78.08% of N_2, 20.95% O_2, 0.03% CO_2). The proper selection of oxygen and carbon dioxide levels and consequent benefits and risks are dependent upon the product, variety, region, physiological age, atmospheric composition, and duration of storage and transport. Controlled Atmosphere (CA) and Modified Atmosphere (MA) differ only in the degree of control. CA is more exact and provides active control during the entire period. Hypo baric (low pressure) storage is a CA storage system involving the use of vacuum to reduce the partial pressure of the gas component of the air. The industry of MA Packaging (MAP) is also gaining popularity all over.

Advantages of Using CA/MA

The advantages of CA/MA are:

- Retardation of metabolic process and slowing down of respiration and ethylene production rates, softening, and compositional changes of perishable products
- Retardation of loss of some nutritional substances such as vitamins
- Alleviation of certain physiological disorders such as chilling injury of fruits and vegetables, russet spotting, and scald of fruits and vegetables
- CA/MA can have a direct or indirect effect on post-harvest pathogens and consequently reduce decay incidence and severity
- Low O_2 (0.5% and lower) and/or elevated CO_2 (40-80%) for short durations, alone or in combination with heat treatments can be a useful tool for insect disinfestations in some commodities to meet quarantine requirements of importing countries.

The CA and MA are used to transport almost all fruits and vegetables. Packaging in MA is also used for several types of foods, including minimally processed fruits and vegetables. It is sure that CA/MA used for short-term storage and transport for fresh horticultural crops will continue to increase supported by technological developments. CA/MA conditions can also replace certain post-harvest chemicals used for control of some physiological disorders, such as scald on apples. Furthermore, some post-harvest fungicides and insecticides can be reduced or eliminated where CA/MA provides adequate control of post-harvest pathogens or insects. CA/MA can also facilitate picking and marketing more mature fruits by slowing their post-harvest deterioration to permit transport and distribution. Another potential use for CA/MA is in maintaining quality and safety of fresh-cut (lightly-processed) fruits and vegetables, which are increasingly being marketed as value-added, convenience products.

In some cases CA/MA may not extend the storage time but may still confer benefits such as preventing chilling injury or maintaining firmness of some fruits.

There are also some potential hazards and harmful effects of MA and CA, when used improperly:

- Initiation or aggravation of some physiological disorders, irregular ripening, and increased susceptibility to decay in fruits and vegetables
- Fermentation and production of off flavors in different types of foods
- Potential development of anaerobic bacteria, especially when temperature is higher than optimum
- Structural deterioration in storage rooms and transport containers that lack proper pressure relief systems

The residual effects of CA/MA on fresh commodities after transfer to air may include reduction of respiration and ethylene production rates, maintenance of desirable color and firmness, and delayed decay. Generally, the lower the concentration of O_2 and the higher the concentration of CO_2 (within the tolerance limits of the commodity), and the longer the exposure to CA/MA conditions, the more prominent are the residual effects.

Ultra Low Oxygen (ULO) Storage

Ultra Low Oxygen systems are made up of not only controlled atmosphere, but several other parameters are also controlled in the cold stores. Fruits and vegetables are basically made up of carbohydrates and when stored in conventional cold store they still have respiration/breathing. Oxygen (from air inside the cold chamber) is thus converted into carbon dioxide and it ripens the stored items faster and causes wastages. This also results in more carbon dioxide and less oxygen in the cold chamber. The ULO system prevents the above-mentioned problem to a very large extent and ensures very long storage periods without deterioration in quality.

After a product is stored in a cold chamber, nitrogen gas is purged in it to flush out oxygen, which as termed as pull-down. The CO_2 generated by the breathing of the commodity is passed through CO_2 scrubber, minimizing the attack of CO_2 on the fruit and as nitrogen is being purged simultaneously, oxygen content in the chamber is also maintained at extreme low level. For example, for some fruits 1% oxygen, 5% CO_2 and 90% relative humidity is maintained in the chamber. But this gas composition

varies with the properties of the stored products. In an Ultra Low Oxygen system, a nitrogen plant is always connected on line but remains mostly (except for pull-down period) in stand-by condition and is started automatically whenever there is a need for it.

Advantages of ULO storages

- Much longer storage periods
- Considerable energy savings in many cases
- Minimal / zero wastage
- Applicable to stationary cold storages as well as containerized and mobile systems
- Suitable for multi-product storages

Recent Developments in CA/MA and ULO Storage systems

In the last 2 decades several advances have been accomplished in storage of foods in CA/MA:

- Development of sealed rooms
- Air separation techniques
- Introduction of membrane technology
- Use of better gas monitoring and control techniques such as infrared for CO_2 and electromechanical and paramagnetic systems for O_2
- Automation, especially for gas monitoring and control

EMERGING SCENARIO AND FUTURE STRATEGY FOR DEVELOPMENT OF MICROIRRIGATION AND FERTIGATION IN INDIA

Ashwani Kumar* and H.P. Singh**

In India, major water resources are river, lake, canal, reservoir, tank and groundwater. It is estimated that around 88% of the fresh water resources are currently being used for agriculture and remaining water is fulfilling the industrial and domestic requirements. In the present era of development, all the sectors of economy are demanding larger qualities of fresh water. Thus, tremendous amount of pressure lies on agriculture sector to reduce its share of water and at the same time to enhance total production, which could be achieved by enhancing productivity with increased water-use efficiency.

In India, the efforts were made to develop irrigated area through development of water resource, in the process, water distribution sector and application of water did not get due attention for its efficient utilization. Many parts of the irrigated areas have become waterlogged and affected by soil salinity problems resulting into low productivity of fertile lands. This is mainly due to traditional flood irrigation and slow adoption of scientific practices of irrigation water management. Added to these drawbacks, major and medium irrigation projects also suffered from wide variations in soils, climate and cropping sequence, across the length and breadth of the irrigated command area. The present productivity of irrigated command area is around 2-3 tonnes/ha against 4-6 tonnes/ha in research farms. The current food production of India is 203 million tonnes and population of the country being around 1,000 million. Although, in present era there is no food shortage to feed a large population in the country. At present under liberalized economic situation and WTO agreements, more concentrated efforts are required to harvest quality produce with minimum cost of production. It is possible with the scientific method of cultivation and judicious use of all the inputs. However, judicious use of irrigation water for agriculture is more important to enhance productivity, at the same time save irrigation water which is so valuable and limited. This can be achieved by introducing advanced method of irrigation like microirrigation coupled with fertigation and other imporved water management practices.

In India, fertigation is in introductory stage with microirrigation system and its success depends upon how efficiently plants uptake the nutrients. Proper scheduling must be planned as to provide nutrients at a time when plants require them. In India, fully soluble fertilizers are limited in availability. However, some firms initiated manufacturing of water-soluble fertilizers but it was not price competitive. The Government of India has a subsidy structure for the conventional fertilizers for approved grades, but for fertigation the requiremnet of water-soluble fertilizer varies with respect to its grade in comparison to conventional fertilizer. The Government should adopt a fertilizer policy in such a way that the manufacturers of fully-soluble fertilizer are not in disadvantage compared to conventional fertilizer manufacturers. The crop experiment also show quite successful results in terms of yield advantage, saving of fertilizer and quality of produce.

The efforts were made to introduce microirrigation system at farmers level around 1980. The growth of microirrigation has picked up momentum which could be observed that in 1985 it had the

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area of 1,500 ha against present area of 0.35 million ha. To promote the concept the efforts have been made at research level by the ICAR. The SAUs. National Committee on Use of Plastics in Agriculture, Ministry of Water Resources and State Governments undertook the promtional activities. R&D efforts are however, required to lack of address the high capital cost, the operational problems of microirrigation system. Non-availability of spares, know-how at grassroot level and integration of fertigation/ chemigation along with the system are other areas needing attention.

MICROIRRIGATION SYSTEM

Microirrigation is an efficient method of providing irrigation water directly into soil at the root zone of plants. It permits the irrigation closely to the consumptive use of plants. Thus, microirrigation minimizes such conventional losses as deep percolation, run off and soil evaporation. It also permits the utilization of fertilizer, pesticides and other water-soluble chemicals along with the irrigation water with better crop response.

Microirrigation system consists of laterals, sub mains and main lines (Fig 1). The lateral can be a small plastic tube combined with emitters or microsprinklers. The laterals are designed for distributing water into the field with an acceptable degree of uniformity. The sub main acts as a control system, which can adjust water pressure in order to deliver the required amount of flow into each lateral. It also controls irrigation time for individual fields. The main line serves as a conveyance system for delivering the total amount of water for microirrigation system. There are supporting parts such as filters, flushing units, pressure gauge, fittings, valves, fertilizer injection etc, which are used to serve different purposes in the irrigation system. The system applies water at low rate under pressure to keep the soil moisture within the desired range for plant growth (Fig 2).

A properly designed microirrigation system can help growers of fruits, vegetables, flowers and

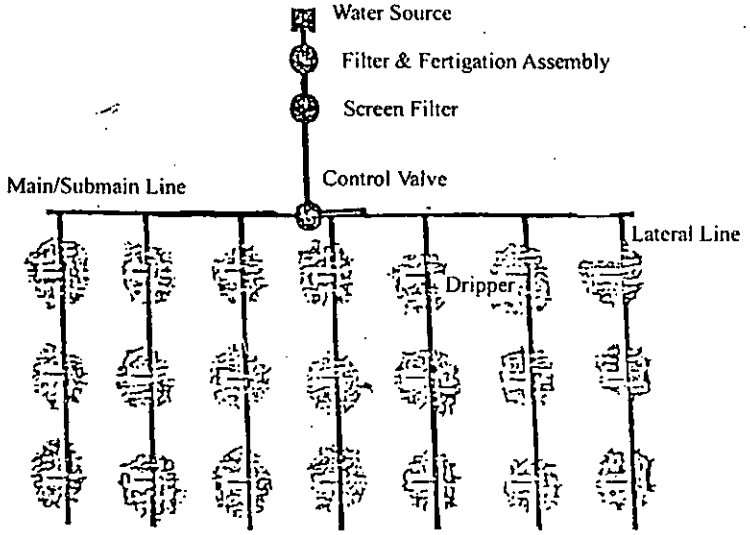

Fig 1. Typical microirrigation system

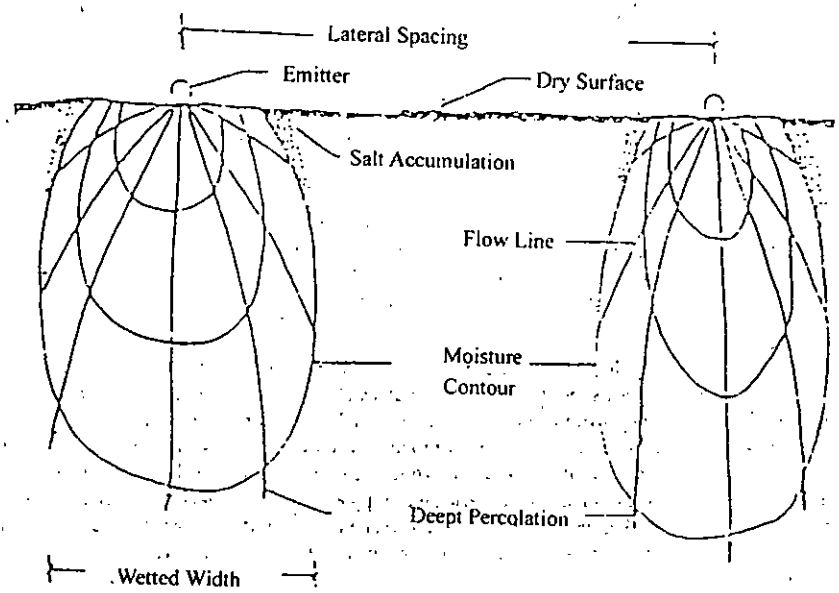

Fig 2. Typical Soil Moisture Pattern Under Microirrigation System

other cash crops by :

- Saves water
- Increases yield
- Improves quality of the produce
- Reduces labour cost
- Reduces salt concentration in the root zone
- Allows chemicals/fertilizers (soluble) to be used through the system
- Keeps inter row spaces firm and dry
- Permits use in greenhouse
- Controls and reduces diseases

There are 3 general types of water emitting devices used in microirrigation :

- Water seeps out continuously along the lateral line/drip

- Water sprays or drips from a micro sprinkler/sprayer/emitter/ spitter connected inserted in the lateral.
- Water sprays or drips from holes punched in the lateral.

STATUS OF MICROIRRIGATION

Historical Perspective

Internationally, microirrigation was developed originally as a sub-irrigation system and the basic idea underlying microirrigation can be traced back to experiments in Germany in 1860s. The first work in microirrigation in the United States was a study carried out by House in Colorado in 1913. An important breakthrough was made in Germany way back in 1920 when perforated pipe microirrigation was introduced.

During the early 1940s. Symcha Blass, an Israeli Engineer, observed that a big trees in the area, which were not reached by water from tap. This led him to the concept of an irrigation system that would apply water in small quantity literally drop by drop. In Israel, the first extensive research was conducted in the Arava and Negave deserts where adverse conditions of climate, very sandy alkaline soils and saline water had produced good results on crops grown with drip irrigation methods compared to conventional methods.

In India microirrigation was practised through indigenous methods such as bamboo pipes, perforated clay pipes and pitcher/porous cup irrigation. In bamboo microirrigation systems, long hollow bamboo pipes of varying diameter (50-100 mm) are used for making channels. In Meghalaya, some of the farmers are using bamboo microirrigation system for betel, pepper and arecanut crops by diverting hill streams in hill slopes. The discharge at the head varies from 15 to 20 litres/min. and is reduced to 10-30 drops/min. at the time of application. Individual farmers for smaller land holdings can advantageously use these methods. In Maharashtra, perforated earthen ware pipes were used and their efficeincy and benefit: cost ratio have been elaborated for popularizing them. Earthen pitchers and porous cups have also been used for growing vegetable crops in Rajasthan. The technique envisages embedding of earthen cups of 500 ml capacity at the site of seedlings. The cups are filled with water at 4-5 days interval.

Clay emitter system is comparable to pitcher irrigation system, which is traditionally being used as a method of irrigation in some parts of India. This system is suitable for crops having low water requirements, because the discharge rate per emitter is only 2-2.5 lpd. The emitters are 8 cm long fired clay tubes tapered at both ends. The emitters are shaped by using press moulds of 8 cm lengths or extruded for 30 cm lengths and larger volume dried in the shade and then fired to about 65° C. According to distance between the plants, the emiters are connected serially at the specified distance with LDPE/

LLDPE pipes, fixed with the help of white zinc oxide paste and laid underground in the fields. The depth varies with soil and crop types. A 300-litre drum filled with water and kept on a slightly raised platform serves as reservoir.

Emitters with greater porosity emit more water. The porosity of the emitters is dependent upon soil type. Further, soil adjacent to the emitter is generally at "Field Capacity". Initially when the soil is dry and has high moisture tension, a large body of water moves actively from emitter to the soil, i.e. about 2,000 - 2,500 ml/day. As the wet soil zone around the emitter stabilizes, the discharge from the emitter also automatically decreases and after a period of just two weeks, 10 - 15 ml of water is discharged per day.

Present Scenario of Microirrigation in India

Microirrigation is used extensively in many countries. In India, its development is slow compared to other developing countries. Experiments and farm trials have been going on in India from 1970 onwards. Progressive farmers in Andhra Pradesh, Karnataka, Kerala, Maharashtra and Tamil Nadu have adopted this method in the late seventies, even though there was no subsidy or any support from the State Government at that time. Research work has been taken up by various agricultural universities, research institutions, PDCs, National Committee on Use of Plastics in Agriculture and AICRP on Application of Plastics in Agriculture of ICAR, manufacturers, farmers etc. The results of various research studies undertaken for the last few years are described in Table 1. It is evident that microirrigation saves water up to 84% depending on crop and situation and increases yield up to 66.6%.

The growth of microirrigation has really gained momentum in recent years. From a mere 1,500 ha in 1985, the area under microirrigation has grown to 3,55,400 ha at present (Table 2). These developments have taken place mainly in areas of acute water scarcity in Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu and Gujarat. The important crops under microirrigation systems are coconut, grape, banana, mango, sapota, pomegranate, other fruit trees, crops like sugarcane, cotton, groundnut, vegetables, flowers etc.

Promotion of Microirrigation in India

To promote the concept of microirrigation system at farmers' level various developmental schemes under Department of Agriculture and Cooperation, Government of India, are being implemented in the country.

- Use of Plastics in Agriculture
- Oil Palm Development Programme (OPDP)
- Integrated Crop Development Programme on Sugarcane (ICDP).

Table 1. Relative performance of crops with drip irrigation in comparison with that of traditional irrigation methods

Crop	Location	Yield (q/ha)		Irrigation water (cm)		WUE (q/hacm)		Adv. of drip irrigation	
		Surface	Drip	Surface	Drip	Surface	Drip	Saving of Water (%)	Inc. in Yield (%)
Ash gourd	Jodhpur	108	120	84	74	1.3	1.6	12	10
Beet	Coimbatore	5.7	8.9	86	18	0.07	0.05	79.1	36
Bottle gourd	Jodhpur	380	558	84	74	4.5	7.5	12	31.9
Bitter gourd	Chalakudy	32	43	76	33	0.42	1.3	56.6	25.6
Brinjal	Akola	91.0	148.0	168.0	64.0	0.55	2.3	62.0	38.5
	Delhi	280.0	33.8	45.0	35.0	6.2	9.7	22.2	17.2
	NCPA	280.0	320.0	90.0	42.0	3.11	7.6	53.3	12.5
	Pune	225.0	245.0	78.0	51.0	2.9	4.8	34.6	8.2
	Rahuri	280.0	280.0	90.0	42.0	3.11	6.7	53.3	0.0
Broccoli	Delhi	140	195	70	60	2	325	14.3	28.2
Cauliflower	Akola	83.0	116.0	39.0	26.0	2.1.0	4.5	33.3	28.4
	Pantnagar	171.0	274.0	27.0	18.0	6.3.0	15.2	33.3	37.6
Chilli	NCPA	42.3	60.9	109	41.7	0.39	1.5	61.7	30.5
Cucumber	Pune	155	225	54	24	2.9	9.4	55.6	31.1
Okra	Coimbatore	100.0	113.1	53.3	8.6	1.87	13.2	84.0	11.6
	Delhi	360.0	480.0	42.0	26.0	8.6	18.5	38.1	33.3
	Rahuri	189.0	203.0	219.0	113.0	0.86	1.8	48.4	7.4
Onion	Delhi	284.0	342.0	52.0	26.0	5.5	13.2	50.0	17.0
	Hisar	93.0	112.0	60.0	45.0	1.6	2.5	25.0	17.0
Potato	Delhi	172.0	291.0	60.0	27.5	2.9	10.6	54.2	41.0
	Hisar	235.7	344.2	20.0	20.0	11.8	17.2	0.0	31.5
	Parbhani	320.0	480.0	32.4	22.2	9.9	21.6	31.5	33.3
Raddish	Coimbatore	10.5	11.9	46	11	0.23	1.1	76.1	11.8
Sugarbeet	Hisar	418	489	50	37	8.4	13.2	26	14.5
Sweet potato	Coimbatore	42.4	58.9	63	25	0.67	2.4	60.3	28
Tomato	Akola	45.0	58.0	102.0	77.0	0.44	0.75	24.5	22.4

	Coimbatore	61.8	88.7	49.8	10.7	1.24	8.28	78.5	30.3
	Delhi	257.0	396.0	47.0	25.0	5.5	15.8	46.8	35.1
	NCPA	320.0	480.0	30.0	19.0	10.7	25.3	36.7	33.3
	Pantnagar	104.0	137.0	22.0	14.0	4.7	9.8	36.4	24.1
	Parbhani	320.0	480.0	32.4	22.2	9.9	21.6	31.5	33.3
	Pune	292.0	413.0	31.0	20.0	9.4	20.7	35.5	29.3
	Rahuri	16.4	17.2	29.7	20.8	0.6	0.82	30.0	4.7
	Udaipur	144.0	175.0	41.0	28.0	3.5	6.3	31.7	17.7
Banana	Bhawanisagar	277.0	329.0	186.0	172.0	1.5	1.9	7.5	15.8
	Kharagpur	290.0	400.0	106.0	106.0	2.74	3.8	0.0	27.5
	NCPA	575.0	875.0	176.0	97.0	3.27	9.0	45.0	34.3
Ber	Belvatgi	13.7 kg/tree	18.0 kg/tree	15.4m³ /plant	12.5m³ /plant	0.9	1.4	18.8	23.9
Grape	Dharwad	101.0	101.	53.0	28.0	1.91	3.6	47.2	0.0
	NCPA	264.0	325.0	53.0	28.0	5.0	11.6	47.2	
Guava	Allahabad	0.16/ plant	0.22/ plant	6.4m³ /plant	5.21m³/ plant	0.03	0.04	18.6	27.3
Kinnow	Delhi	68	98	22.1	17.3	3.1	5.7	21.7	30.6
Lemon	Delhi	15	27	23	17.5	0.65	1.54	23.9	44.4
Papaya	Coimbatore	130.0	230.0	228.0	73.0	0.6	3.20	685	43.5
	Kalyani	312.0	383.0	24.0	11.0	13.0	34.8	54.2	18.5
Pomegranate	Belvatgi Delhi	7.4k/t	14.4k/t	10.7m³	8.7m³/t	0.7	1.7	18.7	48
	Hyderabad	34.0	67.0	t		1.62	4.2	23.8	49.3
		15.0	37.0	21.0	178.0	0.08	0.21	2.7	59.5
				183.0					
Water melon	Jodhpur	294.6	882	80.0	80.0	3.7	11.0	0.065.3	66.6
	Pune	82.1	504	72.0	25.0	5.9	20.2		16.3
Cotton	Coimbatore	26.0	32.6	85.6	30.2	0.30	1.1	64.7	20.2
	NCPA Rahuri	23.0	30.0	90.0	42.0	0.26	0.71	53.3	23.3
		22.5	31.4	81.5	51.1	0.27	0.6	37.3	28.3
Groundnut	Delhi	22.0	27.0	43.0	26.0	0.5	1.04	39.5	18.54.5
	Junagarh	21.0	22.0	110.0	65.0	0.2	0.34	40.9	17.9
	Navsari	23.0	28.0	60.0	59.0	0.4	0.5	1.7	73.8
	Pune	91.0	347.0	87.0	54.0	1.05	6.4	37.9	35.5

Sugarcane	Udaipur	20.0	31.0	73.0	53.0	0.3	0.6	27.4	
	Bhawanisagar	1268.0	1675.0	148.0	119.0	8.6	14.1	19.6	21.3
	Coimbatore	920.0	1190.0	136.0	92.1	6.8	13.0	32.3	22.7
	Delhi	706.0	1161.0	142.0	105.0	5.0	11.0	26.0	39.2
	Navsari	950.0	1338.0	104.0	90.0	9.1	14.9	13.5	29.0
	NCPA	1280.0	1700.0	215.0	94.0	6.0	18.1	56.3	24.7 0.7
	Pune	1200.0	1208.0	180.0	107.0	6.7	11.3	40.6	16.4
	Rahuri	1220.0	1460.0	231.0	162.0	5.3	9.0	30.0	

Source : CAZRI, Jodhpur; TNAU Coimbatore; Water Management Centre, PKVV, Akola, IARI, Delhi; HAU, Hisar; I.I.T., Kharagpur; MPKV, Rahuri; University of Agric. Sciences, Dharward; Rajasthan Agric. University

Table 2. Area covered under drip irrigation in India

State	Area (ha)
Andhra Pradesh	39.500
Assam	200
Gujarat	10.00
Haryana	2.400
Karnataka	50.000
Kerala	7.500
Madhya Pradesh	3.800
Maharashtra	1.54.000
Orissa	3.000
Punjab	2.000
Rajasthan	35.000
Tamil Nadu	42.500
Uttar Pradesh	2.500
West Bengal	200
Others	2.000
Total	3.55.400

OPERATIONAL ASPECT OF MICROIRRIGATION SYSTEM

Since the evolution of microirrigation system, a major problem associated with the system is the dripper clogging. Discrete particulate matter may produce blockage in system, by chemical precipitation, or by microbiological matter either directly or by aggregating inorganic material. If particulate matter (sand) is the cause of blocking, the solution is to ensure by improved primary filtration

Table 3. Fertilizer solubilities of conventional fertilizer (at 20°C)

Fertilizer	Solubility
Potassium chloride	340
Ammonium sulphate	750
Urea	1060
Potassium sulphate	110
Potassium nitrate	320
Monoammonium phosphate	370
Magnesium sulphate	250

that the water pathway in the system is larger in bore than the largest particle. However, if chemical precipitation (or microbiological aggregation) is the cause of blocking a high velocity of flow to prevent such precipitation occurring within the system is required. Unfortunately, these differences in needs are still not widely recognized and a tendency has developed to increase the bore of the water pathway in drip system regardless of the cause of blocking. The need for primary filtration to remove discrete particles is universally accepted and the maximum permissible particle size ratio of 1 to 10 has been suggested by Peleg.

Mc Elhoc and Hilton found that improving filtration to remove particles greater than 25 micron rather than 90 micron reduced the level blockages over 80 days operation from 92 to 78% but treatment with intermittent chlorination at 10 ppm for 20 min. per day on water filtered to 90 micron reduced the level blockage from 92 to 10%. Other additives with bactericidal or algicidal properties had similar but less marked effects. Mc Elhoe and Gibson have confirmed the effect of chlorination but obtained higher levels of blockages with chlorinated sand filtered water than with chlorinated screen mesh-filtered water.

The clogging problem often discourages to the operators and consequently cause the abandoning of the system and return to less efficient method of irrigation. It is the quality of irrigation water, i.e. suspended load, microbial activity and chemical composition, to which, the dripper clogging can be directly related. Fertilizer injected into the drip lines may also contribute to clogging. Consistency of the water quality must be considered and filtration must be planned for the average worst condition. Open water such as lakes, ponds, rivers, streams and canals can vary widely in quality and often contains large amount of organic matter and silt. Warm weather light and slow moving or still water

favour rapid algal growth. The water may also be chemically unstable and produce chemical precipitates in the pipes and drippers.

To rectify the problem for system operation for several years without treatment Moris and Black (1973) suggested slug dosing with chlorine at 1000 ppm for 24 hours to destroy organic matter. Where bore water is used for microirrigation, the chemical composition of water will have an important bearing on the source of clogging material and specific action to overcome each problem may be required. Peleg (1974) suggested that where precipitation of carbonates is a major source of blockages, treatment with one per cent hydrochloric acid for about 10 minutes will clear partially blocked system. Black suggested this problem can be minimized if the reticulation system is buried a few centimetres below the soil surface to reduce the temperature rises responsible for the precipitation of carbonates from the soluble bicarbonates. Biochemical precipitation of iron and sulphur produces blockages from well water in Florida. Sulphur precipitation can be reduced by reducing the pH of the water and iron precipitation may be reduced by chlorination. Calcium and oxidative iron precipitation have been successfully prevented from causing blockages in Australia by injecting poly-phosphates as chelating material into the irrigation water 3-5 ppm.

CRITERIA FOR FERTIGATION

All chemicals applied through irrigation system must avoid corrosion, softening of plastic pipe and tubing, or clogging any component of the system. It must be safe for field use, must increase or at least not decrease crop yield, must be soluble or emulisifiable in water; and it must not react adversely to salts or other chemicals in the irrigation water. In addition, the chemicals or fertilizers must be distributed uniformly throughout the field. Uniformity of distribution requires efficient mixing, uniform water application and knowledge of the flow characteristics of water and fertilizer in the distribution lines. To avoid clogging, chemicals are applied through microirrigation systems, to dissolve the deposits in drip lines. The solubility of some of the fertilizers are given in Table 3.

APPLICATION OF FERTILIZERS

Nitrogen Applications

Nitrogen, the plant nutrient most commonly deficient for crop production, is often applied in microirrigation system. Nitrate nitrogen moves readily in the soil with irrigation water and can be applied separately or in mixture with such compound as ammonium sulphate, urea, calcium ammonium nitrate and ammonium nitrate. Calcium nitrate can also be used when bicarbonates are low. Anhydrous ammonia, aqua ammonia and ammonium phosphaste in most instances cause clogging problems. Nitrogen source selection should be based on its possible reactions with irrigation water and soil. In general, first five nitrogen fertilizers mentioned will cause few, if any precipitation problem in drip irrigation system. Several researchers Bester/Marsh and Shani, have proposed various reasons for the increased efficiency of fertigation because fertilizer is applied only in root zone, improved timing of fertilization, because more frequent application makes it possible to match plant requirements of various growth stages, improved distribution of fertilizer with minimum leaching beyond the root zone or runoff. Phene (1979) found that nitrate concentrations remained higher in root zone with frequent drip irrigation of sweet corn than with flood or sprinkler irrigation. Rolston and Broadbent found that little denitrification occurred in a clay loam soil if the soil tension is higher (i.e. drier soil) than 10 bar. Phene (1979) have shown that high frequentation nitrogen application on shallow sandy loam soil with drip irrigation improved the efficiency of nitrogen use by potato more.

CONCLUSION

In India, the efforts were made to introduce microirrigation system at farmers' level around 1980. Microirrigation conserves irrigation water easily doubling the command area of a water source

and can give yield advantage up to 50%. To promote the concept, research level efforts have been made by Indian Council of Agricultureal Research, Agricultural Universities, National Committee on Use of Plastics in Agriculture, Ministry of Water Resources, Drip Manufactures Association and State Governments. The farmers' level subsidy programmes were undertaken by Ministry of Agriculture, Ministry of Water Resources and State Governments. The worldwide adoption of fertigation has shown favourable results in terms of fertilizer-use efficiency, quality of produce and environmental advantages. Also, in India the fertigation response study reveals the quantum benefit under different agro-climatic conditions, requires promotional measures. To tap full potential of system, appropriate policies may be adopted, through motivating the farmers, ensuring availability of standard materials, field base research activities and solving the operational and maintenance problems. More attention is required towards integration of fertigation/chemigation along with microirrigation system to harness full advantage of the system. Capital cost involved is still high. There is also issue of uniformity in water application. Efforts are needed to develop efficient filtrations units to use surface water for microirrigation with automatic flush back, suiting to small and marginal farms.

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STRATEGIES FOR DEVELOPMENT OF PROTECTED CULTIVATION IN INDIA

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Protected cultivation is intended to mean some level of control over plant microclimate to alleviate one or more of abiotic stresses for optimum plant growth. The microclimatic parameters are temperature, light, air composition and nature of root medium. The major modes of protected cultivation are: mulching, low tunnels,row cover, floating covers, cloches and greenhouses. The protected cultivation increas the yield under unfavorable agroclimatic conditions compared to open field conditions. Quality of the produce is superior with increased water-and fertilizer-use efficiency and higher income per unit area. The protected cultivation practices started in India only during the recent past. Consequently, a vast untapped potential exists to derive benefits on a large scale. Government of India continues to support protected cultivation efforts in the country. This opportunity permits us to have a comprehensive view of the situation.

Liberalization of imports and government support saw the rapid growth of greenhouse projects in India during early 90s. The technology appeared promising and export opportunities unlimited. However, the initial euphoria could not be sustained, essentially due to poor reputation in the world market, inadequate market information, and lack of markets. There is a large potential for indigenous technology upgradation and appropriate human resource development. Recently, concern about suitable disposal of plastics materials used in protected cultivation has also been expressed.

There is a lack of indigenous information base on relevant technologies for use by the prospective users and entrepreneurs. The Plasticulture Development Centres (PDGs)being financed by the National Committee on Use of Plastics in Agriculture (NCUPA) have been conducting field studies on protected cultivation technologies. The data of these studies and those conducted elsewhere need to be processed to develop literature for various sections of the society.

Education and training programmes need to be strengthened to develop human resource for sustainable progress. Adequate provision at the undergraduate and postgraduate level should be made to develop requisite expertise to implement technologies successfully.

Bureau of Indian Standards should ensure that relevant materials and practices' standards are developed to ensure materials and works quality. Both users and the industries are benefited. Efforts and development of management practices, materials and cultivars are required to provide answers to field questions. The ICAR, New Delhi, has initiated several research programmes in this area. There is a need to consolidate these efforts in the form of a Project Directorate of Protected Cultivation Technology to provide the essential focus and leadership. Some major areas of research and developmental efforts are:

FUTURE STRATEGIES

Protected cultivation in India is in its infancy. While, the advantages have been appreciated, large-scale use of these technologies has not been made so far. A small country like Korea has more than 40,000 ha under greenhouses. China has 2 million ha under plastics mulching and more than a 100,000 ha under low tunnels. The scope for the expansion of area under protected cultivation in our

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country is immense. A target of 500,000 ha area under different protected cultivation technologies is being proposed to be covered by the end of Tenth Five-Year Plan. While the target is quite achievable, a number of initiatives and policy changes are called for.

DEVELOPMENT OF APPROPRIATE TECHNOLOGY

Low Tunnels

Low tunnels are reasonably cheap installations. However, design of low tunnels has to be considered in conjunction with the crop microclimate for best results. This could include the development of appropriate plastics film, methods of ventilation, agronomic practices and plant-protection measures.

Plastics Mulching

Although considerable experience has been gained from indigenous studies, there is need for further studies in minimizing the plastics material requirement, selection of surface properties of the films, fertilizer application, irrigation, seed control and plant protection measures. Installation of plastics mulch efficiently is another area of development.

GREEN HOUSES

Structure and Environmental Control

Continues efforts should be made to optimize structural designs for newer locations and applications. Energy efficiency and environmental safety measures require more work. A structural material, which does not cast shadows, and an intelligent glazing material are still not available. Effective application of artificial intelligence to manage greenhouse activities would require modifications in greenhouse structures.

Greenhouse design activities in India are in a nascent stage. A few potentially useful greenhouse designs have been selected and methods of their fabrication have been developed. The Bureau of Indian standards has only recently released a standard on greenhouse designs. There is a need to encourage a few groups of greenhouse designers to scrutinize the existing greenhouse designs from different parts of the world for their applicability under Indian conditions. Any material and component substitution required under specific conditions should be studied both from structural safety as well as functional requirements points of view. It is conceivable that a catalogue of approved designs to meet the Indian requirements is prepared which could keep being updated periodically. Linkages with industries such as Steel Authority of India Ltd (SAIL), Indian Petrochemicals Ltd (IPCL), etc. need to be forged to synchronize the structural designs with material developments.

Greenhouses for many specific locations and crops need to be designed. There is not much success in designing a suitable greenhouse for hot desert areas and cyclone-prone coastal areas. To reduce operational costs of greenhouses, greenhouse designs should not only be energy-conserving but as much use of renewable energy sources should be made as possible. Similarly, greenhouse designs should permit optimum use of water and other agro-inputs.

Greenhouse technology in India has much more potential than what has been realized so far. The total area under greenhouse should increase to over 100,000 ha during next decade. This estimate is based on similar experiences in China, South Korea, Japan, etc. About 1,00,000 ha under greenhouses mean at least 10 lakhs new jobs, greater availability of horticultural produce in domestic sector, and development of remote areas. In the process, greenhouse industry in India would have developed to the extent that we would also be able to export the technology to other developing countries. Thus

thrust areas of R&D would be development of location-specific designs, Integrated Pest Management techniques specific to greenhouse conditions, Integrated Nutrition Management for greenhouse crops and breeding crop varieties suitable for greenhouse conditions.

Cropping Practices

Specific crop varieties suited to protected cultivation should be developed. The package of practices–nutrient management, pest and disease management and irrigation mangement–should also be developed. Employees should be given training on development of suitable equipments for crop cultivation under protected environment. Recycling of plastics used for different protected cultivation applications needs to be studied and suitable policies need to be framed. To address the queries related to protected cultivation technology, it is necessary to have specific research centres in different agroclimatic zones, adequate human resource and infrastructure to fulfill the research and development mandate

POLICY FRAMEWORK

Marketing Infrastructure

For maximum benefit to growers, a well-designed marketing infrastructure and an up-to-date market intelligence are needed. There is a need for Government support in the form of well-laid network of roads to local markets, airports etc. In addition, cold storage units near the farm and at airports are needed. On-farm processing could be encouraged for value-addition and reducing storage and transportation losses. The cooperative movement of AMUL (Gujarat Cooperative Milk Marketing Federation Ltd) could be a good example to be followed by the farmers in specific regions to get rid of the middlemen and reap the benefits of what they have sown. Thus, cooperatives could have processing factories for a more multifaceted growth.

Information

Lack of information and authentic literature has been one of the main hindrances to widespread protected cultivation awareness. Hence books, manuals and handouts should be published on design, environmental control, management, cropping practices and pest control. Websites on protected cultivation for technology transfer to progressive farmers should be developed.

Demonstration

Plasticulture Development Centres of NCPAH have been the only demonstration centres of protected cultivation technology. However, these centres exist in ICAR institutes or in SAUs, which are not at the farmers' fields. Hence, there is a need for :

Model centres : These are required to demonstrate new technologies of crop cultivation to growers and to serve as training-cum-demonstration centres for cropping practices and post-harvest management of crops.

Model village : Model village programme will be helpful to demonstrate various facets of protected cultivation and for frequent interaction between farming community and scientists to transfer complete know-how of growing crops under protected environment and their management.

Human Resource Development

Protected cultivation is a relatively new venture for traditional farmers who have to be re-oriented to various aspects of this technology so that they can avail multitude of opportunities

provided by it. Hence, they should be trained on various aspects of protected cultivation. Apart from this, entrepreneurial skills of enterprising youth and traditional farmers will have to be honed to help them exploit these skills. Thus, we need to organize trainers' training, farmers' training and entrepreneurship training.

The trainings should be both in India and outside. Since protected cultivation technology is an upcoming technology, we should organize trainings outside India in collaboration with an advanced country. Recently, IARI, New Delhi, has proposed a one-year diploma degree on protected cultivation which if approved could create the required skilled human resource. Similar programme could be initiated in other parts of the country.

Financing

At present Government of India is providing financial incentives in the form of subsidy for 500 m^2 at the rate of 40% with a maximum limit of Rs 40,000/beneficiary for a 500m^2 unit. Financial incentives are also available for plastics mulching, low tunnels hail nets, bird protection nets, etc. It is proposed that soft loans form banks and other financial institutions may also be made available to prospective growers. For larger units there should be a provision for low interest loans.

Insurance

Protected cultivation units require substantial financial inputs. It is imperative that such capital-intensive units operating under natural conditions must be suitably insured against natural calamities, and other professional hazards. The insurance companies need to be adequately informed about the technical details for the formulation of cost-effective insurance policies.

Tax Incentives

Protected cultivation activities must be treated as agricultural production activities thereby attracting no income tax. Besides, expenditure on setting up these facilities must be exempted from tax liabilities. The import of equipments and raw materials for the purpose must be tax-free. This is all the more important under the WTO regime where our products must compete in the world market.

Sustainability

Although protected cultivation applications are almost 2 century old, their commercial utilization in India is less than 2 decades old. There is every reason to believe that protected cultivation will have positive impact on socio-economic condition of the country, and therefore it is important that the growth of protected cultivation is sustained against any constraints which might come up. The sustainability requires that there is a **Technology Mission on Protected Cultivation**, which provides the leadership in all these strategies. Besides, this mission should also liaise with similar organizations in other countries to make the progress in the country faster. The mission should also organize training of key personnel abroad and invite experts from international organizations for faster human resource development and technology assimilation.

There is a need for another non-governmental group consisting of users, manufacturers, technocrats, researchers and educators in the form of a **National Society on Protected Cultivation** to provide essential feedback to the technology mission. The society will also function to serve its members in the formulation and execution of appropriate strategies. In this context, the technology mission and the national society are complimentary.

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INTEGRATED MANAGEMENT OF PESTS IN HORTICULTURAL CROPS

V. Ragunathan*, A. D. Pawar, M. P. Misra and Jasvir Singh

Horticultural crops are generally grown as monoculture in temperate, subtropical and tropical climates. All these crops are prone to attack by pests and diseases which are major limiting factors in their successful cultivation. The yield losses caused by pests attack range from 10 to 30% in various crops during different seasons of the year. Unlike agricultural crops, horticultural crops are grown as monocultures, the pest and disease problems are entirely different and complex in nature. Such pests and disease situations have led to repeated and excessive use of chemical pesticides. Till recently plant-protection measures in horticultural crops were calendar-based use of chemical pesticides. This has resulted in development of resistance in the pest species, contamination of horticultural produce, environmental pollution as well as rejection of export material in the international market due to pesticide residues.

INTEGRATED PEST MANAGEMENT IN HORTICULTURAL CROPS

Banana

Banana is a very popular fruit and available throughout the year. Major insect pests of national significance are stem weevil (*Odoiporus longicollis*), corm weevil (*Cosmopolites sordidus*), aphid (*Pentalonia nigronervosa*), leaf- and fruit- scarring beetle (*Basilepta subcostatum*), leaf- eating caterpillar (*Spodoptera litura*) and lace-wing bug (*Stephanitis typicus*). Their stage-wise IPM control measures are mentioned in Table 1.

Table 1. Stage-wise IPM practices to be adopted for banana

Pests/diseases	Stage	IPM practices
Banana stem weevil	5th month	O Install longitudinal split pseudostem (30 cm length) trap to monitor the weevil.
	6th, 7th month	O Swabbing of insecticide over the pseudostem with monocrotophos (2ml/ litre).
	7th month	O If the feeding damage is noticed, give stem injection of monocrotophos (150 ml in 350 ml water) solution @ 2ml/plant using stem injector at 30° angle in two places, one at 2 feet height from the ground and the second at 4 feet, above the ground level.
	Post-harvest	O Cut the pseudostem into pieces and destroy crop residue. Up root the suckers and cut into pieces and place them in the soil to attack weevil as well as to dry the crop residue.

* Directorate of Plant Protection, Quarantine and Storage, N. H. IV, Faridabad 121 001

Banana corm weevil	Pre-planting Planting 3rd month 3rd, 5th and 7th month	O Select healthy, infestation-free suckers. O Paring and pralinage. Hot-water treatment @ 50-55° C for 30 minutes. Dipping sucker in 0.5% monocrotophos solution for 30 minutes and later drying under shade for 72 hours before planting to kill eggs and grubs of weevil. O Install 'Cosmolure' trap @ 4/ha or Pseudostem, longitudinal split and disc on stump trap. O Soil application of carbofuran @ 20 g/plant.
Banana leaf-eating caterpillar	3rd - 5th month	O Hand pick the eggs mass and destroy.
Nematodes	Pre-planting Planting 3rd month 6/7th month	O Select healthy and infestation-free suckers. O Paring and hot water treatment of suckers. O Apply carbofuran @ 40g/plant. O Apply neem cake @ 500 g/plant.
Common diseases	Pre-planting At the time of planting After planting 3 and 6 months after planting	O Selection of wilt and virus-free suckers and paring of corms O Dipping of pared suckers in bavistin (0.2%) for 30-45 minutes. O Application of biocontrol agents, viz. *Trichoderma* sp. @ 15 gm/pit. O Application of carbofuran granules @ 40 gm/plant.
Wilt and viral diseases	Before planting After planting	O Select and plant disease-free vigorous suckers. O As soon as the symptoms are noticed the affected plants should be uprooted and burnt.
Weeds	Before planting After planting One month after planting 2 months after planting 3-5 months after planting 6 months after planting	O Clean cultivation practices like deep ploughing and uprooting of weeds. O Application of pre-emergence weedicide like alachlor @ 9 litres (a.i.)/ha. O Growing of legumes like cowpea. O Diuron spray @ 3kg/ha in 1200 litres of water. O Green manuring of legumes within the field. O Spray of Glyphosate/Gramaxone @ 1.5 litres/ha in 1200 litres of water. O Spraying of Glyphosate/Gramaxone @ 1.5 lit/ha in 1200 litres of water. O Mechanical digging or hoeing. O No need for weed control due to heavy

Mango

India is the world's largest producer of mango (Singh and Goel, 1987). Of the pests of mango, hoppers, fruits flies and stone weevils are considered as the major constraints in mango production in India. The Government of USA, UK and Japan have placed embargo on the import of mango fruits from India because of the risk of introducing fruit flies and stone weevils. The month-wise IPM practices for important pests and diseases are given in Table 2.

Table 2. Month-wise IPM schedule for mango

Month	IPM practices
July	O Deep ploughing of orchard immediately after harvesting to expose eggs and pupae of mealy bug and inflorenscence midge.
August-September	O Removal of webs (made by leaf webber) by leaf web removing device and burning them. O If infestation still continues spray carbaryl (0.2%) or monocrotophos (0.04%). O Pruning of over-crowded and overlapping branches for control of leaf webber.
October	O Flooding of orchards to control eggs of mealy bug, diapausing pupae of midge and fruit fly. O Pruning of infected and dried branches, 10 cm below the dried portion and pasting of copper oxychloride for control of die back. O Spraying 0.3% copper oxychloride (3g/litre) after pruning for the control of die back, phoma blight, anthracnose and red rust diseases. O Removal of diseased foliage/twig infected with anthracnose (twig blight phase). Removal of weeds.
November	O Deep ploughing of the orchards for exposing eggs and pupae of insects and removal of weeds in mango orchard which harbour pests and diseases. O Second spraying of copper oxychloride (3g/litre) for control of dieback and foliar diseases. O Collection of dropped diseased leaves and burning them.
December	O Fastening of alkathene sheet of 400 gauge thickness 25 cm wide around the base of tree for control of mealy bug. O Raking of soil around the trunk and mixing with neem cake for management of mealy bug nymphs or apply 2% dust of methyl parathion @ 250 g/tree or chlorpyriphos 2% dust. Application of Beauvaria bassiana around tree trunk to manage nymphs of mealy bug.
January	O Alkathene bands should be cleaned at regular intervals. O Spraying of fenitrothion (0.05%) or dimethoate (0.045%) at the bud burst stage for control of inflorescence midge.

	O Removal of weeds and infected young leaves of mango for control of powdery mildew.
February	O First spraying with 5% neem seed kernel extract (NSKE) or Nimbicidine (2%) at bud burst stage for control of hoppers. Spraying of Verticilium lacani (10^8) at bud burst stage for control of hopper and should be repeated during July (second appearance) for controlling next generation hoppers.
March	O Second spray with 5% neem seed kernel extract (NSKE) or Nimbicidine (2%) when fruits are at pea size stage. O First spray of sulphur (2g/litre) for powdery mildew.
April	O Third spray with endosulfan (0.07%) if required after 5 days of second spray. O Second spraying of sulphur (2g/litre) after fruit setting against powdery mildew. O Removal of powdery mildew infected leaves and malformed panicles.
May	O Hanging of methyl euginol traps (0.1%) + malathion (0.01%) for control of fruit fly.
June	O Methyl euginol traps should be continued. O Early harvesting of mature fruits to avoid fruit fly infestation. O Collection and destruction of fruit fly infested fruits.

Guava

Fruit fly, fruit-borers and bark- eating caterpillars are major insect pests, whereas guava wilt, fruit rot and die back are important diseases. IPM package of practices for guava pests and diseases are given in Table 3.

Table 3. Integrated pest management practices for guava

Insect Pest Management

- The traps are very useful tool in monitoring and control of population of fruitfly. Hanging of bottle traps containing 100 ml of water emulsion of methyl euginol (0.1%) + malathion (0.1%) during fruiting season (April – July) is very effective for control of fuitfly. Ten traps per hectare of orchard gives satisfactory control. Traps can be fixed during morning time.
- To check the carryover of the fruit fly collect and destroy fallen and infested fruits along with fruit fly maggots. Ploughing of tree basin also helps in checking the pest population as the pupae are destroyed by being exposed to regours of temperature and also becomes the prey for predators. Adult furit flies can be controlled by bait spraying of 0.2% carbaryl +0.1% protein hydrolysases or molasses at preoviposition time.
- After removing the webs of bark-eating caterpillar all the borer holes except the fresh one, should be plugged with mud plastering. After application of 0.05% monocrotophos or DDVP, the fresh hole should be plugged.

O Collection of infested fruits with borer and their destruction to check the carryover of the pest. The adults may be controlled by spraying of carbaryl (0.1%) or fenthoate (0.05%) or phosalone (0.01%) at the beginning of fruiting season and before ripening of fruits. For coccids and mealybugs spray diazinon (0.05%) or monocrotophos (0.05%). The affected leaves and young shoots may be pruned and they may be destroyed along with the pest. This will help in bringing down the pest population.

Disease Management

After appearance of the symptom of guava wilt, uproot and destroy the infected plants. Avoid waterlogging. Use of organic and green manures helps in reducing the disease. Clean cultivation is also helpful in managing guava wilt.

Weed Management

Before setting up of an orchard, the weeds should be destroyed by deep-ploughing, harrowing and weeding. Perennial summer ploughing is advised. Intercropping of short-duration, shallow rooted crops like onion, tomato, radish, carrot, beans, cauliflower, *palak* etc. should be practised to reduce weed infestation.

Grape

Pink mealy bug, *Maconellicoccus hirsutus* (Green), has become a serious pest of grapevine in recent years in south India. Many of the insecticides have been reported ineffective against *M. hirsutus*. Among the natural enemies, parasitoid, *Anagyrus dactylopii* (How.), is promising one, causing up to 70% parasitism in nature. Sustralian lady bird beetle, *Cryptolaemus montrouzieri* (Muls), is a very potential predator, which consumes 1,000-1,500 eggs or 300-500 nymphs of *M. hirsutus* (Jayaraman *et al.*, 1988). The detailed IPM practices to control the major pests and disrases are given in Table 4.

Table 4. Integrated pest management strategies for grape

Control practices	IPM practices
	Cultural practices
	O After pruning remove and burn pruned twigs.
	O Remove loose bark from stem and arms.
	O Thinning bunches and pruning of excess vegetative growth is recommended as it improves ventilation in the canopy, reduces humidity and allows better coverage of pesticides sprayed. Thus keep disease incidence low.
	O Time of forward pruning in Maharashtra and Andhra Pradesh should be postponed to later half of October to avoid rain on tender growth. It will minimize the incidence of downy mildew, anthracnose, bacterial leaf spot and blight.
	O After prunings, rake the soil to expose grubs and pupae of flea beetles, mealy bugs and thrips.
Mechanical practices	O During rainy season prune all canes showing spots of anthracnose and bacterial blight on basal portion and burn.

Biological control	O Collect egg masses and larvae of *Spodoptera* and *Helicoverpa* and destroy O Install pheromone traps @ 5/ha. for monitoring *Helicoverpa and Spodoptera.* O If mealy bugs are observed release *Cryptolaemus* beetles @ 10 grubs or adults per vine. Beetles should be released during evening hours to facilitate their better establishment. O Spray preparation containing *Verticillum leccanii* (10^8 cfu/ g.) @ 5 g./litre on foliage for control of mealy bugs. Formulation is mixed in water at least 4 hrs before spray and spray is given at sunset when canopy temperatures are moderate. O Spray *Ha* NPV or *Sl* NPV @ 250 LE/ha in the evening at 10 days interval. O Apply *Pseudomonas fluorescence* formulation (6 X 10^8 cfu / g.) @ 4 g. / vine, 30 cm away from base of the vine at 15 cm depth at the time of pruning for control of nematodes. O At the onset of monsoon, mix one kg of *Trichoderma viridi* preparation containing 10^8 cfu / g in 100 kg of moist FYM; store the mixture for 7 days and apply it to root zone of each vine @ 5 kg / vine for reducing soil-borne inoculum of downy mildew. O Spray *Trichoderma* preparation on foliage @ 10 g / litre during second half of September which reduces inoculum of downy mildew and *Alternaria.* O Spray *Trichoderma / Gliocladium* preparation @ 10 g/litre on maturing bunches 20 days and 1 day before harvesting for control of post-harvest berry rots caused by *Rhizopus, Alternaria,* and *Cladosporium.*
Chemical practice	O After removal of loose bark, swab stem and arms with carbaryl (0.4%) or chlorpyriphos (0.2%) and melation (0.2%) with brush or jute cloth. O Apply chlorpyriphos dust @ 25 g /vine around stem and /or stone and iron supports. O Spray methyl demeton 0.05% or phosphamidon 0.075% at 15 days interval one month after pruning to till berry formation to prevent thrips damage. O At bud sprout, spray carbaryl 0.2 % or quinolphos 0.05% and repeat after a week to prevent flea beetle feeding. O If mealy bug infestation is observed spray dichlorovos 0.15%. O If defoliators are observed spray carbaryl 0.2% or quinolphos 0.05%. O Apply neem cake 200 g / vine or carbofuran 60 g / vine one week before pruning for the control of nematode. O To eradicate disease inoculum present on stem and arms, spray 1 % Bordeaux mixture or 0.4 % COC immediately after pruning.

	O For control of anthracnose spray systemic fungicides i.e. benomyl / thiophanate methyl / carbendazim @ 1 g / litre. First spray is recommended after appearance of first leaf i.e. about 8-10 days after pruning. Subsequent sprays are given at 10 –15 days interval up to 60 days after pruning if it rains or heavy dew prevails on foliage. Above sprays of systemic fungicides should be alternated with sprays of non-systemic fungicides, viz. mancozeb / chlorothalonil / COC / Captan at 15 days interval to avoid development of disease resistance. O For the control of downy mildew spray systemic fungicide, viz. metalaxyl + mancozeb 2.5 g / litre or phosetyl AL 3 ml / litre + mancozeb 2 g / litre or potassium salts of phoshonic acid 3 ml / litre + mancozeb 2 g / litre or cymoxonil* + mancozeb 2.5 g / litre. First prophylactic spray is recommended when in 80 % buds three leaves are opened i.e. about 12-15 days after pruning. Subsequent sprays are given at 5-10 days interval till 70 days after pruning depending upon weather conditions. O During vegetative phase Bordeaux mixture (0.5%) may be sprayed for the control of antracnose, bacterial leaf spot and downy mildew. O For the control of powdery mildew spray systemic fungicides hexaconazole / penconazole / myclobutanil/ fenarimol @ 35-50 ml/100 litres of water or tridemiofon 1 ml /litre. Non systemic fungicides dinocap 0.5 ml /litre or wetable sulphur 2 g /litre also control powdery mildew. Sprays for control of powdery mildew are required when days are cloudy or in case canopy is thick and light dose not penetrate. Sprays need to be repeated at 15 days interval depending upon weather conditions and may not be required after berry softening stage. O For the control of *Alternaria* blight and other leaf spot spray non-systemic fungicide, viz. mancozeb / ziram / captan / chlorothalonil @ 2.5 g / litre or COC 3 g / litre . O For the control of *Alternaria* blight and other leaf spot spray non systemic fungicide, viz. mancozeb / ziram / captan / chlorothalonil @ 2.5 g / litre or For the control of *Greenaria* spray thiophanate methyl @ 1 g /litre. O For the control of *Alternaria* blight and other leaf spot spray non-systemic fungicide, viz. mancozeb / ziram / captan / chlorothalonil @ 2.5 g / litre or for the control of irregular cane maturity due to Botryodiplodia, drench carbendazim / benomyl / thiophanate methyl twice i.e. 20 and 25 days after pruning @ 1 litre solution containing 1 g / litre fungicide per vine. O For the control of *Alternaria* blight and other leaf spot spray non-systemic fungicide, viz. mancozeb / ziram / captan / chlorothalonil @ 2.5 g / litre or For the control of rust spray 0.5 % Bordeaux mixture or chlorothalonil 2 g / litre. Judicious control of rust on rootstock plants is essential avoid outbreak of disease on commercial varieties.

* Fungicide is yet to be registered.

Citrus

. Mealy bug, *Planococcus citri* (Risso), is a major pest of Citrus crops, infesting tender shoots and fruits. Growth of the infested plant is arrested resulting in fruits fall. Coccinellid predator, *C. montrouzieri* @ 10 beetles/tree and an exotic parasitoid, *Leptomastix dactylopii* How. @ 5,000-7,000/ ha are effective for its control. The IPM measures to control important pests and diseases are Table 5.

Table 5. Stage-wise IPM practices to be adopted for Citrus

Pest	Normal Practice	IPM Practices
		AT SOWING
Soil- and seed- borne diseases	Cultural practices	OSelect tolerant/resistant seeds for rootstocks.
		OKeep the bud union as high as possible.
	Chemical practices	OSeed treatment with fungicides.
		OSeed dipping in antibiotics in canker endemic area.
Sucking pests	Chemical practices	OSeed treatment with insecticides.
		ODeep ploughing in summer.
		PRE-PLANTING
		ORemoval of alternate hosts.
		OSoil solarization.
		OAdequate manuring in pits.
		OUse of *Trichoderma* spp. with organic matter in the ratio of 1:40 @ 2kg/pit.
		OSelect disease-free and certified rootstocks.
		VEGETATIVE GROWTH STAGE (1-5 YEARS)
Weeds	Cultural practices	OInterculture and hand-weeding.
		OMulching with alkathene, wheat bran or rice bran.
		OChemical practices 1. Atrazine (0.5 kg a.i/ha) or Glyphosate (2 kg a.i/ha).
		FRUITING STAGE (5-20YEARS)
Weeds	Cultural practices	OInterculturing and hand-weeding.
		OMulching with alkathene, wheat bran or rice bran.
		OSpacing between trees at close distance should be avoided.
		OWell-drained soil.
	Mechanical practices	OUse of light trap (yellow colour of wave length of 550 mm).
		OUse yellow sticky trap.

	Biological practices	OConservation of indigenous natural enemies.
		O Augmentation of *Chrysoperla spp* and *Mallada boninensis* @ 10-15 eggs/grubs plant.
	Chemical practices	O Use neem product.
		O Spray acephate (0.05%), monocrotophos (0.06%) or endosulfan (0.1%).
Citrus psylla	Cultural practices	O Collateral host like curry leaf (*Murraya koenigii*) plant should not be grown. However, it can be used as trap crop.
		O Use yellow sticky traps.
		O Eradication of affected plants/pests.
	Biological practices	O Conservation of indigenous natural enemies.
		O Augmentation of predators.
	Chemical practices	O Use recommended neem products.
		O Spray monocrotophos (0.1%) or aminophos (0.1%) or acephate (0.1%) or thiometan (0.08%).
Leaf miner	Cultural practices	O Be alert at the active phase of the growth.
		O Avoid pruning during active growth periods.
		O Manage nitrogenous fertilizers.
	Mechanical practices	O Removal of early and late growing flushes and pre-flush pruning.
	Chemical practices	O Use recommended neem products.
		O Soil drenching with lindane @ 15 kg/ha.
		O Use selective insecticides at the new flush only.
Aphids	Cultural practices	O Use trap crops.
	Biological practices	O Conservation of natural enemies.
		O Augmentation of predators.
	Chemical practices	O Spray methyldemeton (0.02%), Phosphamidon (0.05%) or Imidacloprid (confidor 200 SL) at 10 g a.i/ha.
		O Use neem products.
Thrips	Chemical practices	O Use aldicarb (0.06 g/litre), dimethoate or phosphamidon or monocrotophos (1 ml/litre).
Fruit sucking moths	Cultural practices	O Clean cultivation.
		O Destroy fallen fruits.

	Mechanical practices	O Use light trap.
	Chemical practices	O Poison baiting with 20 g malathion WP or 50 ml diazinon + 200 g gur with some vineger in 2 litres of water.
Fruit fly	Cultural practices	O Clean cultivation.
		O Destroy infested fruits.
		O Allow egg laying on punctured fruits under the trees and then destroy.
	Mechanical practices	O Use pheromone traps containing 0.1% methyl euginol and 0.05% malathion.
	Biological practices	O Conservation and augmentation of natural enemies.
	Chemical practices	O Spray malathion (0.05%) or trichlorfon (0.05%) + 1% crude sugar.
Lemon butterfly	Mechanical practices	O Pick and destroy larvae.
	Biological practices	O Conserve and augment natural enemies.
		O Spray *Bacillus thuringiensis* @ 0.05%.
	Chemical practices	O Spray monocrotophos (0.04%) or quinalphos (0.05%) or phosalone (0.05%).
Bark-eating caterpillar. scales	Cultural practices Chemical practices	O Insert a cotton swab soaked in kerosene/petrol and plug with mud.
		O Use selective insecticides
Mealy bug	Cultural practices	O Prune affected shoots during winter and allow canopy to open from centre so that sufficient sunlight is in tercepted below the canopy.
		O Destroy ant colonies.
	Mechanical practices	O Sticky bands on the trunk portion of the tree. should be kept to avoid climbing of the crawlers from the ground.
		O Raking the soil around trunk during summer months helps in the desiccation of eggs and help in exposing the mealy bugs to natural enemies.
		O Use pheromone traps.
	Biological practices	O Conserve indigenous natural enemies.
		O Release *Leptomastyx dactylopi* @ 5000-7000 adults/ha.
	Chemical practices	O Spray dimethoate 150 ml + Kerosene oil 250 ml in

		100 litre of water or carbaryl 10 ml + Kerosene oil 10 ml or malathion 20 ml in 10 litres of water.
Citrus mites	Cultural practices	O Well irrigated especially during the water stress in summer.
	Biological practices	O Conservation of indigenous natural enemies.
		O Release *Chrysoperla* grubs @ 10-15/plant.
	Chemical practices	O Use neem product like neem oil or pongamia oil and mahua oil.
		O Spray oxydemeton methyl 1.5 ml or wettable sulphur 80 WP 3 g/lit of water on the basis of monitoring.
Diseases	Cultural practices	O Use canker tolerant/resistant varieties like Eustis, Lakeland.
		O Prune all the canker infected twigs before monsoon and destroy.
	Chemical practices	O Spray streptocycline 0.01% and copper oxychloride (0.3%) or maneozeb(0.2%).

Apple

San Jose scale, *Quadraspidiotus perniciosus* (Comstock), is one of the most serious pests of apple.The waxy covering of the scale renders it less prone to chemical than biological control measures. Augumentative and inoculative release of important parasitoids, *Encarsia perniciosi* and *Aphytis proclia*, have given promising results in its suppression. The *E. perniciosi* has established in many apple-growing areas where the population of San Jose scale is low (Singh, 1993). Codling moth, *Cydia pomonella* (Linn.) is another serious pest in Ladakh Division of Jammu and Kashmir. Two exotic egg parasitoids *Trichogramma embryophagum* and *T. cacoeciae*, have been found to be promising against codling moth (Pawar *et al.*, 1989).

Cabbage and Cauliflower

Diamond back moth (DBM), *Plutella xylostella* (Linn.), is most serious pest of cauliflower and cabbage since it has developed resistance to wide range of insecticides. Outbreak of DBM during 1999 in and around Delhi on cauliflower has caused heavy losses to farmers. Mustard as a trap crop in cabbage and cauliflower fields attracts nearly 80-90% DBM and other pests. Application of *Bacillus thuringiensis var. kurstaki* @ 1g/litre of water 15 days after planting and release of *Trichogramma chilonis* or *T. pretiosum* @ 50,000/ha also help in its suppression.

Tomato

Fruit-borer, *Helicoverpa armigera* (Hubn.), is major pest of tomato, causing yield loss of 20-80%. Release of egg parasitoid, *T. brasiliensis*, @ 2,50,000 adults/ha provides good parasitism. The IPM practice for tomato fruit-borer includes intercropping of tall variety of marigold as a trap crop. Application of NPV @ 500 LE/ha after flowering reduces the borer infestation to a great extent.

Brinjal

Shoot-and fruit-borer, *Leucinodes orbonalis* Guen, is a major pest attacking brinjal. Even though more than 10 parasitoids are reported but they inflict less than 2% parasitism under field condition. Removing of dead hearts, release of *T. chilonis* @ 50,000/ha and spraying of 0.2% Endosulphan or Carbaryl minimizes the losses caused by this pest.

INTEGRATED PEST MANAGEMENT (IPM) APPROACH IN HORTICULTURE

The global concern regarding the overuse and misuse of chemical pesticides has resulted in adoption of Integrated Pest Managament (IPM) for containing the pest and disease problems. IPM is an eco-friendly approach encompassing cultural, mechanical, biological and need-based use of chemical pesticides preferably in combination with botanicals and biopesticides. The IPM technology manages the pest population in such a manner that economic loss is avoided and adverse side effects are minimized.

The pest problem in horticultural crops have become further complex in nature due to modern practices–monoculture, high-density planting, application of high dosages of nitrogenous fertilizers, frequent irrigation and use of broad-spectrum pesticides. Following Integrated Pest Management strategies will promote safe, sustainable and eco-friendly horticultural produce:

Growing a Healthy Crop

It is achieved by growing crops in areas or in soil and microclimatic conditions, which are most conducive for the crop. Growing crop vericties resistant and tolerant to pests and diseases, use of balanced fertilizer, adoption of suitable irrigation methodology and timely management of weeds and pests are some of the important factors for growing a healthy crop.

Conservation and Augmentation of Natural Enemies

Selective pesticides which do not harm natural enemies should be preferred as a last resort. Conservation and augmentation of natural enemies provide reasonable suppression of many pests of horticultural crops. The predators population could also be encouraged by adopting latest management practices. Many fruit crops provide a stable environment offering good opportunities for biological control.

Pest Monitoring

Pest monitoring is one of the important components of IPM to take proper decision to manage any pest problem. It can be done by:

Agro-ecosystem analysis: Agro Ecosystem Analysis (AESA) is an approach, which can be gainfully employed by group of farmers for decision making in IPM to analyse field situations with regard to pests, defenders, soil conditions, plant health, the influence of climatic factor and their inter-relationship for growing healthy crop. The basic components of AESA are:

- Plant health at different stages
- Built-in-compensation abilities of plants
- Pest and defenders population dynamics
- Soil condition, irrigation dynamics
- Climatic factors
- Farmer's past experience

The objective of the AESA activity is to analyse the field situation by observation, drawing and

discussion. At the end of the activity the group should make a decision about any action required for the field.

Field scouting: The AESA requires training to take decision and so only the trained farmers can undertake this exercise. However, other farmers aiso can do field scouting in their own fields at regular intervals to monitor the major pest activities which may help in minimizing pesticide use to a large extent.

Pheromone traps: Pheromone traps which lure pests are commercially available for lepidopteran pests like fruit-borer *(Helicoverpa armigera)* and tobacco cut worm *(Spodoptera litura)*. Five traps per ha, which lure pests may be installed to monitor the adult population. Replace the lures once in 15-25 days depending upon the weather conditions.

Yellow pan/stick traps: Set up yellow pan/sticky traps for monitoring white fly, thrips etc. @ 10 traps/ ha. The other surface of the locally-available empty tins is coated with yellow paint having grease/ vaseline/castor oil be used as yellow sticky trap.

Economic threshold levels: The economic threshold level is an attempt to improve quick decision making practices, using partial economic analysis of the impact of the chemical control practices. At the ETL, the benefit of spraying is equal to the losses caused by insects in the field. Appropriate control measures should be undertaken only when incidence crosses ETL.

Making Growers Expert in Their Own Field

It can be achieved through a sequence of trainings to the growers. Farmers Field Schools (FFSs), Plant Health Clinics (PHCs) and Krishi Vigyan Kendras (KVKs) may play major role in making growers expert in decision making in plant-protection measures for growing healthy crops.

Farmers' Field Schools (FFSs)

The philosophy behind FFSs is to train farmers in his field to enable him to analyse the situation in the field and take adequate decision on pest management measures needed. The training strategy, having its foundation in non-formal education principles, emphasizes LEARNING BY DOING, and empowering farmers to actively identify and solve their own problems. The trainer is a facilitator instead of an instructor. Only with farmers as central actors in technology development and implementation can agriculture become truly sustainable (Van de Fliert, 1998). In the FFS the farmers are trained weekly on fixed days about the pest/disease problems in relation to prevalent biotic and abiotic factors. This helps the farmers in understanding the fluctuations in the population of insect pests as influenced by increase or decrease in the natural enemy population.

Plant Health Clinics (PHCs) and Krishi Vigyan Kendras (KVKs)

Easily approachable Plant Health Clinics (PHCs) and Krishi Vigyan Kendras (KVKs) should be opened where most of the problems related to their crops can be diagnosed and solved. These Centres may play an important role in transferring the new plant-protection technologies to the growers.

Use of Biopesticides

The use of biopesticides are being encouraged in IPM to reduce the application of hazardous chemical pesticides. The biopesticides includes all biological materials which can be formulated as that of pesticides for the control of pests. These include microorganisms such as bacteria, fungi, viruses and plant materials such as neem . Biopesticides are gaining importance for the control of pests in horticulture

crops especially in vegetables. Increased emphasis is being given by governmental agencies to promote their use in agricultural and horticultural crops. The role of biopesticides in IPM is becoming increasingly relevant in our efforts to reduce our dependence on chemical pesticides. Some of the biopesticides have been recently included in the schedule to the Insecticides Act, 1968 to ensure their registration and quality (Table 6).

Legislative Measures

Table 6. Biopesticides used in India

Plant origin pesticides	:	**Azadirachtin 300 ppm 1,500 ppm 50,000 ppm
Bacteria	:	***Bacillus thuringiensis*
Baculo viruses	:	*Nuclear Polyhedrosis Virus (NPV)
		*Granulosis virus (GV)
Entomogenous fungi	:	**Beauveria bassiana*
		*Verticillium lecanii
		*Metarrhizium anisopliae
		*Nomuraea rileyi
Antagonistic fungi and	:	***Trichoderma* spp. **
bacteria		**Pseudomonas fluorescens*
		*Bacillus subtilis
		**Gliocladium* spp.

* Biopesticides registered in schedule for use in India under section 9(3) of Insecticides Act., 1968.

** Registered under section 9(3b) of the Insecticides Act., 1968

With the implementation of the plants, fruits and seeds (Regulation of Import into India) Order, 1989 and formulation of New Policy on Seed Development, the plants and planting materials are being imported to enrich the quality stocks of agricultural and horticultural crops. Though strict plant quarantine measures are being implemented to check entry of exotic pests and diseases, however, the bulk imports of such plants and plant materials have a risk of inadvertent introduction of exotic pests and diseases.

FUTURE THRUST AREAS IN PLANT PROTECTION IN HORTICULTURE

Computer networking in plant protection shows great promise in the management of agricultural and horticultural crops. Though the use of computer in plant protection is slowly picking up, available information on pests and diseases including weather data may be maintained for control operations. Since all the district headquarters are interlinked with the National Informatic Centre Network (NICNET) major pests incidence and their outbreaks can be effectively tackled in a better way and control strategies can reach the farmers and horticulturists in short time through electronic and press media.

The horticultural crops being of perennial nature, the bringing in genetic resistance is a time consuming exercise. However, duration of screening is being reduced by using technological

advancement of grafting, tissue culture etc. Molecular genetic techniques also allow breeders for selectively and sometimes quickly insert specific traits into a breeding line for developing resistant/ tolerant varieties of horticultural crops. Genetic engineering will play an important role in plant-protection area of agricultural and horticultural crops (Persley, 1996). The genetic improvement of natural enemies of pests will be more effective agents of biological control.

In horticulture, the concept of monoculture needs to be revised by bringing in a concept of mixed plantation approach by adding biocontrol agent supportive plants species with the main crop thereby enhancing the biodiversity in the agro ecosystem. Such percentage of mixing of plant species will greatly depend on agronomically acceptable planting system.

The information on nutritional profile of an insect pest are useful in IPM by efficient manipulation of food components in host-plant (Singh, 1989). It is having great value for the development of host plant resistance to insect pests. Transgenic plant technology has emerged as a useful tool in producing resistance to pests by introducing entirely new genes into plant genes. Transgenic cultivars can provide immunity against pests and diseases.

The use of remote sensing in plant protection is the latest available technique by which precise pest disease situation can be understood. Efforts are being made to use these techniques in the early detection of pest and disease situation and in quick transmission to state functionaries and users, i.e. farmers for taking up timely corrective measures. The use of satellite based remote sensing of crop health coupled with agrometeorological observations offers new opportunities towards pest epidemic mapping and rationalizing the agro-chemical usage.

Under the World Trade Organisation (WTO) Agreement, the criteria for import and export of agricultural commodities has been enhanced. Such large-scale movement of agricultural items have inherent possibility of transfer of injurious pests and diseases from one country to other. In addition, there is a risk to human health due to the presence of pesticides residues in the imported materials. The acceptance of agricultural items in the importing country also depends largely on the quality of the material meant for export with particular reference to presence of pesticide residue in such items. Thus IPM as eco-friendly approach in plant protection, has important role to play both for the items to be exported as well as imported.

To check the introduction of exotic quarantine pests and diseases, there is a provision under the DIP Act, 1914 to screen the plants and plant materials at the international ports of entry, i.e. international airports, sea ports, rail heads and land frontiers. With a view to provide high-yielding planting material available globally to the Indian farmers, provisions have been made under the New Policy on Seed Development (NPSD), 1988 to facilitate imports. To meet the requirement of import of healthy plants and planting materials, NPSD guidelines have been issued under the Plants, Foods and Seeds (PFS) Order, 1989. Under the liberalized policy for large-scale import of agricultural produce, it is essential to ensure importation of pest/disease-free materials for consumption as well as propagation. Simultaneously, to ensure foreign exchange earning through export of agricultural produce, international requirement of pest/disease and pesticide residue-free materials is essential. This is possible by effective implementation of plant quarantine and Integrated Pest Management (IPM) measures.

Though, strict watch is kept on the import of agricultural produce by implementing quarantine procedures under the DIP Act, 1914, however, the bulk import of agricultural commodities are likely to invite problems of inadvertent introduction of pests and diseases in the country. For this purpose, it is essential that the plants and planting materials which are meant for propagation are kept under strict surveillance so that occurrence of any pest or disease are detected in the early stage of the introduction

of the planting materials. In case of any such report of inadvertent introduction of pests and diseases, immediate remedial measures should be taken so that its further spread is checked. In certain situations imposition of domestic quarantine may help in the overcoming the problem in due course.

As an international obligation and to help foreign exchange earning from export of agricultural and horticultural commodities it is binding on each country to issue phytosanitary certificates. In this direction, it is important that phytosanitary certificate issuing authority should undertake thorough scientific investigation to ensure export of quarantine pest/disease-free plants and planting materials. Such measures would help in reducing the complaints regarding presence of pest/disease in the consignments reaching the importing country.

CONCLUSION

With the globalization under the WTO Agreement, there is a scope for large-scale movement of agricultural and horticultural produce from one country to another. Biotechnological developments are likely to provide new genetically modified plant material for increasing the production. These developments have inherent risk of introduction of exotic pests and diseases which need to be prevented by imposing strict quarantine measures. Simultaneously, there is a need to ensure quality produce for the export to meet the international standards.

The future need in plant protection technologies for horticultural crops is to develop, modify, and advance the technology of IPM to successfully manage the insects, weeds, nematodes and pathogens, and also by exploiting complimentary role through production system approaches. The IPM is a key component in the battle for increased and sustainable fruit and vegetable production and has the potential to play a much greater role in future.

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APPROACHES FOR BIODYNAMIC FARMING

R. K. Pathak* and R. A. Ram

Indiscriminate use of chemicals (fertilizers, pesticides and weedicides) over 4 decades has adversely affected the soil fertility, productivity and quality of the produce. In all 6-8 sprayings are required for production of apple, citrus and mango crops. The degenerative effects of intensive farming practices on soil fertility and ecological balance have now forced for alternative system of farming. This includes 'Organic', 'Hama farming', 'Ecological', 'Natural' or in the recent years "Biodynamic" system of farming. In these systems, maximum reliance is placed on self-regulatory agro-ecosystem locally or 'farm-derived' renewable resources. Reliance on external inputs is minimized as far as possible. Organic production has gained momentum in Germany, New Zealand, US, Canada, etc. In India sporadic attempts are being made at few farms and the results are very encouraging.

BIODYNAMIC FARMING

Since in inorganic production system, micronutrients are not taken care, there is very doubt that in long duration their deficiencies may create production problem and it may be a failure rather than a sustainable alternative. "Biodynamic Farming" refers to a working with the energies, which create and maintain life. The term derives from Greek words, 'Bios' (life) and dynamics (energy). The use of word "method" indicates that one is not dealing merely with the production of another fertilizer, organic though it is, but rather that certain principles are involved which in the practical application secure a healthy soil and healthy plants which in turn produce healthful food for man and healthy feed for animals (Pfeffer, 2001).

Principles

Biodynamic method works on the following principles:

- to restore to the soil the organic matter in the form of humus, which holds its fertility
- to establish, maintain and increase soil living system
- organic matter as the basic factor for the soil life
- biodynamic method is not only the fertilizing the soil but skillful application of the factors contributing to soil life and health.
- to establish a system that brings into balance all factors which maintain life.
- in the biodynamic way of treating manure and composts the knowledge of enzymatic, hormone and other factors is included,
- the biodynamic method puts special emphasis on the importance of crop rotation, green manuring, and cover crops,
- the soil is not only a chemical, mineral or organic system, but it also has a physical structure. The maintenance of a crumbly, friable, deep, well-aerated structure is essential feature of fertile soil.

The earthly forces of moon, mercury and venus soak into the earth from the air above and the cosmic forces of mars, jupiter and saturn draw upward from the rocks below. They interact in the region of clay so that the plants grow out of it. The light from the sun, moon, planets and stars reaches the plants in regular rhythms. Each contributes to the life, growth and form of the plant. By understanding

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the gesture and effect of each rhythm, agricultural activities like soil preparation, sowing, intercultural operations and harvesting can be programmed.

Biodynamic Calendar

Agricultural practices (field preparation, sowing, mauring harvesting etc.) done as per constellation are more effective and beneficial. Every constellation has dominant elemental influence and affects four specific parts of the plants.

Element	Plant parts	Constellation
Earth	Root	Virgo, Capricorn, Taurus
Air	Flower	Gemini, Libra, Aquarius
Water	Leaf	Cancer, Scorpio, Pisces
Fire	Fruit	Sagittarius, Aries, Leo

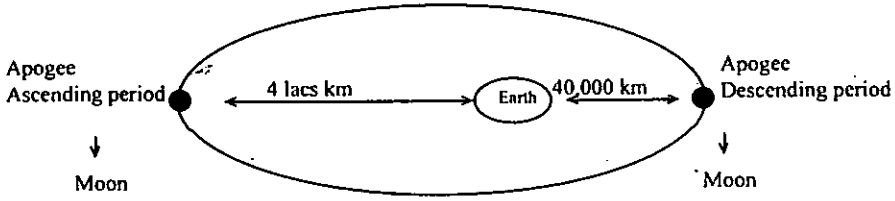
Agricultural practices for better root activity (manuring, rooting), flowering, growth and fruiting/ seed is to be done as per constellation.

Ascending Period of Moon

During this period, cosmic forces are active above the earth/ ground. Any agricultural practice (spray, propagation, harvesting etc.) performed during the period shows beneficial effect.

Descending Period of Moon

During this period, cosmic forces are active below the earth. Therefore, agricultural practices (field preparation, sowing, manuring and harvesting of root crops) performed during the period show success.



Ascending Moon	Descending Moon
The earth is breathing out – the development occurs in upper parts of plants.	The earth is breathing in– the development of the plant occurs parts below the ground, e.g. root
Cosmic energy works above the rhizosphere	Cosmic energy works below the rhizosphere
Spring and summer season	Autumn and winter season
suitable for:	suitable for:
• foliar applications	• root development
• propagation activities	• transplanting
• harvesting	• manure application
• sowing	• harvesting of tuber crops

Perigee (*Poornima*)

When moon is nearest to earth, at perigee plants are more prone to fungal diseases.

Apogee: When the moon is farthest from the earth, it is suitable for sowing tuber crops.

Rahu: Lunar node in ascending period of moon is not suitable for agricultural activities

Ketu: Lunar node in descending period is not suitable for agricultural activities

Biodynamic Preparations

Basically there are 2 types of biodynamic preparations. They are: Biodynamic Compost Preparations (BD- 502-507), and Biodynamic Field Sprays (BD- 500-501) and Field Preparations (Table 1).

Table 1. Biodynamic preparations

Preparation	Substances from which preparation is prepared	Application
BD-502	Fermented flower heads from Yarrow (*Achilles millefolium*)	Rich in S, K, N. Used in CPP, BD compost, liquid manure,
BD-503	Fermented heads from German chamomile (*Mtricaria recutita*)	Rich in S, K, N. Used in CPP, BD compost, liquid manure
BD-504	Stinging nettle (*Urtica dioica*) fermented in the soil	Rich in Fe, Used in CPP, BD compost, liquid manure
BD-505	Oak bark (*Quercus robur*) fermented	Rich in Ca. Used in CPP, BD compost, liquid manure
BD-506	Fermented flower heads of Dandelion (*Taraxacum officinale*)	Rich in K, Si. Used in CPP, BD compost, liquid manure
BD-507	Valerian flower juice (*Valerian officinale*)	Rich in P. Used in CPP, BD compost, liquid manure

All these preparations should be made during descending period of the moon except BD-507, which is best prepared in air/light day. The biodynamic compost preparation sets are used in the cow pat pit (CPP), biodynamic liquid manure, and biodynamic compost. The specification of sets used are described in Table 2.

Table 2. Number of sets used for specific preparation

Specific preparation	No. of sets used
Cow pat pit (CPP)	3 sets per 60 kg of cowdung
Liquid manure	2 sets per 200 feet
Biodynamic compost	1 set per 5 m^2

Cow Pat Pit (CPP)

A biodynamic field preparation it is also called as "soil shampoo." The CPP is a strong soil conditioner. It enhances seed germination, promotes rooting in citing and grafting, soil texture, provides resistance power against pest and disease replenishes and rectifies the trace element deficiency. It is increasingly used in seed treatment and foliar applications.

The CPP may be prepared throughout the year. A pit of 90 cm x 40 cm x 30 cm lined by the bricks is prepared in a root zone free area with a good drainage. In 60 kg cowdung, 250 g eggshell powder and 250 g of basalt/Bentonite powder is thoroughly mixed. Fill the pit to a maximum depth of 25 cm, any deeper will delay the break down into humus. Inject 3 sets of BD preparations 502-507 by pressing them into the dung to a depth of 5 cm, stir 3 sets of valerian preparation BD 507 in one liter of water and sprinkle over dung. Cover it with the gunnysack to retain the moisture.

Dandelion (506)			Yarrow (502)
	Nettle (504)	Oak bark (505)	
Valerian (507)			Chamomile (503)

Depending upon the weather and temperature the preparation should be ready to use in approximately 3 months. Dissolve in 40-45 litres of water overnight and sprinkle in the next morning. Use 500 g CPP/acre of land.

Biodynamic Compost Heap

Biodynamic compost is an effective soil conditioner and is an immediate source of nutrient for a crop. Biodynamic Compost Heap can be prepared by using green leaves (nitrogenous material) and dry leaves (carbonaceous material) in 8-12 weeks. The green leaves (nitrogenous material) and dry leaves (carbonaceous material) are piled up in the alternative layers of 15-25cm thick 5m x 2m x 1.5m size. Integrating with cowdung is always good in decomposition process. For enriching the compost with different nutrients as per the need, rock phosphate (P), slack lime (Ca), wood ash (K) etc. can be used. The composition of air, moisture and warmth is very important in the breakdown and decomposition of the material.

Biodynamic Tree Paste

It is a biodynamic process for the management of orchards and gardens. The "Biodynamic Tree Paste" is prepared by mixing of cowdung, farm soil (clay) and sand in a 2:1:1 ratio and adding BD-500. The tree paste is polished on the tree trunks and cut surfaces. The important properties of the Biodynamic Tree Paste are:

- It nourishes, strengthens and protects the bark and cambium of tree to make it healthy.
- Seals and heals wounds.
- Prevents and controls diseases.
- On application after pruning stimulates tree growth.

In rejuvenation of mango orchard, copper oxychloride pasting (CoC) is very expensive. Pasting with the above paste on tree trunk and cut surfaces, it has shown better response compared with CoC pasting. Similarly, tree paste and simply cowdung paste have shown promising response in controlling

Lasidiplodia theobromae growth in petridishes and on mango bark which is responsible for die back in mango.

Biodynamic Liquid Manures and Pesticides

Liquid manures are prepared using different materials, i.e. liquid fish manure, liquid seaweed manure, and liquid plant manure. The liquid manures are used for the different purposes based upon the quality and composition. On an average, preparation of liquid manure takes 8-12 weeks. One liter of liquid manure dissolved in 4 liters of water is used on plants as foliar spray. Liquid manure is also prepared with neem, *Pongamia* and *Calotropis* leaves which have insecticidal and fungicidal properties.

Biodynamic Field Sprays (BD 500-501) and Field Preparations

There are fundamental biodynamic field spray preparations. Burying cow horns in well fertile soil filled with fresh cowdung obtained from lactating cow. The horns are placed during descending moon in autumn (October- November) for incubation during whole winter. In March-April, it is taken out again in descending period and used or stored in earthen pots at some cooler place. The cow is an early creature with a very strong digestive system. The cow horn has the ability to absorb life energies during decomposition of the dung being incubated in winter months.

For spraying 25g of BD-500 is dissolved in 13.5 liters of water in plastic bucket by making vortex in clock and anti-clockwise for an hour in the evening and the solution is sprayed with the help of natural brush or with a tree twig. Spraying of BD-500 is done at the time of field preparation during descending period of the moon.

Thimmaiah (2001) observed the microbial activity of BD-500 during stirring and very interesting response has been obtained (Table 3).

Table 3. Microbial analysis of BD 500

Stirring interval	Bacteria (efu's/g)	Actinomycetes (efu's/g)	Fungi (efu's/g)
15 minutes	$26x10^3$	$22x10^3$	$10x10^3$
30 minutes	$35x10^3$	$35x10^3$	$14x10^3$
45 minutes	$58x10^3$	$60x10^3$	$12x10^3$
60 minutes	$66x10^3$	$88x10^3$	$35x10^3$

Source: Thimmaiah, 2001

It was interesting to note that during stirring period there is an increase in the number of efu's of bacteria, actinomycetes and fungi after an hour of stirring. Garg (2001) identified some microorganisms (fungi) from BD-500. They are: *Fusarium semifetum, F. sporotrichiodes* and *Syncephalastrum racemosum.*

BD-501 or Horn Silica Manure

Preparation 501 is made during ascending period by filling the horn with 'mealy' silica powder and is buried in spring (March/April) after taking out BD-500. Within 6 months, the preparation is ready for use. The solution is prepared by dissolving 1 g of BD 501 in 13.5 liters of water for use in

one acre. The BD 501 should be applied on the leaves in the form of 'mist spray' in the morning at the sunrise and the best constellation is Moon in opposite to Saturn.

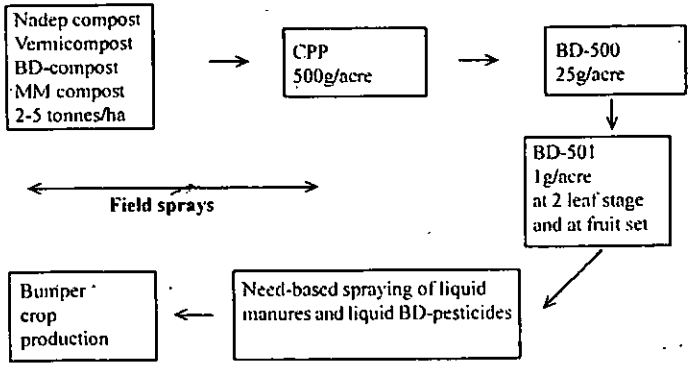
BD 501 works on the photosynthesis process in the leaf. It strengthens the quality of plant and plant product, encouraging the development of fruits and seeds. For maximum effect, BD 501 should be applied once at the beginning of a plant's life, at the 4-leaf stage and again at flowering stage or fruit maturation stage. Garg (2001) isolated some fungi from BD-500. They are: *Fusarium monliformae, Penicillium chrysogenum* and *Syncephalastrum racemosum.*

Due to enhancement of photosynthesis of the plant, the starches, sugars and cellulose are improved. The quality of grains is greatly increased.

Biodynamic system is almost new, but the preliminary observations over 3 years have shown encouraging responses. On the basis of these observations the following interferences are drawn.

- It appears to be a sustainable, economic and eco-friendly.
- There is minimum risk of residual toxicity.
- There has been improvement in soil fertility and produce quality including self-life.
- It will require a systematic approach as summarized.

Incorporation of Organic Matter



STRATEGIES

- Various aspects of organic production of horticultural commodities needs to be standardized.
- Promotion of establishment of demonstration for preparation of biodynamic compost, cow horn silica, cow horn manure, Cow Pat Pit (CPP), liquid manures and liquid biodynamic pesticides.
- Promotion for field demonstrations of biodynamic preparations.
- Organizing intensive training to farmers, NGO representatives, entrepreneurs, and extension personnel of DoH for biodynamic preparations and their applications.

- Scientific explanation for responses of the above materials with reference to soil physical and microbiological properties.
- Helping SAUs to initiate some courses on 'biodynamic agriculture'.
- Facilitation for certification for 'biodynamic produce'.
- Establish national standards governing the marketing of certain agricultural products as organically produced products.
- Assure consumers that organically produced products meet a consistent standard.
- Facilitate commerce in fresh and processed food that is organically produced.
- Market promotion for 'biodynamic produce'.

MARKETING OF HORTICULTURAL PRODUCE – AN INNOVATIVE APPROACH

Mohan Pillai*

Development of a stable and self-sustaining marketing system is the noble gift that any agricultural development agency can offer to its potential customers. A rational marketing system always works backwards as well, means a farmer who is getting remunerative and stable price will increase his area of cultivation and will thrive to increase productivity by using better production and management techniques. Various problems in agricultural produce marketing such as influence of middlemen, lack of grading and standardization, lack of standard weights and measurements, lack of proper market knowledge, adequate finance etc. are main factors influencing the producers' share. A rationale marketing system means reducing the effects of these problems in agricultural marketing. Group-marketing concept, an innovative model of participatory rural marketing has been conceptualized and implemented in Kerala, by the Kerala Horticultural Development Programme (KHDP), a joint venture of Govt. of Kerala and European Economic Commission. The KHDP through its member farmers in the Self-Help Groups (SHGs) has developed one of the best solutions for addressing these problems. It has initiated implementing the concept of Group Marketing as a part of this process through the farmer institution, known as Farmers' Market. It proved beyond doubt that a farmer-driven marketing system with proper management support can provide a rational and sustainable marketing support to farmers.

GROUP MARKETING—THE CONCEPT

The concept of group marketing, in simple terms, is marketing managed by farmers' groups. As the name implies, its major focus is to empower and facilitate the farmers to take more effective decisions with regard to marketing of their produce. The concept of group marketing thereby provides the member farmers better access to markets and therefore a greater share in the consumer's rupee. This system has been acting as better and efficient alternative for farmers growing fruits and vegetables in Kerala for the last 6 years.

Self-Help Groups (SHGs)—The Foundation Stone

Formation and promotion of Self- Help Groups (SHGs) is the core concept to create a sustainable medium to implement group marketing and other developmental works. A voluntary group of 15-20 farmers form an SHG. Each SHG functions according to a set of mutually agreed norms. The SHGs create opportunities for farmers in terms of improved agricultural practices, quality input procurement, and availability of credit, increased bargaining power other than improved marketing system.

Every SHG selects 3 farmers to lead the group in areas of production, credit and marketing. These farmers are given intensive training in their respective areas and are also geared up to impart knowledge to their fellow farmers. The responsibilities of the master farmers include overseeing the activities of group, functioning as the link between other agencies and SHG members, and representing the SHG in the local farmers' markets. Promoting agency extends all its supports and services through the master farmers. Instead of providing subsidies, it is ideal to educate master farmers on various technologies and know-how. Master farmers in turn pass this on to other members and ensure their involvement and active participation.

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Group Marketing

By addressing the basic production and credit needs of the farmers, the SHG's activity gets a momentum. By way of regular meeting, group fund mobilization and technical and management training the group reaches a stabilization phase. A minimum period of 8-12 months is necessary to reach the stabilization phase. During this stage, different problems in selling their produce is discussed. The idea of group marketing as a solution to their produce selling problems is also discussed. Again, through the process of group level discussions, the problems of marketing and need for systems are appraised. Immediately after the completion of group-level discussions, a master farmer meeting is organized. This meeting is the first networking activity with farmers of different SHGs within the operational area helping them to come together to share their problems. This is the first platform to initiate thoughts on group marketing with various groups.

As a second step, visit to existing Farmers' Markets followed by experience sharing by the Marketing Master Farmer is organized. The visits and experience sharing, act as motivation to initiate the market. Through the visits, master farmer understands the system, strategy and idea of operation. It works on famous principle of extension "seeing is believing". If the group is impressed in the concept, the idea of initiating the market can be finalized in the same SHG meeting. The group members also express their ideas about the location of the market and the operational formalities.

A Master Farmer training is organized to give a conceptual background to the Marketing Master Farmers (MMFs), another vital step. The training gives a brief on management procedures in the farmers' market, bylaws for operation, accounting and auditing norms.

The next step is the committee formation and general body meeting of members. The marketing committee consists of MMFs from all representing SHGs. The key office bearers such as President, Vice-President and Treasurer are also selected in this meeting. The first committee finalizes the share amount, location of the market, proposed volume to be traded and trading days. The bylaws for operation is also discussed in details. The committee fixes tentative market days and dates as well as arrangements for trader contact. A bank account for official transactions is also finalized in this meeting. The committee takes decisions on appointment of a qualified Manager-cum-Accountant for book-keeping and regular management of farmers market.

All the participating farmers from SHG constitute the general body of shareholders who officially approve the bylaws after discussion in their respective groups. They also approve the tentative date of inauguration, trading days and venue of marketing. Apart from this, the general body ratifies the decision on the selection of accountant and his training on farm produce accounting system.

Table 1. Steps in establishing farmers' market

Step	Farmers' market
I	Identification of farmers with common interest growing similar crop in contiguous area spread over 5 km radius.
II	Formation of Self- Help Group consisting of 20-25 farmers, 15-20 groups constitute a farmer market.
III	Identification and selection of master farmers by each group
IV	Training to Master Farmers on farm trading activities (by experts).
V	MF Visit to nearest agri-produce market for understanding activities and learning good and evils.
VI	Training master farmers on procurement and book-keeping.

VII	Formation of Executive Committee of MF for future activity planning and management.
VIII	Identification of central point for trading.
IX	Ratification by all members in group.
X	Selection of Accountant/ Manager for book-keeping, office bearers of farmers' market—Initiate bulking of produce.
XII	Auditors appointed and audit of books of accounts after 45 days.
XIII	Stabilization of bulking point to farmers, market requires good farmers and trader participation. • Regular trading • Up to date and transparent book
XIV	All management decisions by Executive Committee headed by President, ie. • Budget preparation • Procurement plans • Audit analysis • Decide product mix for trading • Promoting good farmer and traders relationship
XV	Registration of farmers' market under Societies Act to give legal status.
XVI	Permanent location for farmers' market. • Possible ancillary activity to be initiated beneficial to farmers.

FORMATION OF FARMERS' MARKET AND ITS STAGES

Stage I : Bulking Centre

Completing all the procedures 10-15 SHGs, numbering about 150-250 farmers come together to form the Farmers' Market. These farmers bulk and trade their produce collectively at a central location. This system helps member farmers to have a good volume. Therefore, they are in a better position to negotiate with the wholesalers for 'optimizing their returns'. Large volumes induce traders to buy from these Farmers' Market. The produce has to be sold by bid or tender to ensure competitive prices. In addition to better price, the farmers get benefits such as reduced transportation and handling costs, proper grading and weighing and timely payment. More importantly, the farmers save their time which could be utilized for more productive output.

The initial stage of operations of the market is called as bulking centre. This stage is also considered as the trial run period. During this stage the marketing committee gets familiar with the marketing techniques, trading formalities, accounting procedures, method of payment, procurement system, etc.

Stage I B : Unregistered Farmers' Market

After attaining certain pre-fixed benchmarks, the bulking centre is upgraded to Farmers' Market (Table 2). The marketing committee will be monitoring the day-to-day activities and collective decisions are taken to sort out major issues. The market accounts books are audited by a registered chartered accountant on a monthly basis and provided to the marketing committee. The marketing committee discusses the audited statements and corrective measures taken for maintaining transparency of accounts. Monitoring agency facilitates all the activities of market and help the marketing committee in taking decisions.

Table 2. Benchmarks for upgrading bulking centre

Performance indicator	Benchmarks
Number of SHGs	Minimum of 7 and maximum of 15
Number of member farmers	Minimum of 75 or 50% of SHG members whichever is higher
Number of farmers participating	Minimum of 50 or 25% of SHG members whichever is higher
Quantity of fruits and vegetables traded	30 tonnes if vegetables 50 tonnes if fruits 40 tonnes if mix of fruits and vegetables
Age of the bulking point	Minimum of 45 days
Sales turnover	0.21 million if vegetables 0.4 million if fruits 0.3 million if vegetables and fruits
Net profit	1% of sales turnover
Status of auditing	Monthly audits completed
Debtors	Not to exceed 5% of sales turnover

Stage II: Registered Farmer' Market

It is essential that farmers market be given a legal identity for its success and long-term sustainability. These markets can be registered under the Societies Act of the respective state.

Stage III: Registered Farmers' Market at Permanent Location

The most important support to be provided to the well-established Registered Farmers' Market is a permanent identity for further existence. Various supports have to be provided to these farmers' market at different stages (Table 3) from time-to-time (Fig. 1).

Table 3. Farmers' market-supports to be provided

STAGES OF FARMERS' MARKET	TANGIBLE SUPPORTS	NON-TANGIBLE SUPPORTS
STAGE I A	• Weighing balance • Books of account	•Market intelligence information • Management support • Post-harvest handling information and training • Value-addition
STAGE I B	• Furniture • Table – 1 no • Chairs – 10 nos. • Cupboard – 1 no.	
STAGE II	• Reimbursement for a year • Salary of accountant/ Manager • Rent for shop • Audit fees	
STAGE III	Permanent location for trading	

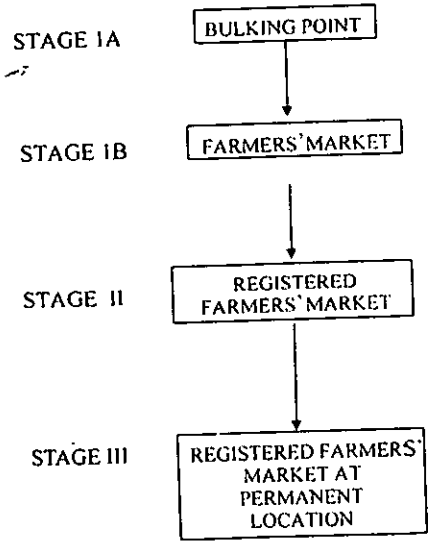

Fig. 1. STAGES OF FARMERS 'MARKET

SYSTEMS —THE STONES OF SUCCESS

Accounting and Management System

A standard accounting system is implemented in the market (Fig 2). A draft management manual is developed to help the marketing committee to manage its day-to-day affairs. Accounting and management norms for all marketing committees, make the accounting process more rigorous and ensure transparency in financial matters. Provisions have to be made for all account books to be audited and presented to marketing committee to ensure proper accounting practice being adopted by the committee. Accountants and master farmers are given regular training to ensure proper account maintenance.

The books of accounts are monitored closely through the audit procedure at monthly intervals and compiled on a quarterly, half yearly and annual basis. Auditing has to be done by qualified chartered accountant to ensure transparency in organization of farmers' market. A detailed flow chart on accounting system is shown in (Fig.2).

Better Trader and Credit Management

As traders are attracted to the farmers' market, farmers have a home turf advantage. This is of great advantage to farmers considering the difficulties they usually experience in the public markets, normally he goes for distress sales. Weighing at the farmers market is done by farmers and is transparent and accurate. The farmers' market is free of loading/unloading workers since the farmers do it themselves, also ensuring careful handling of the produce. Prompt payment within prescribed period is guaranteed, as there is a collective effort in recovery from among debtors. The farmers' market is not envisaged to be an organization involved in pricing and buying/selling of produce but facilitates trading between farmers and traders. The farmers' market is therefore a means for the farmers to improve their bargaining power through better access with markets, traders and customers.

Price Setting Mechanism

The process for trading has to be based on market intelligence information collected from Vegetable and Fruit Market both within and neighbouring district or locations. Ideally the price has to be based on market dynamics of overall demand and supply. In KHDP market intelligence information is collected from 12 main vegetable and fruit market within the state and 5 outside the state for 39 vegetables and 3 fruits.

Trading System

To encourage a healthy competition an open auction system is advisable. The benchmark price has to be based on market intelligence information supplied by promoting agency. In KHDP, a very good market intelligence network has been established. In location with lesser trader participation, a direct negotiation can be adopted.

Forward Integration

Farmers' market with a good population in neighbourhood should initiate retailing. The KHDP's farmer markets have initiated retailing in a few locations has proved successful. Farmer markets close to large Agriculture Produce Market should also establish an outlet in such market for produce trading.

CONCLUSION

Empowering farmers to collectively bulk, grade and trade their produce help them in establishing and efficiently managing a business enterprise for maximizing their benefit. Group marketing concept is therefore the most ideal marketing model for a sustainable future.

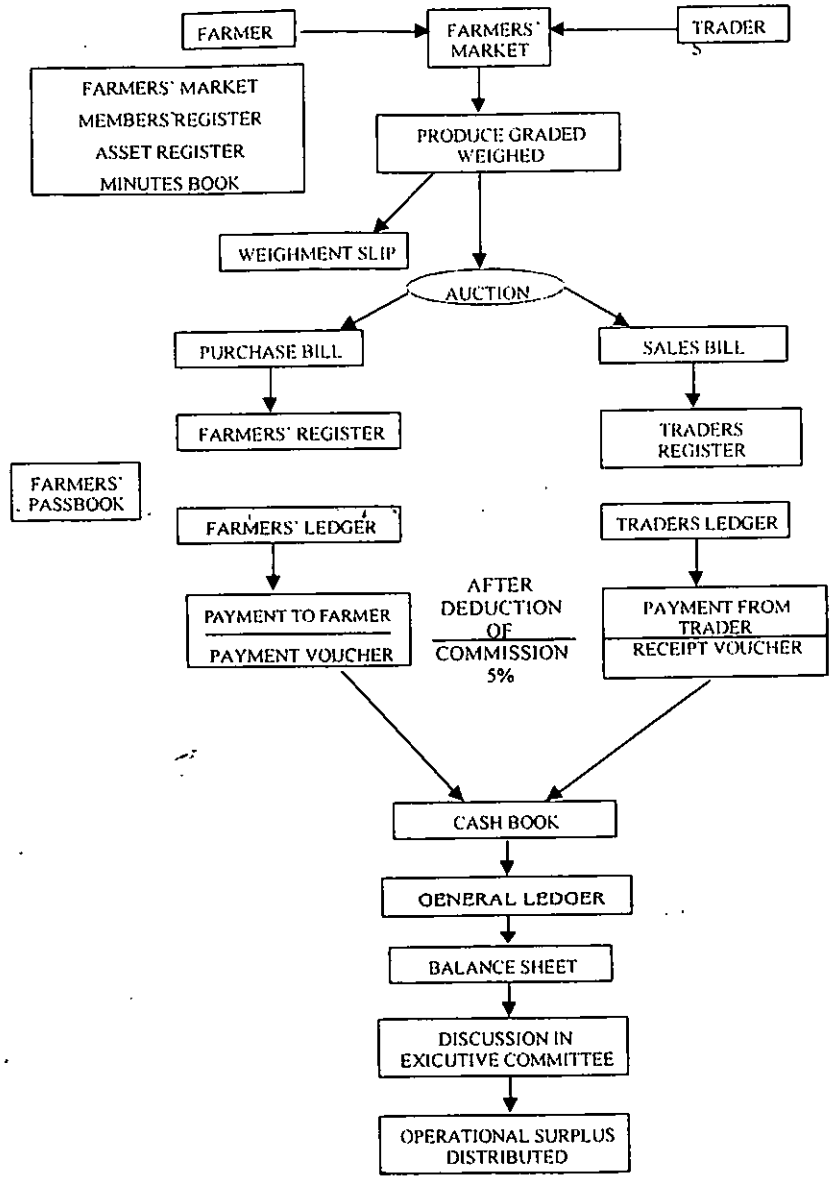

Fig 2. Transactions in farmers' market

HORTICULTURAL DEVELOPMENT IN MAHARASHTRA

J.P. Mahalle*

Maharashtra ranks first in area and production of fruit crops, having an area of 636.23 lakh ha (2000-2001). The geographical area of Maharashtra is 307.58 lakh ha, out of which 180.53 lakh ha is net sown area. However, about 29 lakh ha area is cultivable wasteland which remains unutilized.

INFRASTRUCTURE FOR HORTICULTURAL DEVELOPMENT

The massive plantation under Employment Guarantee Scheme linked with horticultural development programme aims at planting quality planting materials of promising cultivars. The state has 136 Government nurseries with an area of 2,729.63 ha. Presently there are about 2.12 lakh mother plants of various promising cultivars. All the 4 SAUs are also having 24 nurseries on their farms. Besides, there are about 1,674 registered private nurseries, making self-sufficient in planting materials except aonla and spice crops. State Government has also established one hi-tech floriculture project at Pune with an investment of Rs 300 lakhs.

One tissue culture laboratory at Marathwada Krishi Vidyapeeth, Parbhani, has also been established with the cost of Rs 400.00 lakhs. There are 21 tissue culture laboratories in the state with a production capacity of 913 lakh plantlets. Pesticide residue testing laboratories with international standards have been established at Pune and Nagpur.

An independent website of Agriculture Department has been started in the state. To face the challenges of WTO an executive committee has been appointed under the chairmanship of Agriculture Minister, for monitoring the situation and making necessary recommendations to the Government of India.

For promotion of medicinal and aromatic plants, 4 herbal gardens and nurseries have been established in all 4 SAUs. Establishment of 12 plant health clinics for testing genetic purity of horticultural crops is in progress in SAUs. To monitor the occurrence of pest and disease incidence on important horticultural crops, establishment of 8 disease forecasting units is in progress in all SAUs.

For testing micronutrients/establishment of leaf and tissue analysis laboratories one each at Dr Punjabrao Deshmukh Krishi Vidyapeeth, Akola, and Dr Balasabheb Sawant Konkan Krishi Vidyapeeth, Dapoli, is in progress. Similarly establishment of 4 analytical laboratories for medicinal and aromatic plants is in progress in all SAUs.

DEVELOPMENT OF FRUIT CROPS IN MAHARASHTRA

Employment Guarantee Scheme Linked Horticultural Development Programme

The soil and climatic conditions of Maharashtra are very congenial for cultivation of fruit crops. Therefore an ambitious scheme, Employment Guarantee Scheme Linked Horticultural Development Programme, has been launched in 1990-91 with following objectives.

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- To utilize 29 lakh ha cultivable waste area.
- To convert the land from low-value crops to high-value crops.
- To generate employment opportunities in rural areas.
- To control soil erosion.
- To control pollution.
- To improve socio-economic conditions of farmers.

Salient Features of Employment Guarantee Scheme

About 25 fruit crops have been covered under the scheme. Each beneficiary can avail the facility having up to 4 ha. However, farmers having up to 10 ha in Konkan region avail 100 % subsidy on wages and inputs. It is for small and marginal farmers and those belong to SC, ST, VJ, NT and Nav Buddhist categories. However, other beneficiaries can avail 100 % assistance on wages and 75 % on inputs. Subsidy amount ranges from Rs 17,281 to 49,189/ha as per the crop. Subsidy is given in cash for wages and in kinds for planting material, fertilizer and plant-protection chemicals for 3 years. Subsidy amount is directly deposited by Demand Draft in beneficiaries' bank account.

Achivements of Schemes

Area covered during 1990-91 to 2000-2001 is 9.70 lakh ha. Thus total area under fruit crops in the state has gone up to 12.45 lakh ha (Table1). About one lakh ha area/annum has been covered under the scheme. More than 2.76 lakh ha (29%) area is waste / fallow land of the total planted area under the scheme. About 7 and 11% SC and ST farmers respectively have been benefitted by this scheme until now.

- Mandays generated are 2.141 lakhs.
- 3,5525 villages are covered under the scheme.
- Since 1990-91, Rs 744.51 crores have been distributed as subsidy.

Mango

Mango is one of the most important fruit crops in the state having an area of 4.03 lakh ha under cultivation with productive area of 1.47 ha and 50.05 lakh tonnes of production. Out of this, 1.58 lakh ha area is in Konkan division under export-oriented Alphonso variety. Besides, there is a good demand for Alphonso, Keshar, Dashehari, etc. Considering the demand for processed products like pickles, juice, etc. there is a scope for establishment of processing units in the state.

Grapes

Maharashtra stands first in area and production of grape in the country. At present, 29,756 ha area with 7.8 lakh tonnes of production is in the state. Normally, 20,000-25,000 tonnes of fresh grapes are exported worth Rs75.00 crores. Every year, about 1.20 lakh tonnes of fresh grapes are used for making 30,000 tonnes of resins. The average productivity of grape in Maharashtra is 1.5 tonnes/ha compared to 0.8 tonne/ha at the national level.

Cashew

Maharashtra is leading in area under cashew in the country. At present, 1.38 lakh ha area is under cashew crop against 7.57 lakh ha in the country. Total production in the state is 1.01 lakh tonnes.

Table 1. Area and production under fruits in Maharashtra (2000-2001)

Crop	Area before 1990 (ha)	Area from 1990-91 to 2000-01 (ha)	Total area (ha)	Productive area (ha)	Production (tonnes)
Mango	35,400	368,155	403,555	147,206	500,500
Cashew	16,000	122,414	138,414	67,650	101,475
Coconut	17,000	21,447	38,447	15,765	*
Sapota	3,900	49,190	53,090	12,631	116,310
Orange	33,600	98,581	132,181	125,604	1,077,68
Sweet lime	5,700	66,903	72,603	19,930	298,352
Guava	8,500	23,394	31,894	17,620	211,440
Pomegranate	7,700	67,352	75,052	40,970	409,700
Ber	0	71,129	71,129	33,391	500,865
Custard-apple	2,800	26,890	29,690	17,600	52,800
Tamarind	0	16,274	16,274	5,260	10,520
Fig	0	538	538	0	0
Jamun	0	366	366	366	915
Jackfruit	0	1,260	1,260	1,475	44,250
Aonla	0	4,889	4,889	1,084	5,400
Kavath	0	18	18	0	0
Kagzi lime	14,000	20,170	34,170	10,300	97,850
Spices	0	558	558	0	0
Others	28,000	11,082	39,082	17,450	87,250
Total EGS	**172,600**	**970,580**	**1,143,180**	**534,302**	**2,913,334**
Banana	59,400	-	72,175	72,175	4,330,500
Grape	10,000	-	29,756	29,756	779,012
Total	69,400	-	101,931	101,931	5,109,512
Gross total	**242,000**		**1,245,111**	**636,233**	**8,022,846**

* Production of coconut: 3,344 lakh nuts

However, only 10- 15% raw cashew is processed in the state.Therefore, there is a need to establish cashew processing units in the state. In order to encourage cashew processing units in rural areas, assistance has been given to 45 units during 2000-2001. During 2001-2002, 50% subsidy up to Rs 25,000 will be given to 100 units.

Pomegranate

Maharashtra stands first in the country in area and production of pomegranate. At present, 75,000 ha area is under pomegranate, with 41,000 ha as a productive area. The total production is 4.10 lakh tonnes.

Orange

Oranges are mainly grown in Vidarbha region of the state. The total area under orange is 1.32 lakh ha with 1.25 lakh ha as a productive area, the total production being about 10.77 lakh tonnes.

Sweet Orange

Sweet orange is a major fruit crop in Marathwada. About 73,000 ha area is under this crop and 29,000 ha is under production. The total production is about 3.00 lakh tonnes. Since 1998-99, control market is started at Jalna for sweet orange growers.

Banana

Maharashtra stands second in area and first in productivity of banana in the country. Its productivity is more than 60 tonnes/ha. At present, 72,000 ha area is under banana. However, export-oriented varieties need to be evolved. Similarly for value-addition, establishment of processing units is also required.

DEVELOPMENT OF VEGETABLES IN MAHARASHTRA

Maharashtra contributes 6% of production of vegetables in the country. The area under vegetable crops is about 3.19 lakh ha (Table 2). The total production is 46.74 lakh tonnes/ha and productivity is 12 tonnes. Maharashtra is the largest producer of onion in the country covering an area about 1,12,630 ha with an average production of 14 lakh tonnes. It accounts for 20% of total area and 25% of the total output of onion in India, Maharashtra is exporting about 2,50,000 - 3,00,000 tonnes onion every year.

Table 2 . Area and production of vegetable crops in Maharashtra (1999- 2000)

Vegetable	Area (ha)	Production (tonnes)
Ash gourd	320	3,520
Beet root	360	8,640
Bitter gourd	3,000	36,000
Bottle gourd	3,200	80,000
Brinjal	29,000	464,000
Beans	32,000	128,000
Cabbage	12,500	287,500

Cauliflower	11,000	275,000
Carrot	3,150	44,100
Cucumber	4,700	84,600
Cowpea	8,000	32,000
Fenugreek	21,050	168,400
Knol-khol	2,600	52,000
Okra	25,000	150,000
Onion	112,630	1,351,560
Peas	5,500	22,000
Potato	15,000	150,000
Radish	4,510	40,590
Ridge gourd	2,100	10,500
Snake gourd	800	9,600
Spinach	11,000	88,000
Tomato	35,988	1,007,664
Muskmelon	1,200	12,000
Watermelon	3,000	33,000
Others	41,895	335,160
Total	**389,503**	**4,673,834**

During Tenth Plan, state will give more emphasis on post-harvest handling of vegetable crops. The State Government has also laid emphasis on providing assistance for construction of improved onion storage structures to help the onion growers. During 2000-2001, an amount of Rs 68 lakhs was distributed to farmers as a subsidy for construction of 219 onion storage structures and provision has been made for constracting 550 onion storage structures by providing Rs 175 lakhs as subsidy during 2001-2002.

STATUS OF FLORICULTURAL DEVELOPMENT

Maharashtra stands sixth in respect of area under floriculture in the country with approximately 7,000 ha. The major flower crops grown are roses, chrysanthemum, aster, tuberoses, jasmine, galardia, marigold, etc. These flowers are mainly grown in Pune, Nasik, Ahmednagar and Sangli districts. Recently many private companies and progressive farmers have started export-oriented cultivation of flower crops. They are growing roses, carnations, gerbera, gladiolus, lilium, etc. These companies have contributed much more in floricultural development through greenhouses and tissue culture technology (Table 3).

Table 3. Area and production of flower crops in Maharashtra (1999 - 2000)

Flower	Area (ha)	Production (tonnes)
Aster	90	900
Chrysanthemum	1,200	4,800
Gladiolus	32	320
Jasmine	720	1,440
Lily	9	18
Marigold	1,470	14,700
Rose	1,850	3,700
Others	1,229	2,458
Total	**6,600**	**28,336**

Under Government of India's scheme " Commercial Floriculture", Horticulture Department of Maharashtra has established a model floriculture centre at Rajgurunagar in Pune district. Besides this, 808 small greenhouses are erected on farmers' fields and 14 big greenhouses are erected under corporate sector.

Use of Plastics in Agriculture

Drip irrigation has become a general practice with an area 1,92,852 ha under various crops. Out of this, banana (22%), grapes (18%), sugarcane (13%), citrus (12%), pomegranate (10%), cotton (5%), mango (5%) and other crops having an area of 20% for drip installation (Table 4). An amount of Rs 30,478.10 lakhs has been distributed as subsidy to farmers. Besides Government of India, State Irrigation Corporations are also providing funds for drip irrigation.

Table 4. Area and production of spices in Maharashtra (1999-2000)

Spice	Area in ha	Production in (tonnes)
Chilli	107,000	1,070,000
Coriander	16,720	16,720
Garlic	9,860	59,160
Ginger	3,200	3,200
Black pepper	5,595	5,595
Tamarind	5,260	10,520
Turmeric	7,785	116,775
Other	7,100	35,500
Total	**162,520**	**1,346,270**

Implementation of Central Sector Schemes

During Ninth Plan, various central sector schemes were implemented. The schemes are modified, as per the needs of the state under work plan. Due to this, the central sector schemes are implemented in the state more efficiently and effectively.

The area and production of different horticultural crops have been increased tremendously in the last decade . In order to have market support, export, processing opportunities and to face the challenges of WTO, the agri-business schemes are included and implemented in the work plan.

Similarly considering the suitability of climate and soil conditions for cultivation of tea and coffee, a scheme to promote tea and coffee plantation in the state is also included in the work plan for the first time.

Supply of quality planting materials of genuine varieties is most important in the production of fruit crops. Therefore, scheme for strengthening of Government horticultural nurseries is also included in the work plan.

Implementation of Board Schemes.

At present, the schemes of Coconut Development Board needs modification on the lines of work plan. It is suggested that, the Board may issue administrative approval along with release of funds in the month of April every year so that, the state can utilize the allotted funds more effectively and efficiently as per the need of States. The implementation of National Horticulture Board schemes also needs modification: The Board may indicate state-wise financial allocation of Funds before begining of the financial year. Also powers to sanction proposals needs to be given to the state.

The regional offices of different commodity Boards needs to be established in Maharashtra.

HORTICULTURAL DEVELOPMENT SCENARIO IN UTTAR PRADESH

M.M.Sinha*

Uttar Pradesh is a major horticultural crops-producing state. Varying soil and agroclimatic conditions of the state are favourable for producing almost all tropical and subtropical horticultural crops. It contributes about 40% of the potato production of the country along with major share (20%) of fruits and vegetables. Mango, guava, aonla, litchi, ber, bael and citrus are major fruit crops, whereas almost all vegetables are being cultivated commercially. Mentha has come up in a big way in a few districts of the state in last few years. Uttar Pradesh has traditional betelvine cultivation areas. Beekeeping has also come up as a subsidiary agricultural enterprise along with mushroom production in certain areas. There are traditional flower-producing areas in and around metropolitan towns and religious cities. Flowers had been an integral part of our living; its uses, particularly for religious and social offerings have been on the increase, which is evident from the number of florist shops coming to the fore in almost all the districts of the state. Commercial production of gladiolus, marigold, jasminum, rose, gerbera, tuberose, lillium, etc. is being taken up by the farmers.

Having achieved self-sufficiency on the food front, the focus in Indian agriculture, in the last decade or so, shifted to other fields of commercialization. The areas that have emerged as viable diversification options have been different horticultural crops including floriculture. Horticulture sector has been acknowledged as a remunerative means for diversification of land use for improving productivity and returns providing nutritional security, increasing employment opportunities, providing raw materials for growing food processing industries and improving foreign exchange earnings through export.

Uttar Pradesh is the first state which has taken initiatives in declaring fruit belts in specific areas for specific crops. So far, 17 fruit belts of mango, guava and aonla have been declared by the state Govt. and schemes are being run for further intensification in these fruit belts. Latest technologies such as installation of drip irrigation systems on farmers' fields, in-house cultivation of horticultural crops, low-tunnel-agronet, production of tissue-cultured plants and export-oriented floricultural units are being promoted and now Food Analysis and Research Centre is being established at Lucknow.

As a result of continuous and rigorous efforts by the department, SAUs and progressive farmers of the state, Uttar Pradesh has been at the forefront as production of fruits has increased 20 times, production of vegetables 19 times and potato 13 times since 1950-51 (Table 1).

Table 1. Production level of horticultural crops in Uttar Pradesh

Year	Area (lakh ha.)			Production (lakh tonnes)		
	Fruits	Vegetables	Potato	Fruits	Vegetables	Potato
1950-51	1.00	1.00	0.97	5.00	10.00	6.86
2000-01	7.15	11.23	4.00	69.24	163.30	85.00
2001-02 (Target)	8.85	11.25	4.05	100.00	191.05	103.00
2009-10 (Projection)	8.98	12.00	4.10	108.00	252.00	105.00

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The Department is producing quality plants in 133 Govt. nurseries/vegetable and potato seed multiplication farms and distributing about 50 lakhs of them every year to farmers on no-profit and no loss basis. About 3,000 quintals of certified vegetable seeds and 26,500 quintals of potato seed were produced and distributed to progressive farmers of the state. Private sector registered nurseries are producing approximately 75 lakhs of plants and distributing them all over the country and even to neighbouring countries (Nepal and Bhutan).

The Department is imparting following trainings to farmers and women :

- 15-day fruit preservation training to 31,000 beneficiaries.
- 100-day entrepreneurship development training to 630 trainees.
- 1-year food processing, bakery and confectionery and cookery training to 720 trainees.
- One-month bakery, cookery and combined training to 1,075 trainees.
- Community canning of 6.49 lakhs kg of fruits and vegetables.
- 2- year Associateship Course in Fruit Technology to 25 trainees.
- Beekeeping training to 2,800 beneficiaries.
- Mushroom training to 215 beneficiaries.
- One or two days training to the beneficiaries under different schemes.
- Betelvine cultivation training is also being imparted to the growers in 19 districts where betelvine is being cultivated.

Besides, day-to-day technical problems of farmers regarding crop cultivation are also taken care of at 7 departmental experiment centres located at different regions.

PRESENT STATUS

Uttar Pradesh is a vast state having 70 districts and 97,134 revenue villages. In order to reach out to the potential farmers of the state, the department is equipped with 4,450 officers and employees which are too meagre a number. Department has identified 100 'A' category, 125 'B' category and 225 'C' category potential blocks in the state keeping in view of the suitability of agroclimatic conditions and availability of infrastructure in Govt. and private sector. Thus, basic minimum staff at these potential blocks is a prime necessity, which at present, is not adequate. Only 126 blocks of the state have a few staff members.

The state has following Govt./private sector infrastructure.

- 227 Govt. nurseries/potato and vegetable seed multiplication farms/progeny orchards/ Horticulture Experiments and Training Centres.
- 10 Govt. Food Science Training Centres at divisional headquarters.
- 103 Govt. Community Canning Training Centres in all the districts of the State. Besides one Govt. Food Processing and Canning Institute at Lucknow.
- 3 Beekeeping Centres and 14 Beekeeping Subcentres for imparting training to farmers in beekeeping.
- 3 Mushroom Spawn Production Labs.

- 2 Govt. cold storages and 1,027 private sector cold storages.
- 1,055 registered private nurseries.
- 265 *mandies.*
- Higher education in agriculture/horticulture in the state is imparted through 4 SAUs and 24 degree/postraduate colleges. Every year 2,900 agriculture graduates and 1,400 post graduates pass out from these institutions.
- Food Analysis and Research Centre (FARC) being set up at Lucknow to ensure international quality and standards for agri-export.
- Five Agri-Export Zones are being proposed to be set up for fruits (Lucknow), vegetables (Varanasi), potato (Agra Division), mentha (Rampur and Barabanki districts), floriculture (Noida) and aonla (Pratapgarh).
- Uttar Pradesh has already declared its Agriculture Policy in 1999 which aims at promotion of scientific and diversified agriculture with the objective of attaining a sustainable growth rate of 5.1% through adoption of eco-friendly farming systems. To facilitate this, the policy also aims at encouraging the agro-processing and related industries and developing core infrastructure. Special attention and thrust have been given to diversification to horticultural crops which has creditability in improving productivity of land, employment generation, improving economic conditions of farmers and entrepreneurs, enhancing exports and above all providing nutritional security to the people.
- 33,720 small-scale and 282 large-scale food processing units.
- 274 registered Primary Horticulture Cooperative Marketing Societies with approximately 6,000 members.
- 364 Commodity-Specific Farmers Interest Groups (FIGs) have been formed under UPDASP.
- UPDASP project is being implemented in 24 selected districts. Horticulture being major component amongst 6 implementing departments.

THRUST AREAS

In order to achieve quality production and higher productivity thrust areas have been identified. They are :

- Improvement in production and productivity through production and supply of disease -free quality planting materials.
- Use of latest improved technologies.
- To adopt latest organic farming practices, IPNM, IPM etc.
- Rejuvenation of old under/unproductive orchards.
- Strengthening of extension services with the help of NGOs, FIGs etc. and creation of additional manpower.
- Focus on HRD in horticulture and transfer of technology.

- Promotion of export-oriented horticulture.
- To promote horticulture in wastelands, arable-lands and drylands.
- To facilitate pre-and post-harvest management in horticulture and value-addition to horticultural products.

STRATEGY

- Increase in productivity of fruits, vegetables and potato.
- Special emphasis on valued crops like mango, banana, litchi, citrus, tomato, pea, okra, cauliflower, cabbage and potato by time bound production programmes, input management and technology transfer.
- Production of exportable fruits, vegetables and flowers in compact areas, to create infrastructure in these compact areas.
- To increase the availability of quality planting material and to ensure farmers participation in it.
- To impart training in fruit and vegetable preservation, mushroom cultivation, cookery, bakery and bee-keeping.
- To rejuvenate old under-and unproductive orchards with the help of latest technologies.
- To establish the marketing facilities by way of organizing the farmers under horticultural marketing cooperative societies.
- To provide pre-and post-harvest training to farmers to minimize the post-harvest losses.
- To increase the income of SC/ST and small/marginal farmers through vegetable and floricultural production programmes.

PRESENT PROGRAMMES/SCHEMES/FACILITIES

Under centrally sponsored macro management of agriculture, following programmes are being run by the department They are :

- Tropical/arid zone fruit development.
- Use of plastics in agriculture (installation of drip irrigation facilities).
- Integrated development of spices.
- Integrated development of vegetables.
- Production and supply of vegetable seeds.
- Establishment of nutritional gardens in rural areas.
- Border area development programme.
- Promotion of potato export from the state.

District sector schemes

- Establishment of seed processing centres and intensification of horticultural production.
- Development of specific fruits in selected areas.

- Development of vegetables and spices.
- Development of ornamental gardening.
- Development of betelvine cultivation.
- Development of bee-keeping.
- Special component plan for SC/ST beneficiaries.
- Establishment of nurseries in private sector.

State sector schemes

- Development of mango fruit belts.
- Development of medicinal and aromatic plants.
- Strengthening of Central Directorate.

PROMOTION OF FOOD PROCESSING AND AGRO-BASED INDUSTRIES

Uttar Pradesh has adopted food processing and agro-based industries as thrust sector for promoting exports. Some special packages for the promotion of agri-based and food processing industries in Uttar Pradesh are being initiated. They are :

- Adequate and regular supply of raw materials for agri-export.
- Proximity to Indira Gandhi International Airport, New Delhi.
- Strategic location makes Uttar Pradesh ideal production and distribution centre.
- Lucknow has air cargo complex to facilitate agri-export.
- Provision for modern packing techniques like use of corrugated boxes as per international acceptability.
- Exemption from *mandi* fee to export-oriented agricultural and horticultural produce and processed food stuffs.
- Establishment of a cargo centre with the assistance of APEDA for handling and landing facilities for perishable commodities at the international airports of Lucknow and Varanasi.

CONSTRAINTS

Keeping in view the potential and possibilities of horticultural development in the state, proportionate allocation of funds in different central sector programmes/schemes is needed to give impetus to the horticultural development. Minimum staff at potential horticultural blocks is needed to reach out to the progressive farmers. Strengthening of database with respect to area, production and productivity of horticultural crops is an equally important thrust area. A scheme has already been submitted to Economic and Statistical Adviser, Govt. of India, to strengthen the on-going CES-FV scheme which will enable us to generate reliable statistics on scientific lines. Transfer of improved technology has been identified as one of the major constraints in improving productivity and quality. Using participating rural appraisal techniques even ITKs developed by farmers can be replicated on

other farmers' fields and simultaneously scientific recommendation can also be amalgamated for the benefit of the farmers. Close coordination among SAUs/ICAR institutions and departments is very much needed.

Post-harvest management and marketing is prime need to minimize the losses. Assistance for creation of post-harvest infrastructure can be helpful in this direction. Export of horticulture from the state has yet to make a major dent in the international market. Production of export quality material, improving post-harvest handling and strengthening of other support is required from the Govt. of India.

New Horizons

- Second Food Analysis and Research Centre in the country is being set up at Udyan Bhawan, Lucknow and foundation stone laid on 17th October, 2001 by the Hon. Minister of State for Food Processing Industries, Govt. of India.
- Varietal change programme has been taken up by replacing traditional potato varieties with processing varieties like Chipsona-I and Chipsona-II. Jamuna Safed variety of garlic and Agri-Found Dark Red and light variety of onion. *Kharif* onion production programme has also been initiated in the state.
- Quarterly Bulletin is being published on policy decisions, success stories and communication with the farmers. Three issues have already been published.
- Effective liason with SAUs has been initiated. *Gosthies* within the premises of 4 SAUs in the state are being organized to augment the *rabi* compaign in the state.
- Division level *gosthies* are being organized for the entrepreneurship development in the field of food processing, providing them the latest information on different schemes of GOI, APEDA and Deptt. of Horticulture.
- Horticulture is the major component under UPDASP World-Bank aided project. Performance of horticultural component has been appreciated by the World Bank Appraisal Team.
- State level Horticulture Policy Formulation Group of eminent scientists, entrepreneurs and officers has been constituted. Two meetings have been held so far.
- Commodity-specific 365 FIGs being formulated under UPDASP and 4,000 more being formed.

As our honourable Chief Minister says, that Uttar Pradesh has unlimited potential for growth, it also has unlimited horticultural development potential. Farmers of the state are very innovative and ready to accept the challenges of 21st century. Very few years back, Mentha was new to this state but farmers of the state have widely accepted this crop. Now we have approximately 54,000 ha of area under this crop. All we need is a caring hand on our back.

Fruit Belts of Uttar Pradesh

District	Areas	Fruit	Area under fruit belt (ha)
Lucknow	1. Mal,Malihabad,Kakori	Mango	11,500
	2. Baxi-ka-Talab	Mango	4,000
Pratapgarh	1. Kunda,Kalakankar	Mango	1,700
	2. Sadar,Mangraura	Aonla	1,000
Allahabad	Chayal,Mooratganj	Guava	1,000
Bulandshahar	Syana, Unchagaon	Mango	5,000
Saharanpur	Behat	Mango	1,700
Faizabad	Masaudha, Sohawal	Mango	2,100
Varanasi	Chiraigaon	Mango	2,000
Moradabad	1. Amroha, Joya	Mango	2,600
	2. Gajraula,Hasanganj	Mango	1,500
Barabanki	Banki, Deva	Mango	1,100
Meerut	1. Khekra, Jani, Pilana	Mango	2,000
	2. Shahjahanpur	Mango	700
Unnao	Shafipur,Fatehpur-Chaurasi, Miyanganj, Auras and Hasanganj	Mango	5,000
Sitapur	Mahmodabad	Mango	303
Hardoi	Shahabad	Mango	6,874

Area and Production of Major Fruits and Vegetables

Crop	Major Producing Districts	Area (ha.)	Production (tonnes)	Productivity (tonnes/ha.)
Mango	Lucknow,Pratapgarh, Allahabad, Bulandshahar, Saharanpur,Faizabad,	2,49,080	22,50,281	9.034

	Varanasi,Moradabad, Barabanki, Meerut,Unnao, Sitapur andHardoi.			
Guava	Allahabad,Lucknow,Farrukhabad, Unnao,Kanpur-Nagar,Badaun and Varanasi.	18,528	1,35,557	7.32
Aonla	Pratapgarh, Sultanpur, Raibareli, Varanasi and Fatehpur.	14,317	82,137	5.74
Banana	Maharajganj, Gorakhpur, Deoria, Siddharthnagar,Bahraich,Sant Kabir-Nagar, Basti, Kushinagar and Barabanki.	1,303	29,822	22.89
Potato	Meerut,Muzaffarnagar, Ghaziabad, Bulandshahar, Moradabad, Badaun, Agra, Aligarh,Mathura,Farrukhabad, Mainpuri,Kanpur-Dehat, Itawah, Kannauj, Barabanki,Faizabad, Varanasi and Allahabad.	3,99,019	84,96,851	21.29
Onion	Badaun,Kannauj,Bulandshahar, Farrukhabad,Fatehpur,Jaunpur, Ghazipur,Ballia,Azamgarh, Shravasti, Hardoi, Sultanpur and Barabanki.	25,409	3,63,603	14.31
Sweet-potato	Bulandshahar,Aligarh,Mainpuri, Etah, Badaun, Shahjahanpur, Farrukhabad,-Kanpur-Dehat, Fatehpur,Kannauj,Kaushambi, Hardoi and Sultanpur	25,583	3,01,982	11.80
Tomato	Agra,Firozabad,Kanpur-Nagar, Fatehpur,Allahabad,Jalaun, Barabanki,Ghaziabad,Varanasi, Ballia, Faizabad; Bahraich and Barielly.	6,979	1,39,580	20.00
Chilli	Varanasi,Gorakhpur,Siddharth-nagar,Kheeri,Bulandshahar and Faizabad.	18,018	1,00,000	5.55
Turmeric	Kushinagar,Shravasti, Bahraich, Kheeri, Lalitpur and Maharajganj.	1,069	1,871	1.75

Corriander	Barielly,Badaun,Agra, Hathras, Kanpur-Nagar, Kanpur-Dehat, Fatehpur, Deoria,Basti and Bahraich.	6,350	3,741	0.59
Garlic	Mainpuri, Etah, Badaun, Farrukhabad, Kannauj, Etawah and Rampur.	7,005	28,160	4.02

UP DIVERSIFIED AGRICULTURE SUPPORT PROJECT

(Horticulture Component)

With the World Bank assistance, horticultural development programmes are being run in 24 selected districts and 80 blocks of these districts. The project started during September 1998 in 18 districts and 56 blocks were taken up under Horticulture component. During 2000-01, Allahabad district has been assigned to NGO BAIF, for horticultural development and 7 new districts with 20 new blocks have also been included in this project since January 2001.

The objective of the project is to increase the productivity, quality and income with respect horticultural crops by way of diversification by imparting training and making available of high-level technology, quality planting material and latest post-harvest technology to farmers. The progress under this project is given below:

Area expansion (ha)

Crop	Achievement		2001-2002	
	1999-2000	2000-2001	Target	Achievements
Fruits	760	1,219	1,114	955
Vegetables	2,708	3,220	3,985	835
Spices and aromatic plants	435	760	1,034	387
Flowers	45	121	101	79
Total	**3,948**	**5,320**	**6,234**	**2,256**

Demonstration (nos)

Item	Achievements			2001-02	
	1998-99	1999-2000	2000-01	Target	Achievement
Fruits	-	27	36	335	195
Vegetables and potato	41	124	173	722	102
Spices &aromatic plants	-	491	113	394	146
Flowers	-	-	-	45	19
Mushroom	-	-	3	20	-
IPM	-	-	-	35	-
Post-harvest	-	-	241	1520	-
TOTAL	**41**	**642**	**566**	**3071**	**462**

Establishment of nurseries in public sector (nos)

Item	Achievements			2001-02	
	1998-99	1999-2000	2000-01	Target	Achievements
Fruits	3	17	20	8	5
Vegetables	3	17	25	70	11
TOTAL	**6**	**34**	**45**	**78**	**16**

The other achievements include:-

- To impart training to the farmers, *Mitra kisan* and officers of the Deptt., 3 HETCs, 8 FPTCs and 8 CC Centres have been upgraded with lastest equipments and facilities.
- To produce quality planting materials, model nurseries are also being set up at 3 HETCs and 2 SAUs.
- During 2001-02, six such model nurseries are likely to be set up.
- 667 officers and 22,317 farmers were trained under HRD in premier institution of the country during 2001-02, About 29,221 officers and farmers are to be trained during 2001-02 and 1,796 above already been trained.
- FIGs being constituted at *Nyay Panchayat*/Block level to facilitate input supply and marketing.
- 25 each beneficiaries from Lucknow and Saharanpur are being trained for last 2 years for quality mango production with the help of APEDA.

New technologies have been disseminated to the farmers. They are:

- Low tunnel polyhouse technology to raise off season vegetable seedling.
- Potato production by TPS.
- Use of staking in tomato production.
- Rejuvenation of old mango orchards and use of polinizer varieties for top-working.
- Plantation of Amrapali, Totapari and Ramkela varieties for processing industry (juices and pickles).
- *Kharif* onion cultivation.
- To facilitate the uses of hybrid vegetable seeds to increase production, quality and productivity to meet WTO challenges.

EXPERIENCES OF DIVERSIFICATION IN AGRICULTURE IN UTTAR PRADESH

C.B. Paliwal*

Agriculture has been the mainstay of our economy since ages. Perhaps it has been synonymous to our existence. Since demographically India has been "rural" in nature, intensive effects were made to develop agriculture sector since the dawn of Independence. Thanks to the incessant endeavor of our scientists and hard toil of our farmers, we achieved self-sufficiency in food production. We are able to withstand successfully even the unfavourable weather conditions if they occur in a particular year. The plight and miseries of the people due to scarcity of food are now the grand parents' fable. But still it is not the time for respite. Challenges of future are even greater today than ever. Population is continuously showing an increasing trend over the decades and the pressure on land is becoming enormous. Acquisition and adoption of latest technologies are now the need of the hour in the present age of globalization and commercialization. Against the above backdrop, it is therefore, necessary to manage agriculture sector like all other sectors of economy more scientifically and on modern lines. No longer traditional systems of agriculture are feasible. Besides, agriculture is not an isolated pursuit but it encompasses the whole gamut of activities right from sowing and tilling to harvesting, processing and marketing of the produce.

The U.P. Diversified Agriculture Support Project (UPDASP) is, therefore, conceived as an integrated project in Uttar Pradesh with the assistance of the World Bank to take stock of various requirements for strengthening rural economy by focusing on agricultural development of the state. The project design includes all such activities that contribute to rural prosperity and raise the income of farmers thorough increase in productivity and decrease in cost of production. It also undertakes the construction and development of rural roads and rural markets to strengthen and develop the marketing network to help farmers in appreciating the prices of their produce. The project also purports to strengthen people's organizations and encourage eco-friendly sustainable agricultural practices by reducing the application of chemical fertilizers and pesticides, replacing them with bio-agents. A number of innovative strategies have been introduced in the project with a marked success in the field. A few of them are given below:

INNOVATIVE STRATEGIES

Strategic Research and Extension Plan (SREP) through People's Participation

It is frequently noticed that the greatest malady of the government programmes has been of their being structured without involving the intended beneficiaries or inviting their suggestions. This results in a sense of "aloofness" and "non-adoption" at their level later and consequently not only defeats the very purpose of the programmes but also accounts for their poor performance in the field. Drawing lessons from the above scenario, it is decided in the project to prepare SREPs through PRA exercises involving people right from the initial stage of assessing their needs and requirements to enlisting priorities and suggesting suitable interventions to address the felt needs of the villages. NGOs are chosen to conduct the PRAs in the project area. Scientists from ASVs, KVKs/KGKs, agricultural research stations and Uttar Pradesh Council of Agriculture and other experts are involved in the preparation of SREP. After the SREP is prepared, it is presented in a meeting chaired by the

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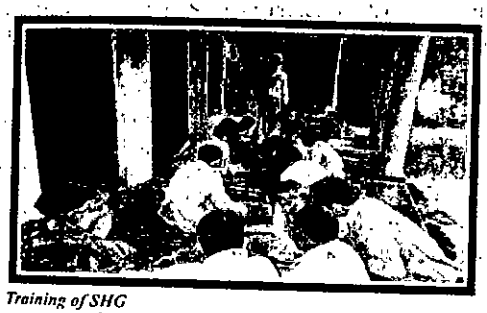
District Magistrate of the district concerned and attended by all the officers of the departments at the district level, representatives of the NGOs and farmers for suggesting modifications, if any, and approving it finally. Once the SREP is finalized, Village Action Plans are prepared and annual targets are set for each department. This preliminary exercise helps in a great way to develop a sense of ownership about the programmes amongst the farming community and their active involvement at subsequent stages.

Training programme under UPDASP

Formation of Self-Help Groups (SHGs) and Farmers' Interest Groups (FIGs)

Observations support the hypothesis that farmers when form themselves into groups/associations have a better bargaining power to sell their produce. They can have a better access to various facilities and manage inputs in a more systematic manner. Collective efforts multiply the results many a times. A simple mathematical situation that one and one if added together becomes two and if put together become eleven holds the key here. Besides, it is also diagnosed that the development of agriculture in the state suffers largely due to inadequate mechanism for transfer of latest technologies to farmers. It is due to lack of sufficient number of extension workers with the department on one hand and their low level of motivation and commitment on the other. The situation further compounds when it is seen that their knowledge is also not updated and suitable to the present-day requirements.



Training of SHG

In UPDASP, it is, therefore, endeavoured to encourage the progressive farmers to come together as a group and disseminate the technology to their fellow villagers. The group of farmers under the project is known as Farmers Interest Groups (FIGs) and Self-Help Groups (SHGs). The NGOs are engaged in the project to motivate and mobilize farmers to form the groups. These group members are provided necessary training on various subjects from the primary agricultural operations to the marketing of the produce. Exposure visits to appropriate places and institutions are also arranged for them to apprise them of the latest innovations and technologies. At a later point of time, say about 6 months, when the groups become sufficiently matured and sustainable they are linked to credit institutions to take up the economic activities of their choice. So far more than 6,000 groups have been formed under the project. Of which about 2,000 groups are Women Self-Help Groups (WSHGs). These groups are successfully pursuing the activities of honey production, mushroom cultivation and Chicory cultivation etc.

Role of NGOs in Project

A new paradigm is being explored in the project where 'working with the people' rather than 'working for the people' has been adopted as the guiding philosophy in the project. In UPDASP, therefore, an experiment is being tried in a select number of blocks where extension activities till date being carried out by the respective departments have been entrusted to the identified NGOs. The government departments are now providing the NGOs only requisite assistance. Based on the success of this

experiment, the decision would be taken in terms of gradually withdrawing the government intervention from the area where these private entrepreneurship may prove equally effective. The NGOs are otherwise also involved in the project to organize the farmers into groups and take up the extension activities in the fields. About 24 NGOs are currently associated with the project and are supplementing government efforts in different ways. Their entry being mere informal is readily acceptable by the villagers.

Bio-village

Excessive application of chemical fertilizers and pesticides over the years has not only adversely affected the soil texture and its fertility but also posed serious health hazards for human beings. Many serious ailments are caused due to presence of toxic chemicals in foodstuffs. Sustained and indiscriminate use of harmful chemicals lower the productivity also in the long term through deterioration in soil fertility and soil health.

Now there is a growing concern across the world to check or reduce the application of these chemicals on the crops. Therefore, a comprehensive strategy has been evolved and pursued in the project to sensitize the farmers about the harmful effect of these chemicals. Besides concerted efforts are being made to promote the production and application of various bioagents like Tricoderma ,Tridogramma and biodynamic preparations like cow pat pit (CPP), NADEP, vermicompost etc. Stress is being laid to develop such villages in the project wherein entire farming community produces their crops without using any chemical fertilizer or pesticide and apply only biopreparations in the crops. By now 374 such villages have been developed under the project. Response of farmers is also highly encouraging as they are fetching higher prices for their produce on one hand, while their cost of cultivation has also come down substantially on the other. Going by the results and responses of farmers, it is expected that number of Bio-villages would swell up 2-3 times within next couple of years.

Seed Village

Researches have established that an increase to the extent of 15-20% in productivity may be easily achieved by simply encouraging farmers to replace their old seed by foundation or certified seed after every alternate cropping year. Therefore, seed village concept is introduced in the project to meet the requirement of farmers of new and popular varieties that have a proven record in a particular area. Under the seed village scheme, a few villages are selected, where farmers and SHGs are encouraged to produce quality seed of different crops for the consumption within the village itself and also to sell surplus to the neighboring villages. Thus, it may be viewed as a scheme to make the villages self-reliant in quality seeds. This programme has been proved very successful in Farrukhabad and Jhansi districts where farmers and SHGs are producing quality seed of Halna variety and Durum wheat respectively. In almost every project district, 2-3 villages are identified as seed villages. At present, 608 seed- producing groups are engaged in this activity. The success of this programme has considerably reduced the dependence of farmers on external agencies to supply seeds. All efforts are being made to ensure the quality of seed at the local level.

Farmers' Schools

Technology dissemination through farmers is the basic idea behind the concept. New technologies

developed and invented at various institutions should reach the farmers to yield results. State extension services are neither adequate nor professionally trained to deliver the requisite goods. It is, therefore, proposed that the progressive farmers should be trained to serve as master trainers and be facilitated to disseminate the latest technologies to their fellow brethren. These farmers' schools are developed with the above objective in every project district as it is established that without transfer of technology and latest techniques to the farmers, efforts for diversification would not meet desired results. In these schools farmers may learn and acquire the latest techniques and set of practices by paying a nominal amount. One such experiment is being carried out at the village Narangpur Patti in Pratapgarh District. This small insignificant village, which has the first farmers' school in Asia, now figures prominently on the map of the State. The success of this experiment may be measured by the applause and aplomb it has drawn from every quarter right from the State Govt. to the Central Govt. and to the World Bank. Here the farmers of the neighbouring and adjoining villages are being trained in every crop season by the farmers themselves in their own vernacular on various aspects of agriculture and the real field problems are solved by mutual involvement.

It is hoped that by replicating the above model of alternative system of extension, we would be able to develop a self-reliant non-government system for technology disseminating that has a chance to survive and sustain.

Integrated Farming System

One of the major objectives of UPDASP is to recommend and suggest appropriate farming systems to the farmers to help them utilize their resources to the optimum and assure the maximum return of their investment. It has been observed that the priorities and requirements of farming community even in the same village vary substantially largely on account of their varied socio-economic conditions. It is, therefore, neither possible nor desirable to recommend a particular cropping system for the entire farming community of a village. The aforesaid situation obviously highlights the need to go deep down at the micro level. The above requirement is addressed under the project through Integrated Farming System approach. It is no gain saying to state that small and smaller size of land holdings, big and bigger aspirations of the farmers for improved life standards, increasing pressure of population on land and vagaries of monsoon, all these characterize the dichotomy of rural economy. An attempt is, therefore, made in the project to select 20 farmer families in every project block, which may be a representative segment of various categories of the farmers of the village and study the cropping system they are parsuing at present and the resources that they possess. After a careful study appropriate module of agricultural practices is developed for each of those 20 farmer families and an annual action plan is prepared to see and analyze the results. The suggested agricultural practices are also dovetailed with the programmes of other departments concerned to prepare a comprehensive plan for each farmer family. However, the scope is left to modify the plan in subsequent years depending upon the results. The scheme is primarily designed to help the small and marginal farmers to raise their income even with their meager resources.

Agriculture Helpline

Despite latest breakthrough in information technologies, our villagers still languish for the timely guidance relating to various agricultural issues. Sometimes they need to be guided which variety of a crop is to be sown, when the fertilizer or pesticide is to be applied, irrigation to be given or what precautions are to be taken to save a particular crop from a particular disease or pest. Agricultural help- line is a solution to their problems. Scientists of Agricultural University, KVK/KGK are available on a particular telephone line on certain days at a particular place to advise the farmers and solve the problems. Farmers may contact them through a phone call telling them what type of assistance they

need from them and this telephone facility is available free of toll to the farmers and the bill of the telephone is being reimbursed from the project resources. Their increasing interest in availing this service is itself a testimony of its worth.

Agriculture Technology Management Agency (ATMA)

The genesis of establishing an independent and autonomous agency – Agriculture Technology Management Agency – hereafter called "ATMA" lies in the fact that the Government efforts hitherto, at the best have been restricted to involving masses in planning or implementation of different welfare schemes but they very scantly have been aimed at empowering the people to assess their needs and suggest suitable interventions at their own level in order to address the issues that are related to their occupation and affect their economic well-being.

Concept of ATMA is an experiment undertaken in the project to enable and empower the masses to plan and formulate the schemes as per their own requirement. Establishing ATMA in various project districts is an attempt to decentralize the process of planning and implementation at the district level. ATMA is one such innovation like many others, which are introduced and tried under the project in the belief that if the process of planning were set right, the results would automatically flow there-from.

ATMA is established as an automonous body to prepare the district plans and utilize the funds relating to extension activities of the various departments, viz. Agriculture, Horticulture, Sericulture, and Animal Husbandry. Now instead of deciding from the state level, it will be ATMA which will decide as to which extension activity is to be taken up in which part of the district. The concerned departments will part with their funds to ATMA for execution of the plan.

Project Development Facility (PDF)

The greatest paradox with the agriculture sector is that despite of its being highly appreciative in terms of returns against investment, it could not attract private investors in the proportion of its potential. One of its reason might be the investors apprehension about agriculture of largely being driven either by uncertain weather conditions or dominated by the government polices. Market based economy has therefore found very little interest in it. Nevertheless, the above scenario is changing and has changed to a considerable extent. A number of commodities have been de-regularized, procedures for issuing licences etc. simplified and economy is continuously showing signs of improvement since over a decade. In UPDASP, a Project Development Facility (PDF) is being established with the sole objective of assisting the entrepreneurs. This PDF would help the industrialists to identify suitable projects in agriculture sector, prepare bankable project profiles and it would facilitate finances for them from lending institutions.

Income Enhancement for Farmers

Despite the fact that agriculture provides sustenance to about 70% of the rural population, income from the sector is continuously on decline. Employment elasticity in agriculture is also no better and showing a dwindling trend. The above scenario has led to the low-income generation and growing unemployment in rural areas. Further, mechanization of agriculture, shrinking size of land holdings and ever increasing population has left very scarce opportunities of employment for educated rural youth. Against the above backdrop, the project endeavours to diversify traditional agriculture into more economically profitable pursuits with a view to generating additional sources of income on one hand, while to provide opportunities for gainful employment to rural educated youth on the other. Here below is a brief account of the activities that are undertaken in the project to meet the above twin objectives.

Area Expansion under Horticultural Crops

Uttar Pradesh has its specific reckoning in the country, as it stands first in production of mangoes and potatoes. Besides there is a vast potential for promotion of many horticultural crops including floriculture. However, major constraints in the growth of the Horticulture sector have been non-availability of quality planting material and proper technology inadequate linkages between research institutions and producers and lack of appropriate infrastructure. Under UPDASP, it is attempted to address all these issues in their totality. It is proposed that by the intervention of the project the area of horticultural crops will increase to about 5 times from that of present level. The current coverage under horticultural crops is about 11,777 ha.

Promotion of Floriculture

High prospects for floriculture are visible in North-West and Western strips of the State. It is one of the most popular and traditional activities in and around Kannauj district where aromatic flowers are grown on a large scale. Districts like Lucknow and its surrounding belt is coming up very fast in the cultivation of cut flowers. Under the project, therefore, steps are initiated to ensure supply of high quality seeds to the cultivators. Efforts are also afoot to ensure that market information with respect to prevailing prices in major national and international markets are available to the producers on their demand.

Post-Harvest Handling, Transportation, Processing and Marketing of Horticulture Products

Uttar Pradesh has emerged as one of the leading producers of fruits and vegetables in India but most of the fruits and vegetables are consumed as fresh within the country. Due to inadequate application of modern post-harvest technologies including harvesting, handling, post-harvest treatment, packaging, storage and transportation about 25-30% of the produce valued over Rs 25,000 crores are wasted annually in the country resulting in poor returns to the growers and increase in the cost of raw materials. Precooling of horticultural produce is an important post-harvest handling operation and is often used in conjunction with refrigerated transport system. Precooling extends product life by reducing field heat, rate of respiration, rate and ripening, loss of moisture and production of ethylene.

Under this project, Horticultural Post-Harvest Technology Centers and Sub-Centers are being upgraded to minimize post-harvest losses. There is a need to supplement post-harvest management, processing and marketing facilities for horticultural products. This facility will create awareness among the farmers and ultimately will lead to enhanced processing of horticultural products.

Packaging also plays an important role in marketing of horticultural produces. Therefore, there is a need to change the packaging technology from traditional packing materials. Awareness is also being created among farmers to pack their produce in corrugated and plastic containers. There are several advantages in corrugated boxes. These are lighter by 70 - 80% and convenient to handle and cheap to transport. Their smooth surface causes very less bruising to fruits compared to wooden boxes. These can be telescoped ventilated for atmospheric control, printing and decorated on, according to need. They are more clean and hygienic than wooden boxes. These can be stacked without deterioration and pilferage. They are completely recyclable as pulp or paper compared with their wooden counterparts which find their way as fiber wood as per convenience. Another important alternative to wood for packaging is plastics. Various types of polymers can be used for packaging fruits and vegetables.

The UPDASP is addressing the problems related to storage, handling, transportation, processing and marketing of horticultural products. Proper storage of fruits and vegetables is necessary to extend

their shelf-life especially if the product is transported to the long distance and time between the production and consumption is large. Various storage facilities like ventilated storage as well as low temperature storage, controlled atmospheric packaging and cool chains are being adopted for proper storage. A cool chain system for handling of fruits and vegetables is being created at the wholesale level but sufficient attention is not been paid at the retailer level which needs to be addressed through some Central Government programmes.

Inadequate network of roads that impedes quick and safe transportation of highly perishable agricultural and horticultural produce, absence of organized marketing system which leaves the producers to sell their produce at distress prices to the middlemen is what one can easily observe everywhere in countryside. The UPDASP being a holistic project in its conception and approach attempts to redeem the aforesaid concern by including the components of construction of rural roads and rural markets. Under this project, it is proposed to construct approximately 3,000 km rural roads in different project villages which have an established potential of producing high-value perishable commodities. These rural roads are supposed to link the fields to the marketing centres to enable the producers to sell their produce at an economical price rather than to dispose it off at the hands of middlemen on their terms. So far, about 630 km rural roads have been constructed and another 1,000 km approximately, are in the various stages of completion.

Similarly, 143 rural markets are chosen for development in various project districts. Of them, 10 have been completed while construction of 50 other markets is under way. It is expected that once these roads are constructed and markets are fully operationalized, farmers would be able to market their produce at substantially appreciated prices. Besides, 2 state-of-the-art horticultural markets are proposed to be constructed under the project by the Marketing Board at Lucknow and Noida where all the modern storage and grading facilities - cool chain, grading chambers etc. - will be provided.

Nursery Under Low-Tunnel Polyhouse

Efforts are being made to grow off-season, healthy seedlings under low-tunnel polyhouse. In this technique, farmers are growing seedling in off-season including rainy season. The entry of white fly is checked resulting in healthy seedlings.

Rejuvenation of Old Mango Orchards

By this technique unproductive old mango orchards are being converted into productive orchards. The demonstrations of this technique have been organized successfully in different districts covered under the project. This technique has been standardized by the Central Institute of Subtropical Horticulture, Lucknow.

Introduction of *kharif* Onion

Under the project onion production in *kharif* season has been introduced. Onion variety Agri-found Dark Red is suitable for cultivation in *kharif* season. Demonstrations of this variety have been organized successfully in different districts under the project. This programme has been implemented with the help of National Horticulture Research Development Foundation, Nasik

Introduction of New Variety of Garlic

Yamuna Safed (G282), a new garlic variety, has been introduced in different districts of the project. The clove size is bigger and it yields higher than traditional varieties. It is quite suited to growers.

Demonstrations

Demonstrations of hybrid/improved seed/technology are being demonstrated at farmers' fields.

Marketing Tie-Up

In a few districts of the project the marketing tie-up of growers' produce has been made with the Mother Dairy Fruit and Vegetable Project, Delhi, for getting better remunerative prices of their produce.

Strengthening of Nurseries

To ensure the genuine and quality planting materials model nurseries with facility of polyhouse, net house, and mother stock protection house have been established at Horticulture Technology Dissemination Centres and SAUs. In addition, post-production and maintenance sale nurseries are being established at different Govt. horticultural farms.

Block-Level Functionary Horticulture (BLF- Horticulture)

Under BLF- Horticulture, horticultural activities have been engaged on contractual basis for performing extension activities under the technical guidance of staff of the Department of Horticulture.

Capacity Building

Under this, capacity building of horticulture related officials and farmers is being upgraded through imparting training, exposure visit at identified institutes/universities, etc.

TAMIL NADU – A GIFTED LAND AND PARADISE OF NATURAL RESOURCES BUT UNUSED

Surjeet Choudhary*

Tamil Nadu has many types of soils spread all over the state. It has many soil orders and their fertility status varies from place-to-place. There are a large chunks of problem soils spread in different pockets needing attention and care (Tables 1and 2). Tamil Nadu has the lowest and highest levels of altitude from mean sea-level where plant life can exist. It has places like. Tuticorin, Cuddalore, Tiruvallur etc. right on the coast and also the peaks of the Nilgiris and Kodaikanal, with more than 2,500 m above mean sea-level. It has all variations in temperature required for plant life. Parts of Tamil Nadu have temperature above 40°C and some areas have below 10°C, highest and the lowest required for plant life. There are areas under south-west monsoon and north-east monsoon as well. This state has all shades of humidity spread throughout the year all over the State, which is conducive to plant life. There is a long coastline of about 1,000 km. The diverse combination of these variables enables Tamil Nadu to have almost all varieties of fruits, vegetables, flowers, spices and condiments, medical and aromatic plants and plantation crops spread all over the state. Many fruit trees when put in their most congenial environment, they fruit almost throughout the year like mango, grape, sapota, goosberry, etc.

Table 1. Land use profile

Classification of area	Area (ha)	Total area (%)
Total geographical area by village papers	1,29,97,822	100.0
Forests	21,40,342	16.5
Barren and uncultivable land	4,77,517	3.7
Land put to non-agricultural uses	19,67,765	15.1
Cultivable waste	3,48,497	2.7
Permanent pastures and other grazing lands	1,23,451	0.9
Land under miscellaneous tree crops and groves not included in the net area sown	2,39,501	1.8
Current fallow lands	9,55,507	7.4
Other fallow lands	11,10,728	8.5
Net area sown	56,34,514	43.4
Area sown more than once	9,92,611	7.6
Total cropped area	**66,27,125**	**51.0**

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Table 2. Land available for future development

Classification of area	Area (ha)	Total area (%)
Cultivable waste lands	34,8,497	2.7
Current fallow lands	9,55,507	7.4
Other fallow lands	11,10,728	8.5
Area sown only once	46,41,903	35.8
Total	**70,56,635**	**54.29**

HISTORICAL FACT SHEET OF AGRICULTURAL DEVELOPMENT

Area sown more than once is less than 10 lakh ha (7.6% of total geographical area). The area under non agricultural use is 47,09,075 (43.58% of the total geographical area) and it is not available for development. Large area of 70,56,635 ha amounting to 54.29% of total geographical area is either not utilized or under-utilized, due to various reasons. This is readily available for development. This area is fragmented and spread over 83 lakhs land holdings. Gross irrigated area has marginally increased over the last 30 years: Total cropped area, area sown more than once and cropping intensity have all steadily decreased. The number of white blocks is consistently decreasing, whereas there is corresponding increase in grey and dark blocks. Sub soil water is fast depleting due to over exploitation. Wasteland is steadily increasing for the last 30 years at an average annual increase of 0.36 lakh ha. Average annual growth rate of foodgrains is 1.25% over the last 30 years, whereas the area has been by and large static. Productivity of some of the foodgrains has increased. Sugarcane production in Tamil Nadu has recorded a high annual growth rate of 8.75% on average. Area under horticulture has considerably increased, from 4.62 lakh ha in 1980-81 to 9.31 lakh ha in 1999-2000. Horticultural production has increased from 44.78 lakh tonnes in 1980-81 to 126.32 lakh tonnes in 1999-2000. The productivity of many crops has also increased. Number of agricultural labourers has steadily increased for the last 30 years, from 44,90,065 in 1971 to 78,96,295 in 1991, which means per capita availability of agricultural work and productivity is steadily decreasing. The share of agriculture sector in GSDP has steadily decreased from 22.43% in 1993-94 to 16.88% in 1999-2000. Growth rate of agriculture sector in GSDP is -0.52% against overall GSDP Growth rate of 7.04% for 1999-2000 (AE). Tamil Nadu Agriculture University, Coimbatore, its academic campus, Research Stations and Extension Centres, Krishi Vigyan Kendras, Plant Clinic Centres, State Forest Research Institute, Genetics Research, Minor Produce Research, Industrial Wood Research, Modern Nurseries, Forest Colleges and Training Centres, 54 State Horticulture Farms, 2 Regional Training Centres, 11 Farmers' Training Centres, 22 Soil Testing and other laboratories, Biofertilizer Units, Micro-Nutrient Production Unit, Renovation of Saline Acedic-Land Centre, Land Utilization Institutions, etc. make Tamil Nadu scientifically rich state.

VARIOUS LAND DEVELOPMENT PROGRAMMES SPENDING AND PULLING DIVERSELY

Horticultural Department

- Integrated Horticultural Development Scheme
- Integrated Tribal Development Programme
- Western Ghats Development Programme

- Hill Area Development Programme
- Wasteland Development Programme
- Rejuvenation of Hill Banana
- Integrated Programme for Development of Cashew
- Integrated Programme for Tropical, Arid and Temperate Zone Fruits
- Integrated Programme for Development of Spices
- Scheme for Development of Floriculture
- Scheme for Development of Medicinal and Aromatic Plants
- Scheme for Development of Vegetable and Root and Tuber Crops
- Scheme for Development of Cocoa

Agriculture Department

- Drought-Prone Area Programme (DPAP)
- National Watershed Development Project for Rainfed Areas (NWDPRA)
- Comprehensive Watershed Development (CWDP)
- Coconut Development Programmes
- Area Expansion Programme on Coconut
- Integrated Farming in Coconut Holdings for Productivity Improvement
- Oil Palm Development Programme

Agricultural Engineering Department

- Drip Irrigation to Horticulture and Coconut
- Integrated Wasteland Development Programme
- Western Ghats Development Programme
- Hill Area Development Programme
- Drought-Prone Area Programme
- National Watershed Development Project for Rainfed Areas

Forest Department

- OECF – Tamil Nadu Afforestation Project
- Watershed Development Programmes especially under National Afforestation and Eco-development Board Assistance
- Coastal Area Management Programme
- Integrated Tribal Development Programme
- Bio-diversity Conservation Schemes including Wildlife Schemes

- Minimum needs programme like AOFFP
- Conservation and Development of Medicinal Plants and Non-wood Forest Products
- Hill Area Development Programme
- Western Ghats Development Programme

Rural Development Department

- Samagra Awaaz Yojana
- Environment Improvement
- Watershed Development
- Social Forestry Scheme
- Horticulture Scheme

Public Works – Irrigation Department

- Medium Irrigation Schemes
- Minor Irrigation Schemes
- Special Minor Irrigation Programme
- Water Resources Consolidation Project
- Modernization of Periyar Vaigai Irrigation System
- Tank Modernisation Scheme with European Economic Commission Assistance
- State Tank Irrigation Project
- Desilting of Tanks
- Integrated Tribal Development Programme
- Hill Area Development Programme
- Western Ghats Development Programme
- Scheme with NABARD Assistance
- Modernization and Desilting of Cauvery Delta
- Anti-sea Erosion Works

ADVANTAGES OF HORTICULTURE

Horticulture is an answer for malnutrition of Tamil Nadu. Study conducted by Dr M.S. Swaminathan Research Foundation under FAO, in Pennagaram Block of Dharmapuri district has concretized that about 90% of the rural poors suffer from diseases caused by iron deficiency, about 55% by deficiency of vitamin A etc. All the required micronutrients are available in abundance in fruits and vegetables which have been historically cultivated in Tamil Nadu. Deficiency of vitamin A can be overcome by eating more papaya, mango, carrot and pineapple which can be easily cultivated in Tamil Nadu. Deficiency of iron can be cured by eating more greens traditionally cultivated in Tamil

Nadu. Horticulture is a strong and trustworthy friend to ensure nutritional security in Tamil Nadu. Average edible biomass of horticultural crops is very high compared to grains. By virtue of its high productivity, the overall income it brings in to the farmers is substantial.

Many horticultural crops, particularly tree crops can withstand longer tenures of hostile climate and water scarcity. The horticultural crops cultivated suiting to the regional agroclimate and natural conditions will generate enormous rural employment. The tree crops will also bring much required green cover and clean environment. These crops will help in stopping soil erosion and add to the humus and better productivity of soil.These crops can help recharge subsoil water and rains.

New initatives

.Development of 20 lakh ha of wasteland. Watershed Development Authority of Tamil Nadu is being organized with the Chief Minister as the Chairperson and Dr M.S.Swaminathan as Vice-Chairperson. **Redeployment of Manpower from Agriculture to Horticulture after Intensive Training has been ordered.** The present manpower distribution in Tamil Nadu is given in Table 3.

Table 3. Present manpower distribution

Department	Total	Total per district
Agriculture	15,904	548
Horticulture	1,996	69
Agricultural Engineering	6,840	236
Agricultural Marketing	2,300	79
Seed Certification	549	19
Total	**27,589**	**951**
Proposed Manpower Requirement for Horticulture		
Taluk level	One Assistant Director of Horticulture with Training and Information Facilities	
Block level	One horticultural Officer and 5 Assistant Horticultural Officers	

Agri-Business - New organization is being created

Corporate and Contract Forming Policy Announced – Exemption from land ceiling up to 1,000 acres.

Quality Planting Material

The capacity of the State Horticulture Farms is limited. The production in the private nurseries is not trustworthy. Biotechnology Laboratories located in Tamil Nadu are historically serving for the States of Maharashtra and Andhra Pradesh. Moreover, standards for many fruit crops have not been developed. There is no trustworthy mechanism to certify the pedigree of the vegetatively propagated materials. The Department of Seed Certification has not attempted the standardization of this material and does not have required manpower. Procuring the pedigree planting materials is the difficult task. In this context the following strategies are being adopted. They are:

- All the 54 State Horticulture Farms should utilize their maximum capacity.

- The regional nurseries and private nurseries are being given training for production of pedigree materials by vegetative propagation through Tamil Nadu Agricultural University.
- Pedigree material can be procured even from outside the state.
- State Government should coordinate with the Biotech Laboratories.
- The Department in coordination with Agricultural Unviersity has started standardization process and its enforcement.

Interface Between Research and Farmers

Tamil Nadu has made strides in research in agriculture and horticulture and had a well-reputed Agricultural University. Dr M.S.Swaminathan Research Foundation, is also stationed in Chennai. Government of India has also developed many Research Stations in Tamil Nadu including National Banana Research Centre, Trichy. But there have been complaint that this research is not readily transmitted to the advantage of the farmers. On the other hand, farmers have been complaining that many of their field needs have not been answered by the research. To get over the missing links, some steps are being taken.

- TNAU, Coimbatore, has redesigning their research. Emphasis on creation of more varieties is being eased and research is being made commercially viable.
- Horticultural *melas* are being organized in districts.
- Exhibitions, workshops and seminars, at state and district levels are being organized.
- Annual competition is being organized among horticulturists.
- TNAU, Coimbatore, has formulated a programme where all horticultural scientists would meet region-wise with farmers.
- Annual farmers meet being conducted at TNAU, Coimbatore, CBE are useful only to the farmers located in Coimbatore and not in far away areas. This year it was organized in Madurai District.
- The Department of Horticulture will also chalk out training programmes by utilizing the infrastructure available in different departments.
- The farmers are being taken to Maharashtra, Andhra Pradesh and Karnataka for their field studies.
- A vigorous programme to train our extension workers and farmers.
- Need-based farmers associations at district and state level like Banana Growers' Association, Grape Growers Association and Mango Growers Association are being encouraged. They can sensitize small and marginal farmers having fragmented holdings and who are incapable of marketing their produce and are victims of the middlemen to the business and industrial activities. These associations can also become easy medium of transmission of latest cultivation practices, joint marketing of their produce and afford a forum for their need articulation to authorities and researchers
- This pattern of horticulture leadership and commercial research has to be widely spread.

Biotechnology Policy

Biotechnology allows us to identify and transfer the specific genes that creates a desired trait in a plant, and offers a more precise way to produce plants with certain beneficial characteristics. It will arm some vital crops with defenses against viruses, reducing insect damage in the field during storage and transportation. Biotechnology can help create more vitamin A and iron in food and offer tremendous opportunity to reduce the risk of blindness, anemia, etc. It helps increase crops' ability to withstand natural environmental factors, such as heat, drought, soil toxicity and floods, improving farming in regions in which food is difficult to grow. Farmers can reap more bountiful harvests from existing land, while sustain land's ability to support continued biofarming. Tamil Nadu has already developed good biotechnology both in private and public sectors. This is being popularized. Policy on commercial Floriculture has been announced.

Microirrigation to make it common man's technology: Rs 18 crores has been sanctioned in the current budget. An area of 30,000 ha has been targeted during 2001-02.

Agri-Export Zones

Tamil Nadu has potential for various horticultural crops. In conforming with the Government of India Policy, following zones may be identified as export zones.(Table 4)

Table 4. Agri-export zones in Tamil Nadu

Produce	Zone
Summer mangoes	Dharmapuri district
	Salem district
Winter mangoes	Kanyakumari district
Grape	Theni district
English vegetables	Hosur (Taluk – Dharmapuri district)
	Nilgiris district
Banana	Trichy district
	Tanjore district
Cashew	Cuddalore district
	Pudukottai district
Cut flowers	Hosur (Taluk – Dharmapuri district)
Onion	Palladam area of Erode district

Handful of farmers in the contiguous area should be identified and they should be trained in the latest cultivation practices and guided for export. They should become centers of excellence so that other farmers can imitate their practices. It required focused and need-based research by Agricultural University and focused extension activities by the Department of Horticulture and export with the help of Department of Agricultural Marketing.

Publicity and Training To Researchers, Extension Workers and Farmers

- Agroclimate
- Biotechnology
- Pedigree planting materials
- Plant protection
- Quality hybrid seeds
- Certified seeds
- Vegetatively-propagated planting materials for fruits
- Microirrigation management
- Manuring and composting
- Biofertilizers and biopesticides
- Micronutrients
- Hygiene codex, sanitary and phytosanitary standards
- Quarantine requirements
- Organic farming
- Toxicity
- Use of chemicals
- Relevance and irrelevance of greenhouses
- Shade nets
- Post-harvest management
- Plucking, breeding, grading, packing,
- Quality requirements of local market, international market, and export
- Cold chain
- Food processing
- Value addition, etc.
- Farmers Associations
- Self-Help Groups
- Chambers of commercial and other interests, etc.

A CASE STUDY ON DEVELPMENT OF AONLA IN TAMIL NADU

S.S. Mehta*

Aonla (*Emblica officialis*) is a verstile fruit tree. Its fruits have high nutritive and therapeutic value. Food, cosmetics and aurvedic medicines are prepared from various parts of the tree since time immemorial. It has been used in *Kaya kalpa*.

As an indigenous fruit aonla has extensive adaptability to grow in diverse climatic and soil conditions. The climate ranges from hot tropical plains to humid subtropical mid elevation hills. It is successfully raised in arid, semi-arid, coastal and warm temperate situations. Similarly, it grows well in acidic saline, alkaline, degraded as well as in sandy, red and claycy soils. In India, Uttar Pradesh is major aonla-growing state. Aonla is also commercially cultivated in Andhra Pradesh, Karnataka, Tamil Nadu, Haryana, Punjab and Himachal Pradesh, the total area under its cultivation being 25,000 - 50,000 ha.

Aonla in bearing stage

The Study

I was always distressed to see the large empty spaces. Every time I passed, I felt it would be a good idea to see all those areas full of trees, but with what? This idea was haunting me for quite some time. I used to discuss this with my brother late H.S. Mehta and collegue Shri K.N. Singh. After

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sometime, I saw a large-sized Aonla market. This set me wondering if this could be the answer. I bought some. At Salem the seeds were extracted and sown. This was the beginning of the saga of Aonla in Tamil Nadu. At this juncture, I also decided on introducing tamarind as a companion crop. Aonla and tamarind were not being raised as orchards. I had quite a time in convincing people that it was financially rewarding to grow these crops. Drs Irulappun and Anbu of Tamil Nadu Agricultural University, Coimbatore and my friend Late Dhanushkodi Nadar were very much appreciative and supportive of this idea.

Once we saw the seedlings were coming up and yielding well, we started discussing with the scientists enquiring for better varieties and their sources. Some of the seedlings yielded 160 kg during eighth year. During the course of discussion with Dr Kaul, the then Horticulture Commissioner and Dr H.P. Singh, Horticulture Commissioner, Govt. of India, visits to Pratapgarh and Faizabad were suggested. With the cooperation of Dr O.P. Pareek, the AICRIP for Arid Fruits in Faizabad was contacted. Hearing about aonla there and seeing the trees loaded with fruits was an experience not easily forgotten. We brought the materials from there with the cooperation of Dr R.K. Pathak and started their propogation. Then some problems were faced. They were: method of propagation, potting mixture, containers, post- propagation handling etc.

We tried various methods, after trial and error we standardized the budding, as one of the best and wedge grafting as the next best. Here our best results were achieved by putting the plants in polysheds. After budding and grafting within 21 days the sprouting took place and the growth picked up. Wedge grafts were ready in 10-20 weeks. We found that on the field breaking of joints by wind was less in budded plants. After various trials we found that potting mixture should be light. We used a combination of composted coirpith with cattle manure, some sand along with soil, Azospirllum, phosphorus- solublizing bacteria, VAM and a dose of neem cake.

CONSTRAINTS

We tried various containers like pots, baskets, polythene bags, ball of earth in jute and straw. We standardized polythene bags of 150" x 5" x 9" as the best suitable size for growing rootstocks. The plants transplanted in polythene bags had maximum rate of survival. The post field planting losses were hardly 1.5 - 2% against 25 - 30% which were brought with the ball of earth.

Still the question asked most was "where is the market ?". By assuring growers that there is a market and by displaying its various products like murabba, salted and sweet segments, shareds, jams, juice, squashes etc. I was able to get people interested and plant. Fortunately, my wife prepares all these products in spite of her personal inconvenience. Whenever she heard of some body planting aonla she used to be very happy. She passed away on 21 December, 2000. I miss her today in my campaign to introduce Gael (*Engle marmelos*) in the south.

The Progress

Among the first to plant aonla on a commercial-scale were Shri W.P.A.R. Nagarajan and his son Mr Arun Nagarajan. Today I am glad that a large area in almost all the districts in Tamil Nadu, aonla has been planted. The methodology for various aspects of raising its plants was appreciated by the Maxworth Orchards Ltd., who sent a group of field managers for training to the nursery. Very recently the Department of Horticulture of Uttar Pradesh sent 20 persons for training at the nursery. The Department of Horticulture, Tamil Nadu, is contemplating sending a batch to us for training. We have been given to understand that a similar nursery is to be set up at Lucknow. Given the opportunity we would only be happy to spread success with our experience.

We also found that by manipulation of irrigation we were able to stagger the cropping and harvesting of fruits over a 6 - 7 month period from April-end to October. This would make aonla

available over 10 months considering November - February season in the north. This brought in drip irrigation as a component of its cultivation. Fertigation has also been experimented. With the use of drip irrigation yield of 30 kg/ tree is achieved in third year itself in gravelly soils against 20 kg in 4-5 years in rainfed orchards.

In old orchards where NA-7 etc. were introduced the cropping increased. This brought to light the need of pollinizer. We recommended planting of mixed varieties for better crop pollination resulting in better yields. We also noticed some of the varieties are picking up a reddish tinge, may be by cross-pollination. We are now looking at a breeding programme.

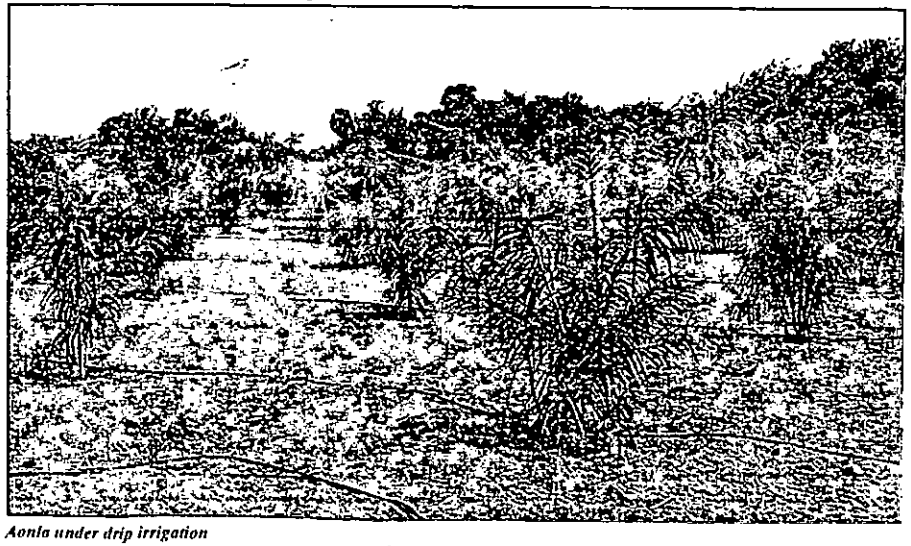
Planting was at first done at a spacing of 20' x 20' in pits of 3' x 3' x 3' size. Soon experiments with various spacings brought us to 20' x 20' with 1 in centre, giving 216 plants/ acre. The 15' x 15' spacing gave 198 plants/acre. These are the 2 spacings commonly used for planting now. We now have a capacity to produce one lakh plants each of aonla and tamarind apart from many others.

For the extension of horticulture the crucial bottleneck is the non-availability of good planting material. We at the Nursery are happy that to some extent we have filled this need. In fact by introduction of both these crops on a commercial scale in Tamil Nadu the annual income of Tamil Nadu has increased by over Rs 50 crores every year.

Tamil Nadu government has announced an ambitious wasteland development programme. In this, 2 million ha (50 lakh acres) of wastelands is to be converted into productive lands within a period of 5 years. Therefore, every year 4 lakh ha (10 lakh acres) is to be developed. Horticulture has been assigned the thrust area and shall play the dominant role in this programme. Surely, aonla has been identified as an important crop for planting in larger extents of area either as a pure crop or as a component crop in the envisaged horticultural cropping system.

EMERGING ISSUES

- Demand-driven expansion of area.
- Identification of right varieties.



Aonla under drip irrigation

- Supply of elite and quality plants.
- Publication of a production manual on good horticultural practices.
- Organizing extension support with periodical training programmes.
- Developing post-harvest practices–technologies and infrastructure.
- Starting of aonla based processing industries as well as new product development.
- Reorientation of research and development.

What has been done by introducing commercial cultivation of aonla can be done with other crops also by others.

Sky is the limit if the desire and commitment is there.

This, if done, will bring ecological, health and financial benefits to our country.

TECHNOLOGICAL ADVANCES IN BANANA PRODUCTION

S. Sathiamoorthy* and M.M. Mustaffa*

Bananas and plantains are fourth most important global food crops after rice, wheat and maize in terms of gross value of production. Banana and plantain provide staple food for millions of people, playing an important role in the social fabric of many rural communities. As a staple food crop, banana is particularly important as it produces quality food round the year and is adaptable to a wide range of cropping systems. Being a cheap and easily-produced source of energy, both are also rich in minerals and vitamins A, C and B6. Thus, bananas and plantains offer vital support not only for food security but also for nutritional security. Only 13% of bananas and plantains produced enter the world export market. Although this is relatively a small proportion of total world production, this crop is extremely important as an export commodity for many countries. About 83% of banana exports originate from Latin America and the Caribbean, 11% from Asia and 3% from West and Central Africa, while the export from India which is the largest producer, is negligible (0.1%) (see Tables 1 and 2).

Table 1. State-wise area, production and productivity of banana

State	Area ('000 ha)		Production ('000 tonnes)		Productivity (tonnes/ha)	
	97-98	98-99	97-98	98-99	97-98	98-99
Andhra Pradesh	45.3	36.9	1131.9	922.1	25.0	25.0
Assam	41.4	41.9	575.2	581.9	13.9	13.9
Bihar	27.6	28.3	551.7	566.4	20.0	20.0
Gujarat	31.2	32.7	1113.8	1097.3	35.7	33.6
Karnataka	60.9	60.9	2010.4	2010.4	33.0	33.0
Kerala	24.7	29.1	351.5	415.1	14.2	13.3
Maharashtra	53.2	59.0	3130.0	3455.6	58.8	58.6
Orissa	23.9	24.7	257.4	276.8	10.8	11.2
Tamil Nadu	82.3	88.1	3144.4	4405.5	36.2	50.0
West Bengal	16.2	18.7	210.1	301.2	13.0	16.1
Others	42.4	44.0	863.1	1040.4	-	-
Total	**449.1**	**464.3**	**13339.5**	**15072.7**	**29.7**	**32.5**

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Table 2. Banana-growing states with major cultivars grown in different states in India

State	AA	AB	AAA	AAB	ABB	BB
Andhra Pradesh	-	-	Dwarf Cavendish, Robusta, Thellachakkarakeli	Amrithpani, Karpura chakkarakeli	Monthan, Yenugu Bontha	--
Assam	-	-	Jahaji, Borjahaji, Manjahaji, Robusta, Dwarf Cavendish, Honda	Chenichampa, Jatikol, Digjowa, Kulpait	Manohar, Kanchkol, Bharatmoni	Bhimkol, Attikol
Bihar	-	-	Dwarf Cavendish, Chinia, Jahaji	Chenichampa, Alpon, Kothia, Malbhog	Muthia, Gauria, Kanthali	--
Gujarat	-	-	Dwarf Cavendish, Lacatan, Harichal, Gandevi	--	--	--
Karnataka	Bale	Elakki Robusta	Dwarf Cavendish, Jwaribale,	Poovan, Rasabale	Karibale	--
Kerala	-	Nijali Poovan	Sevvazhai	Nendran Pakyankodan Poovan	Monthan	Elavazhai
Maharashtra	-	Safed Velchi	Dwarf Cavendish, Robusta, Grand Naine, Sindhurni, Hanuman, Ardhapuri	Lalvelchi, Rajeli	-	-
Tamil Nadu	Matti, Namarai, Sanna Chenkadali	Ney Poovan	Sevvazhai, Robusta	Poovan, Rasthali, Virupakshi, Pachanadan, Nendran	Karpuravalli, Sakkai, Monthan, Ney Poovan, Peyan	Elavazhai
West Bengal	-	Amrit Sagar, Giant Governor	Mortman, Champa, Lacatan	Monthan, Kanthali		

IMPROVEMENT OF BANANA

Even though the origin of banana is from India, the genetic base of edible bananas is very narrow. Hence, there is a need to widen its genetic base for resistance breeding and exploiting hybrid vigour in banana. Inter diploid crosses, mutation breeding and using triploids as male parent are attempted to evolve dwarf-statured hybrids, high yield, resistance to Panama disease, leaf-spot disease and nematodes. Screening of germplasm reveals that Yangambi KM5, PV-03-44 and PV-03-22 and cultivar, Rose, are field tolerant to leaf-spot disease. The exotic accessions, viz. FHIA-01, FHIA-17, FHIA-03, Saba and Pisang Nanga are promising under Indian conditions. Polyploidization of diploids using colchicin offers a new avenue for breeding triploids.

Production Technology

Priorities are to be given on planting system and density, fertigation, integrated nutrient management, cropping system research, organic farming, biocontrol of nematodes and control of Panama disease, post-harvest technology and processing of bananas for value-added products.

Clean Planting Material

The banana industry is ravaged by wilt, nematodes and virus diseases. To overcome these problems, planting of disease-free suckers is very important. There is an urgent need to contain the spread of the virus diseases through infected suckers. Total devastation of hill banana in Tamil Nadu by bunch top virus infection is a classical example. Of late, bract mosaic virus has been causing slow decline of bananas and plantains. Banana streak virus enters into the genome of the Poovan (Mysore AAB) cultivar and is difficult to flush out the virus. Hence, there is an urgent necessity to go in for an alternative. Use of tissue culture plantlets is expected to solve this problem to a certain extent. There is a big question about the quality of the tissue culture planting material supplied by tissue culture laboratories. There are instances that tissue culture plants themselves become a source of spreading the viruses and diseases in newer areas. The reasons could be the mother plants are not properly indexed for viruses, faulty indexing methods, lack of prophylactic measures at the time of acclimatization. In addition, a lot of undersirable somaclonal variations were also observed among the tissue culture plants due to the faulty propagation techniques like number of sub-culturing and duration between sub-culturing. Hence, there is a dire need to bring commercial tissue culture units under the supervision of appropriate scientific body for producing quality planting materials.

Total packages of practices for growing tissue culture plants have to be standardized region-wise as the plants are highly prone to various pests and diseases particularly *Erwinia* head-rot (bacterial soft -rot) and root-knot nematodes.

In general, farmers and farm labourers should be trained in identifying virus diseases on suckers and mother plants to eliminate diseased plants now and then. This would check further spread of virus diseases, nematodes and other diseases.

Organic Bananas

Indiscriminate application of heavy dose of inorganic fertilizers, chemicals, pesticides and fungicides have caused a lot of environmental pollution and degradation of soil physical and chemical properties, resulting in collapse of fragile soil ecosystem sustaining favourable flora and fauna of the soil. There is an urgent need to evolve a farming system for banana which avoids or minimizes the use of inorganic chemicals. At this juncture, for enriching soil, application of 75% of nitrogen requirement as organic and remaining 25% as inorganic has resulted in increase in productivity of banana. Application of 15kg of poultry manure per plant has reduced 50% of the recommended fertilizers need of banana.

Use of biofertilizers, biopesticides, botanicals and biocontrol methods are gaining attention in improving the soil health, ecosystem, control of fungi, nematode and insect pests of banana.

New High-density Planting Systems

Studies on different plant population has indicated that a plant population of 6,944 plants/ha (1.2mx1.2m), 4,440 plants (1.5mx1.5m) and 2,267 plants (2.1mx2.1m) yield 170, 145 and 87 tonnes/ha respectively, while recommended plant population of 3,086 plants/ha (1.8mx1.8m) gives 115 tonnes/ha in Robusta banana.

High-density planting in banana can be due to decrease in the spacing or increasing the number of suckers/pit (hill) or both. Recent studies on planting more than one sucker/hill (2, 3 or 4 suckers/hill) are encouraging. By this new system, the plant population could be increased without affecting the bunch size and quality of the fruits. Such densities would be more input-efficient and cost-effective. In such studies, it was evident that yield per unit area increased though the individual bunch weight decreased marginally without affecting the quality of fruits.

Studies on modified high-density planting with Nendran banana showed a marked increase in vegetative growth parameters with highest total yield of 58.65 tonnes/ha population of 7,500 plants/ha (2mx2m with 3 suckers/hill). The closest spacing of 2mx2 m give highest yield in Nendran. Of them 2 and 3 suckers/hill increase the yield by 39 and 55% respectively over the single sucker/hill. The bunch weightis obtained lowest in highest- planting density of 3 sucker/hill (7,500 plants/ha) and weight in Nendran ranges from 7.8 to 9.5 kg in different spacings. With 2 suckers/hill, bunch weight ranges from 8.7 kg (2mx2 m) to 10.18 kg (2mx3 m), while bunch weight is highest (10.6 kg) in single sucker/hill spaced at 2mx2 m and 12.8 kg in 2mx3 m spacing. The increase in number of bunches per unit area was much more influential than the combined effect of smaller average bunch weight and longer crop duration. Thus, an yield per annum was significantly higher (47.23 tonnes/ha) at a spacing of 2mx3 m with 5,000 plants/ ha).

In addition, there is a scope for adopting fertigation in this system of planting which would reduce 40-50% fertilizer and water needs. By these methods, there is also considerable reduction in the cost of production leading to increased profit per unit area.

Fertigation in Banana

The introduction of drip irrigation in the early eighties made it possible to utilize the available water resources at optimal quantity to achieve maximum return per unit area. In banana, increase in yield due to drip irrigation is 30- 40% with a water saving of 40%. With the ever-increasing water scarcity in India, drip irrigation offers a permanent solution to a large-scale cultivation of banana.

About 40-50% of fertilizers applied are lost either by leaching or volatilization without any benefit to plants.About 40-50% of the money invested on fertilizers is also lost without fulfilling the nutrient requirement. Fertigation offers an opportunity to increase the fertilizer-use efficiency with minimum leaching losses. Thus, fertigation offers, precise and multi -split application of water-soluble fertilizers and other nutrients at appropriate time with desired concentration leading to increased utilization by plants.

Fertigation Schedule for Banana

The fertilizer shedule for banana is NPK (315:140:315 kg/ha), accommodating 4,440 plants/ha (Table 3).

Table 3. Fertilizer schedule for banana

Growth stage	Duration (weeks)	Recommended NPK dose	Required quantity (kg/ha)	Schedule of application (kg/ha/week)
Rooting	1 - 4	Urea+12:61:00	62.5+62.5	15.5+15.5
Juvenile	5 - 9	19:19:19+Urea	125+125	25+25
Critical growth	10 - 19	0:52:34+Urea	100+125	10 -12.5
Fruit bud differentiation	20 - 32	0:52:34+Urea+ 13:00:45	50+125+125	4.5+10+10
Bunching	33 - 37	13:00:45+Urea	145+100	29.0+20.0
Bunch enlargement and maturity	38-50	00:00:50	230	18.0

Water-soluble Fertilizers

Liquid fertilizer is solutions which contains one or more nutrients in liquid or suspension form ideally suited to crop needs. In India, these types are not yet popular compared to other advanced countries. The fertilizers are in solid form, but soluble in water completely carrying 2 or more macro as well as micronutrients.

Organic Bananas and Their Export

Growing bananas under partial/total organic means has been drawing the attention of the scientists and advocates of eco-friendly agriculture. The sudden shift from present way of 'exploit agriculture' to total organic farming has resulted in yield reduction even up to 40%. The domestic market price for organic bananas did not adequately compensate such yield loss. No doubt organic cultivation has great impact in stabilizing / changing the fragile soil ecosystem, but such changes are slow. Adequate research in this regard to hasten such changes should be more rewarding.

CROP PROTECTION

Occurrence of a new banana pest banana stem weevil, *Odoiporus longicollis*, has been reported. This has caused serious crop loss (80%), if unchecked . Most preferred host is found to be plantain cultivars (AAB) followed by Red banana (AAA) and hill banana Virupakshi (AAB). Stem injection of Monocrotophos (diluted at 1:2.5) @ 4 ml / plant 4 times at monthly interval from 4th month onwards is effective to control stem weevil.

Wide spread occurrence of root-lesion nematode (*Praylenchus coffeae*), burrowing nematode (*Radopholus similis*), root-knot nematodes (*Meloidogyne incognita*) and spiral nematode (*Helicotylenchus multicinctus*) on banana in southern India, Gujarat, Maharashtra and north-eastern hill regions has been reported. Significant reduction in nematode population is recorded when 50% 'N' was applied through neem cake. Biocontrol of nematode by the application of 20g of *Trichoderma viride* and *Pseudomonas fluorescence* is effective. Diploids AA and AB genomes with resistance / tolerance to nematodes have been identified.

Widespread occurrence of banana bract mosaic virus(BBMV) and banana streak virus (BSV) is found in all banana-growing regions of India. Electron microscopy and serological analysis have confirmed their identity. The yield loss due to BBMV and BSV ranges from 48 to 70%. The DIBA, DAC-ELISA tests have been standardized as diagnostic kit for BBMV and BSV identification. BSV expression in cv.Poovan is highly influenced by the temperature.

Fusarium wilt disease is serious in Silk, Red banana, Virupakshi, Karpooravalli and cooking bananas. *Trichoderma viride* and *Pseudomonas fluorescence* inhibit wilt pathogen in dual culture. Banana Poovan, a known wilt resistant clone, is now becoming susceptible in certain areas. Occurrence of new race is suspected.

Occurrence of black sigatoka and septoria leaf-spots have been recorded, isolated and pure - cultured for the first time in India. These are more aggressive in many of the commercial cultivars which cause severe defoliation and loss in yield and quality. Propicanzole or Hexacanazole (0.1%) is effective control sigatoka and septoria leaf-spot diseases. Pitting disease caused by *Pyricularia grisea* has been recorded for the first time in India

POST-HARVEST MANAGEMENT

As the fruit has a limited shelf- life, processing is important and a range of products has been developed, some are being exploited on a commercial scale. As the crop produces fruit throughout the year, it is possible to provide a regular supply of raw materials to processing industry. Modern methods of processing include the production of chips or crisps, drying and pureeing. Unique bananas and plantains are usually used for preparing chips. Sweet banana figs are prepared by drying slices of ripe fruits. Bananas are processed into puree, and the puree subsequently used in the preparation of dairy products such as yogurts and ice creams, in baking breads and cakes, in making banana flavoured drinks and in producing baby foods, sauces and weaning food. In the Philippines, bananas are used to produce ketch-up, which is sold commercially. Banana powder from ripe fruits is used in confectionery. Dried, ground and roasted green bananas are also used as a coffee substitute in some countries. A ready- to-serve banana juice has attracted the attention of consumers and entrepreneurs. Banana wine is yet another value-added product. It is comparable/better than grape. Being an alcoholic beverage commercial breweries can produce for domestic and export markets.

Banana fibre is used widely in the production of handicrafts such as baskets, toys, tablemats, hammocks, wall-hangings and lamp shades. Such non-food banana products have immense scope for export. To achieve production targets, increase profitability from unit area and make the system less labour intensive, research and development should focus on use of quality tissue culture plants, high-density planting and fertigation of banana. Organic farming of banana for export and domestic markets, through small farmers cooperative system as in Thailand has a good scope. Technology development for export needs to be taken up on priority basis.

New technology advancements taking place in banana production should reach the farming community in an effective manner. Considering the importance of bananas and plantains, it is necessary that a separate training center exclusively for this crop with necessary infrastructure and manpower is established at NRC for Banana, Tiruchirupalli. Without effective transfer of technology system, the very purpose of conducting research would get defeated.

INTEGRATED DEVELOPMENT OF APPLES

R.P.Awasthi*

Commercial cultivation of apple in India is largely confined to the north-western Himalayan states of Jammu and Kashmir, Himachal Pradesh and Uttranchal, whereas north-eastern states comprising Sikkim, Arunachal Pradesh, Meghalaya, Manipur, Nagaland and North-Cachar hills of Assam have a meager share of less than 1% in the total production. Apple occupies a dominant position among all the temperate fruit crops, accounting for 27.8% of the total area under fruits in the Indian Himalayan states and 6.2% in the country respectively (1998-99). Similarly, it constitutes 31.4% of the total production of fruits in the Indian Himalayan States and 3.1% in the country. Average productivity of apple in the Himalayan region is 6.05 tonnes/ha in comparison to 25-30 tonnes/ha in Europe, America, Australia, and New Zealand. Although, India is considered to be one of the major world producers of apple yet India's share in total apple production is only 2.4% (Table 1).

Table 1. Major world producers of apple (1998-99)

Country	Production ('000 tonnes)	Share to world production (%)
China	17,508	31.24
USA	4,964	8.85
Turkey	2,500	4.46
Poland	1,687	3.01
Russian Federation	1,200	2.14
France	2,500	4.46
Italy	2,115	3.77
Germany	2,154	3.84
India	1,380	2.46
Others	20,052	35.77
Total	**56,060**	**100.00**

WORLD SCENARIO OF APPLE PRODUCTION

Of the total production of 56.1 million tonnes of apples in the world, China is the largest producer, as a result of agrarian reforms carried out in 1980's which extended up to 1990's. China first became the world leader in apple production in 1990. Until that USA has dominated the world production that was 43.8 lakh tonnes compared to 43.3 lakh tonnes of China as reported by the World Apple Review. In 1997, USA production increased to 46.3 lakh tonnes but China produced 180.09 lakh tonnes, almost 4 times as much as in USA. China has had an estimated 75 lakh acres apples planted many of which are non-bearing. This compares into about 5 lakh acres under production in the USA. According to the Washington Apple Commission, some estimates show that new plantings since 1990 could double Chinese production in the next decade.

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China may account for nearly 40% of the total world production, nearly 270 lakh tonnes by the year 2005 compared to 10% in the early 1990's. The Indian production scenario has not changed much during the corresponding period and the production was 13.2 lakh tonnes from 5.6 lakh acres during 1998.

DISTRIBUTION OF APPLE IN INDIA

Presently, apple occupies an area of 23,400 ha which is 28% of the total area under fruits in the Indian Himalayas and contributes 13,80,400 tonnes of total fruit production, constituting 32% of the fruit basket of the Indian Himalayan states (1998-99). There was an increase in area and production of apple by 17 and 15% respectively during 1991-98 period. Jammu and Kashmir, Himachal Pradesh and Uttranchal occupy major share of apple production. In north-eastern Himalayan region, apple occupies 2.5% of total fruit area, contributing 0.65% of the total fruit production (1998-99).

Table 2. Status of apple in the Himalayan states

States	Area (ha)		Production (ha)		Productivity (tonnes/ha)	
	1991-92	1998-99	1991-92	1998-99	1991-92	1998-99
Arunachal Pradesh	5,122	6,500	9,330	16,000	1.82	2.5
Himachal Pradesh	66,767	85,600	3,01,730	3,93,600	4.52	4.6
Jammu and Kashmir	69,457	83,300	6,24,469	7,91,600	8.99	9.5
Uttaranchal	53,000	55,800	21,200	1,78,900	4.00	3.2
Others	97	2,00	1,98	3,00	2.04	
Total	**1,94,443**	**2,31499**	**11,47,727**	**13,80,400**	**5.90**	**6.0**

Source: **Indian Horticulture Database** (1999), National Horticulture Board, Gurgaon

In north-eastern Himalayan region, its cultivation is scattered in Sikkim, at higher elevations of Arunachal Pradesh, Meghalaya, Manipur, Nagaland and north-Cachar hills of Assam. It is successfully grown in Bomdila, Tawang and Tero areas of Kameng and Subansiri districts of Arunachal Pradesh. Scattered apple orchards are also found in Ukhrul district of Manipur and Pfuesero in Nagaland. It has also been introduced in Shillong plateau. Among all areas producing apple in the region, qualitatively Arunachal Pradesh apples are better with fruit size and attractive colour. Apple is also cultivated in Ooty in Nilgiri Hills in south India.

CHALLENGES TO APPLE PRODUCTION IN INDIA

- A rapid expansion in apple cultivation in India was made after 1960's when Delicious varieties were largely planted to replace the English varieties. Apple acreage in India is dominated by a major proportion of Delicious varieties, accounting for more than 83 % of the total production in Himachal Pradesh, 45% in Jammu and Kashmir and 30% in Uttranchal. These varieties are commercially unfruitful and very sensitive to changes in temperature and other weather conditions at the time of flowering and fruit setting. Temperatures above 22°C and below 15°C are not conducive to bees activity and adversely affects fruitfulness. Besides, inclement weather and rains during fruit setting, drought conditions accompanied by high temperatures above 22°C also affect fruitfulness.

- Most of the plantations in India are now more than 35-40 years old and have surpassed the commercial bearing life of apples, needing replacement. However, due to perennial replant problem new plantations on old sites are not coming up. Slightly younger plantations need rejuvenation to improve size and quality of fruits.
- The major threat to apple cultivation in India was posed when apple scab was reported in an epidemic form in Jammu and Kashmir, Himachal Pradesh and Uttranchal in early 1980's. However, regular spray schedule was formulated to contain the disease and keep it under check. Later on in early 1990's occurrence of premature defoliation due to *Marsonina coronaria* blotch was also reported in an epidemic form and this has also been contained by following a proper spray schedule of fungicides. Now the problem of red spider mite is catching the attention of growers and its control through summer oil sprays and acaricides is under evaluation.
- Most of the apple orchards in India are rainfed except Jammu and Kashmir where more than 60% of the orchards have assured irrigation. Otherwise 95% of the orchards in Himachal Pradesh and Uttranchal are rainfed, which at times face severe drought conditions, which not only affect production and quality of fruits but also promotes early decline of the trees. Moreover, trees suffer from nutritional deficiencies and disorders under drought conditions.
- Apple cultivation in India is mostly restricted to the high hills except Kashmir valley where flat, fertile and irrigated soils are available. The orchards in the high hills are located on steep slopes which increases soil erosion, leaching of the nutrients and does not facilitate proper orchard floor management and mechanical cultivation, harvesting and spraying thereby depleting the soils of its nutrients and also increasing the cost of cultivation. Moreover, use of dwarfing rootstocks and high-density planting to increase the productivity are not possible under these conditions.

In addition to these problems some factors have also been posing serious threats in its successful cultivation. They are :

- inadequate proportion of pollinizers
- lack of pollinators
- poor canopy management
- incidence of root rot, collar rot, powdery mildew, cankers, viruses, woolly apple aphid, San jose scale, borers, thrips, defoliating beetles and hairy caterpillars.

THRUST AREAS FOR INTEGRATED DEVELOPMENT OF APPLES

Varietal Upgradation

A number of noteworthy changes in apple varieties have taken place during the past 40-50 years in the world. Among these changes are the use of spur varieties and market acceptability of some poorly coloured rather unattractive small but highly flavoured varieties. Today Granny Smith is the third leading commercial variety in the USA after Red Delicious and Golden Delicious strains. Among new varieties, Fuzi from Japan and Gala from New Zealand have shown greater acceptance.There has been a dramatic shift towards planting more Fuzi, Galas and other improved varieties and much fewer Red Delicious and Golden Delicious selections. In USA, consumer is no longer buying apples on the basis of appearance but rather on their flavour and other charecters.

In India, area under apple cultivation is dominated by a major proportion of Delicious varieties. It is estimated that Delicious varieties account for 83% of the total production in Himachal Pradesh, 45 % in Jammu and Kashmir and 30% in Uttaranchal. In fact, area under apple cultivation has surpassed its production during the last 2 decades, resulting in poor performance of Delicious varieties. Besides, much of the failures in production have been attributed to the prevailing inclement weather conditions at the time of flowering and fruit setting, and due to lack of pollinizers and pollinators. Therefore, proportion of Delicious varieties is required to be decreased and maintained at a reasonable level lower than 50% with 33% for compatible pollinizers and the remaining area is required to be planted under regular-bearing, table and processing varieties. In Himachal Pradesh, 2 promising cultivars, Scarlet Gala and Red Fuzi, were introduced during 1996.These were evaluated in high hills temperate wet conditions of Mashobra (Shimla) and midhills sub-humid conditions of Bajaura (Kullu). The initial performance has been found to be very promising. Now these varieties have been recommended for plantation in the state. Further, some old traditional varieties like McIntosh, Granny Smith, Cox's Orange Pippin, Jonathan, Commercial Spartan and Gloster known for regular bearing over the years but not recommended for commercial cultivation have now been recommended for commercial cultivation but now needs to be popularized besides new promising spur type varieties such as Red Chief, Oregon Spur, Golden Spur and Silver Spur, and colour mutants such as Top Red and Vance Delicious. Also performance trees of standard commercial varieties should be identified and mother tree orchards should be established as source of scion wood.

Availability of Clonal Rootstocks for High-Density Plantings

Availability of clonal rootstock material such as MM-106 has remained a major constraint for raising high-density plantings. During recent past, many programmes for micropropagation started with the sole objective of mass multiplication of clonal rootstocks failed due to poor field success. Therefore, for mass multiplication of clonal rootstocks, strengthening of the weaknesses of the micro propagation programmes is required. Simultaneously, large-scale plantations of mother stools for stooling can also be taken up for raising the required material.

Nursery Upgradation

Most of the nurseries in the private and public sectors do not produce standard plant material which ultimately affect not only the production potential but also the yield of quality fruits. These nurseries lack basic infrastructural facilities such as greenhouse, mist propagation units, cold storage, modern irrigation systems and efficient nursery tools, implements and machinery. These are mostly situated on marginal lands and survive under rainfed conditions. Therefore, modern nurseries need to be established on flat, fertile and irrigated lands for the production of quality planting material.

Adoption of High-density Plantings

Those sites which meet the requirements for high-density plantings comprising flat, fertile and irrigated soils should be brought under high-density plantings using proper production systems comprising stock, scion, spacing and training systems.

Canopy Management

This aspect has remained most neglected since not many research efforts have been made to develop canopies suitable for planting on varying types of sloppy lands. Modifications of the training

systems found most adapted in other countries are Head and Spread System for central leader trees, Vertical Axis system and Slender Pyramid systems should be diversified for production of quality fruits.

Soil Water Nutrients Management

It has been observed that soil water environment of an apple orchard degrades rapidly with an increase in slope, shallow nature of soil profile and depletion of organic matter.In Himachal Pradesh, there is deficiency of N, P, K and Ca, Zn and B. An optimum soil water nutrient management of orchard soils requires serious attention on some points. They are :

- Designing and creation of rain-water harvesting structures based upon irrigation requirement of the orchard.
- Increasing irrigation efficiency through modern irrigation systems like drip and sprinkler irrigation.
- Development of soil water conservation and irrigation strategies for rainfed apple orchards.
- Increasing soil fertility and moisture status through fertigation.
- Substitution of costly chemical nutrients by biofertilizers and slow release fertilizers.
- Development of balanced nutrition schedules for apple orchards based upon nutrient requirements of the plants.

Integrated Insect Pests and Disease Management

The emerging complexities of plant protection problems like apple scab; premature leaf fall, red spider mite and soil borne diseases of apple plants demand integrated insect pests and disease management and further refinement.

Replant Problem

Replanting has become major concern because of low productivity of the existing fruit trees and limited availability of suitable land for additional plantation. The problem is serious in areas where severely damaged fruit trees (either by insect pests/disease or because of unknown reasons) after removal are replaced with young seedlings at the same sites. The nature of the problem is complex due to involvement of biotic (micro pathogen) and abiotic factors (soil environment) in varying proportions. Presently, there exists no specific control measures against this problem, as the complete information about different factors responsible for this malady have not been worked out. The remedy to this complex problem lies in the adoption of integrated pests management practices, extensive studies and refinement of cultural practices, fertilizer application, chemical control, biological control and screening of rootstocks for resistance against biotic and abiotic stresses.

Rejuvenation of Senile Orchards

The old orchards which have turned unproductive and produce low-grade fruits require special attention. They should be rejuvenated through heavy pruning and fertilization. Demonstration trials on suitable locations should be laid out for the benefit of the growers.

Post -harvest Management

Post-harvest management is a process which begins from harvesting of apple fruits, passes through primary processing, grading, packing, transportation, storage and ends at marketing. Therefore, confining it to the problems of processing and post-harvest product protection is a half-hearted approach towards reduction of colossal 25-30% post-harvest losses suffered annually by us in production frontiers of apples in the country. The post-harvest management in national apple industry can be strengthened through paying attention on some points. They are :

- Post-harvest plant protection
- Development of maturity standards for each commercial variety
- Standardization of harvesting techniques
- Standardization of primary processing and post-harvest treatment strategies
- Evolvement of cost-effective packaging
- Standardization of precooling
- Development of palletization techniques
- Development of low- cost, environment-friendly cool chambers
- Standardization of containerization of transportation
- Creation of cool-chain network
- Standardization of variety-specific processing based upon minimal processing
- Standardization of carbonated processing and solar drying, and
- Development of value-addition techniques for commercial utilization of under-utilized fruits and wastes.

Organized Marketing

Presently, wholesale apple marketing is largely confined to domestic market of metropolitan cities of India, dominated by a large number of private intermediaries in the form of commission agents wholesalers and retailers. Though wholesale markets of fruits and vegetables in big cities are regulated but market functionaries are unregulated causing thereby financial hardships to the apple growers. The share of apple growers in consumer rupee will not enhance more than 30-35 % unless attention is focused on some points. They are :

- Development of apple growers' associations
- Creation of service-oriented marketing committees and boards
- Introduction of transparent and standard marketing operations like weighing, grading, selling etc.
- Strengthening of advanced marketing intelligence and information level up to growers association level
- Marketing of apple fruits based upon opportunity marketing windows.

Export Orientation

Areas known for quality production of apples should be identified for raising high-quality exportable fruits. These fruits are to meet the international standards enforced by different countries. The requirement of various importers for varieties and quality standards should also be ascertained and required steps should be taken to meet these standards.

FUTURE PROSPECTS

The future prospects of apple cultivation are bright and promising in the light of introduction of advanced technologies in apple orchards, export potential of apple trade and new agricultural policies of the Government of India. During 1997-98, our country exported 11,094 tonnes of apple fruits to UAE and Sri Lanka with a total export earning of Rs114.57 million. This momentum is likely to continue because there is a tremendous scope for export earnings with the signing of WTO and other similar treaties besides governmental patronage. On the basis of past trends and weighted responses, anticipated levels of area, production and productivity of apple are given in Table 3. The 2000-2020 period promises remarkable increase of 252 % in apple production over only 52% increase in apple acreage. Consequently, this period will witness an appreciable increase in apple productivity from 6.75 tonnes/ha in 2000 to 15.67 tonnes/ha by 2020 AD. However, the trend of declining apple productivity may extend up to 2010 in Himachal Pradesh but it would be arrested thereafter by an increasing trend. The apple cultivation in Uttranchal is a matter of concern due to continuous decline in apple productivity throughout the entire 2020 period. In Jammu and Kashmir and Arunachal Pradesh, apple cultivation will follow an exponential development path due to 197 % and 15% increase respectively in apple productivity during the same period. Future status of apple industry in india is given in Table 3.

Table 3 Future status of apple industry in India

Year	Arunachal Pradesh			Himachal Pradesh			Jammu and Kashmir			Uttaranchal			Total		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
2000	5.4	10.3	1.89	93.57	328.1	3.50	89.2	1106.2	12.40	57.5	215.2	3.74	245.7	1660.1	6.75
2005	5.6	11.0	1.97	109.8	362.3	3.30	100.6	1677.8	16.67	60.0	217.4	3.62	276.02	2268.5	8.21
2010	5.7	11.7	2.04	126.1	410.0	3.25	112.0	2477.8	22.12	62.5	220.5	3.52	306.4	3120.0	10.18
2015	5.9	12.6	2.10	145.5	485.4	3.31	125 7	3739.4	28.41	65.6	225.3	3.45	342.8	4462.6	12.51
2020	6.1	13.0	2.18	161.8	563.2	3.48	137.1	50542.1	36.78	68.1	230 2	3.38	373.1	5848.8	15.67
2000 to 2020(%)	+13	+26	+15	+73	+72	-0.6	+54	+356	+197	+18	+7	-10	+52	+252	+152

The future of our apple industry, therefore, be decided by the promptness through which we can conceptualize and implement developmental strategies towards conversion of weaknesses of apple industry into its strength, harnessing of agroclimatic niches to optimum level, development of in built sustainability in apple-based farming systems, and management and marketing efforts to meet challenges of international trade of apple in an effective manner.

STRATEGIES FOR PRODUCTION AND MARKETING OF LITCHI

Mathura Rai, Vishal Nath, H.P. Singh and Bikash Das**

Litchi (*Litchi chinensis* Sonn.) is one of the most important subtropical fruits. It is highly specific to its climate and soil requirement. Probably due to this, its cultivation is restricted to a few countries in the World. In India, it might have been introduced through Myanmar and north- eastern region during the 18th century which can be traced back to the establishment of over 100-year-old litchi orchards known as Litchi Bagan in Tripura by Maha Raja of Agartala. In India, litchi matures during mid-May in Tripura, West Bengal, Jharkhand; May-end and June in north Bihar, followed by northern tarai region of the Himalayas in Uttar Pradesh. In Uttaranchal,litchi grown in tarai region matures during first fortnight of June and in the valley of Pithoragarh during August-end and offer rich potential of expansion of area. The fruits of litchi are known for their fragrant, juicy and delicious aril. Litchi is a non-climacteric fruit possessing poor shelf-life. Thus, it needs specific treatment, packing and transportation for distant markets.

CURRENT SCENARIO

In India, its commercial cultivation is restricted in north in the foothills of the Himalayas from Tripura to Jammu and Kashmir and plains of Uttar Pradesh and Madhya Pradesh. Its commercial cultivation is done in the parts of north Bihar; Ranchi, Hazaribagh, Gumla and adjoining areas of Jharkhand; Udham Singh Nagar and valley of Pithoragarh in Uttaranchal; north-eastern districts of Uttar Pradesh and Murshidabad and 24 Parganas in north-eastern parts of West Bengal. It is also cultivated on a limited scale in Tripura, Sarguja district of Chhattisgarh, Panchmarhi area of Madhya Pradesh, Jammu area of Jammu and Kashmir, Gurudaspur district of Punjab, Kangra valley of Himachal Pradesh. Sporadic cultivation has also been reported from Nilgiri hills of Tamil Nadu, parts of Orissa, Maharashtra, Karnataka and Haryana.

India is second largest producer of litchi in the world after China. Presently litchi is cultivated in an area of about 56,200 ha with a total production of 428.9 thousand tonnes indicating the productivity level of 7.60 tonnes/ha. The area under litchi cultivation which was 11,410 ha in 1961-62 increased to 56,200 ha in 1998-99, resulting in 493% growth. Among all litchi-growing states, Bihar, West Bengal and Uttar Pradesh accounts for 68.14% of area (1998-99). In Bihar, it is cultivated in an area of about 25,800 ha, 45.9% of the total area under litchi. The national average productivity of litchi is 7.6 tonnes/ ha which is much lower than the realisable yield of the crop under managed condition. The average productivity of litchi in Bihar is highest in the country, whereas in other states the productivity is much lower than national productivity level. The productivity in Bihar is 12 tonnes/ha, followed by West Bengal (9.7 tonnes/ha), Punjab (5.7 tonnes/ha) and Tripura (5.7 tonnes/ha). The lowest productivity of 1.6 tonnes/ha is from Uttar Pradesh, whereas a productivity of about 20-25 tonnes/ha under managed orchard condition has been experienced.

The short span of fruit availability coupled with poor shelf -life limits the duration of availability of litchi fruits in the domestic as well as international market. The fruits are available from 15 May to

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15 July and the shelf -life varies from 3 to 5 days. With the proper post- harvest treatment the shelf-life can be extended up to 2 -3 weeks. This includes, precooling, sulphur and acid treatment, packaging, cold storage and refrigerated transportation. At present, about 37,000 tonnes (0.8- 1.0%) of litchi fruit is exported annually to the Mid east, Europe, Russia and Canada from India. APEDA and NAFED are major export promoters of litchi from the subcontinent. In international market, litchi fruits remain available in plenty during November - March from Australia(Nov-Mar), Mauritius(Feb.-Mar), South Africa and Madagascar (Nov.-Jan.), whereas in India availability of its fresh fruits coincides with the lean period, i.e. May - July. During this period, its fruits can be exported to the European market (Ghosh and Mitra, 2000).

APPROACHES FOR IMPROVED PRODUCTION

Selection of Cultivars

In India, about 50 cultivars are under cultivation. However, Shahi, China and Purbi are leading commercial varieties for north Bihar and eastern Uttar Pradesh; Purbi, China and Deshi for north eastern Bihar; Rose Scented for north-western Uttar Pradesh and adjoining area; Shahi, Ajhauli, China, Swarna Roopa and Purbi for Jharkhand and Bombai, Bedana and Rose Scented in eastern parts of West Bengal. Three varieties are promising for high yield and quality fruits. These have been adopted in the region. The important varieties suitable for growing in different parts of the country are:

Shahi : This is most popular cultivar of north Bihar, Jharkhand, Uttaranchal and Uttar Pradesh. Its fruits have distinct rose aroma and hence called as Rose Scented. It is known as Shahi in Bihar, Rose Scented in Uttaranchal and Muzaffarnagar in western Uttar Pradesh. This is an early-maturing cultivar. It ripen during last week of May to first week of June at various locations. It matures during 12-15 May in Jharkhand, 25th May in north Bihar and by May-end in tarai region of Uttaranchal. Its trees are very vigorous (7.6 m height and 8.2 m canopy spread) and high-yielding (90-100 kg/tree) but mature fruits are prone to cracking. Fruits are medium to large in size (3.2 cm length and 3.1 cm diameter), medium in weight (20.49 g/fruit), globules-heart or obtuse in shape having rose madder and fuchsia purple background with red tubercles at ripening. Pulp grayish-white, soft, moderately juicy (54.8%) and sweet with 20.0% TSS, 12.79% total sugar and 0.33% total acidity. Seeds are small (1.89 cm length, 1.32 cm diameter and 2.07 g weight), smooth, shining, round-ovate in shape and blackish-chocolate in colour. Rind : pulp : seed ratio by weight is 12.22 : 75.93 : 11.85. The fruits are known for excellent aroma and quality.

Early Bedana : It is also known as Early Seedless because of its early ripening and small seeds. The cultivar is very much popular in Uttar Pradesh and Punjab. Trees are medium, attaining an average height of 5.0 m and spread of 6.2 m. It is a medium yielder cultivar (50-60 kg/tree) but bears fruits regularly. Fruits are medium in size (3.2 x 3.0 cm) and weight (16.33 g) having oval or heart shape, rough surface with uranium green skin covered with carmine red tubercles at maturity. Aril is creamy white, soft, juicy (69.0%) and sweet containing 19.8% TSS, 13.6% total sugar and 0.54% titrable acidity. Seed is very small, shrunken, glaorous, dirty chocolate in colour with an average weight of 0.82 g. The rind : pulp : seed ratio by weight is 13.06 : 83.19 : 3.75 (Pandey and Sharma, 1989). The overall fruit quality of the cultivar is good.

Late Bedana : Also known as Late Seedless, this is a late- maturing cultivar which usually ripens in third week of June in Uttaranchal and May-end in Jharkhand. The trees are vigorous having an average height of 5.5 m and spread of 7.0 m. It is a high-yielding cultivar giving an annual yield of 80-100 kg/tree. Although the fruit size is medium (3.2 cm 2.9 cm) but average weight is 25.0 g. The fruits are conical in shape with vermilion to carmine in colour having dark blackish-brown tubercles at maturity. Pulp is creamy-white, soft, juicy (65.4%), sweet having 20.0% TSS, 13.8% total sugar and

0.44% acidity. Seeds are very small (1.8cm x 0.9 cm in size and 0.85 g in weight), shrunken, glaborous, chocolate in colour having fusiform shape similar to canine of dog. The skin : pulp : seed ratio (by weight) of late seedless is 14.76 : 81.89 : 3.35 (Pandey and Sharma, 1989). Overall quality of fruit is very good.

Swarna Roopa (CHES 1) : It is an early-mid maturing, cracking resistant cultivar of litchi belonging to seedless group released by CHES (now HARP), Ranchi. The tree is medium tall with medium spread, dense foliage. Leaves are 9.5-11.5 x 3.2-3.5 cm in size and dark green in colour whereas new flush is pink. the cultivar has 18.5-22.5 cm long, compact panicles. The fruits is average in size (3.0 x 2.7 cm) attractive red in colour cantain small seed and high edible percentage. Fruit weighing 18.95 g contains 76.6 per cent pulp, 19.0% TSS and 0.39 per cent acidity. Total sugar content in fruit is 13.0 per cent out of which 8.5 per cent is reducing sugar. Skin : Pulp: seed ratio by weight is 8.7 : 76.6: 16.4.

CHES-2 : A late-maturing genotype identified by HARP, Ranchi. Its trees are medium, vigorous in growth, bears fruits in outer as well as inner canopy which escape from the sun burn as well as fruit cracking. The fruits are deep red in colour, conical in shape and bear 10-18 fruits in a cluster. The fruit has an average weight of 21.3 g with 19.8% TSS and 0.2% acidity, containing 3.8 g seed and 16.1 g pulp. The skin : pulp : seed ratio by weight is 18.0 : 66.7 : 15.3.

Ajhauli : This is another early-maturing variety, in which fruits become ready for harvesting by 15-18 May, yielding 80-100 kg from a 16 year-old tree. The tree is vigorous in growth attains 7.2 m Light and 8.5 m canopy spread. It bears red fruits with average weight of 17.3 g and contains 20% TSS 0.4% acidity, 12.37% g sugar and 59.3 mg/100 g vitamin C the fully grown-up tree yields 70-95 kg fruits in a year.

China : This is one of the best cultivar for north India. It is tolerant to hot waves and fluctuations in soil moisture which escape to fruit cracking. It is also known as Calcuttia in West Bengal. This is a medium-late season cultivar and its fruits ripen during end of May in West Bengal, first week of June in Jharkhand and during week of June in north Bihar. Its trees are dwarf (4.0 m height, and 6.0 m spread) and high yielder (80-100 kg/tree) but prone to alternate bearing. It bears fruits in cluster of 12-18. The plants bear less fruit in southern direction. Fruits are large in size (3.86 cm length and 3.26 cm diameter), medium in weight (22.0 g/fruit), oblong in shape with dark red tubercles at maturity. Aril is creamy-white, soft, juicy, sweet having 18.17% TSS, 11.0% total sugar and 0.43% titrable acidity. Seeds are glaucous, dark chocolate in colour; oblong to concave or Plano convex in shape, medium in size (2.9 cm length and 1.5 cm diameter), average in weight (3.49 g). The ratio of skin : pulp : seed by weight is 16.42 : 69.22 : 14.36 (Pandey and Sharma, 1989).

Bombaiya : This is an important cultivar of West Bengal, vigorous in growth, attaining a height of 6-7 m and spread 7-8 m. The cultivar matures early (second to third week of May), yield 80-90 kg fruits/tree. Fruits are large in size (3.5 cm long and 3.2 cm diameter), obliquely heart-shaped, weighing 15-20 g. The colour of ripe fruits is attractive carmine-red with uranium green skin background. Like Chinese cultivar "Hom Shen Chi", this cultivar also has a small, tiny under developed fruit attached to the fruit stalk of each fully developed fruit. Pulp is greyish-white, soft, juicy, sweet containing 17% TSS, 11.0% total sugar and 0.45% acidity. Elongated, smooth and shining seed of light chocolate colour is 2.3 cm long with 1.6 cm diameter and 3.4 g weight. The ratio of skin : pulp : seed is 12.1:70.1:16.8.

Dehra Dun : This is an important cultivar of Uttar Pradesh and Punjab.also known as Dehra Rose. It is a late-maturing cultivar in which fruits start ripening by third week of June. Medium vigorous

trees (5 m height and 7 m spread) produce medium to high yield (80-90 kg/tree). Fruits are medium to large in size measuring 3.7 cm length, 3.5 cm diameter, 15.2 g weight having oblique-heart to conical shape. Bright rose-pink coloured fruits of Dehra Dun look very attractive at ripening. Pulp of this cultivar is grayish-white, soft, moderately juicy (61.9%), with 17% TSS, 10.4% sugar and 0.44% acidity. Seeds remain small (2.4 cm length, 1.4 cm diameter and 2.4 g weight), shrunken, mostly oblong in shape and dark chocolate in colour. The skin : pulp : seed ratio is 18.4 : 64.4 : 17.2. The major defect of the cultivar lies in its susceptibility to sunburn and cracking.

Genuine Planting Material

Litchi is commercially propagated through asexual method. The plants raised through sexual method have slow growth, long juvenile period (8-12 years) and do not produce true-to-the-type fruits. Therefore only vegetatively-propagated genuine planting material should be planted. The commercial methods are:

Layering : Air-layering is commercially used for its propagation. It can successfully be done just after harvesting in May-June when plants are in active phase of growth. Usually sphagnum moss is used as rooting mediciam. The best season for air- layering with high success of plants is monsoon season (Vyas, 1938; Roy, 1952).

Healthy terminal branch 1.2-1.5 cm thick receiving good sunshine are selected. A cut is made in the terminal branch and 2.5 cm ring is prepared by removing the bark 45-50 cm below the apical growth. Further, the cambium layer is rubbed off and woody portion is exposed properly. For early and proper rooting pasting of 2500 ppm IBA at upper end of out may be done immediately. A layer of moist sphagnum mass is placed and wrapped with a piece (20 cm x 25 cm) of 400 gauge polythene sheet and tied properly on both ends to ensure supply of proper moisture and development of roots. A decomposed mixture of pond silt (40 kg), FYM (40 kg) jute bag (10 kg), castor cake (2 kg), and urea (200 g)is ideal media for root initiation, development and better survival of plants at Ranchi. The rooting media is placed covering about 2 cm from the upper end of the ring. After 50-60 days, adequate root system is developed from the upper end of the ring which is visible through the polythene film. The layer is removed by giving sharp cut about 5 cm bellow the lower end of the ring, preferably in 2-3 stages. The detached layers are planted in the root trainers (300 cc capacity) under partial shade preferably under litchi tree. At the time of planting excess vegetative growth may be removed to maintain balance between the top and newly developed root system. Regular irrigation and weeding should be done for better establishment and growth. Marked improvement in root formation in air-layer is obtained by treatment with 5000 ppm IBA in lanolin paste at the upper end of the ring (Bose, 1966).

Cutting : The propagation in litchi has also been tried through cutting under controlled condition. Sen (1941) recorded rooting in cutting from 2-year-old shoots after treating with IBA. High percentage of rooting is also obtained from the cuttings planted in April-May under propagation chamber containing high humidity (Ochse, 1953) in Florida. Sen *et al.* (1967) reported good success in rooting from ringed shoots treated with IBA under mist condition. Beneficial effect of root formation in cuttings treated with IBA and planted under intermittent mist has been reported by Bhandary and Shivshanker (1970).

Orchard Establishment

Litchi plant starts bearing after 5-6 year and attains commercial production stage after 10-12 years (Rai *et al.* 2000). The performance of orchards depends on the management of the orchard which

includes water and nutrient management, selection of right cultivars, planting system, care and maintenance of young and bearing trees, stature and canopy management of plants, treatment of shoots for flowering and fruiting and use of plant growth regulators to optimize the quality production. The suitability of a cultivar is the factor of ecological condition of the site, availability of genuine planting material, consumers and market preference.

Selection of Site

Selection of location for litchi orchard is vital for optimum production owing to its specific climatic requirement. Frost-free climate with mild cold (8-14°C minimum temperature) and dry period prior to flowering during autumn-winter, moderate temperature and humidity during flowering, fruit setting and fruit maturity and absence of high speed wind during fruit development and are maturity are considered ideal for litchi cultivation. Plants are also specific to their soil requirement, therefore, cultivation the site should have deep, mild acidic, well-drained, soils with high organic matter (Galan, Sauco and Menini, 1989).

Litchi can be cultivated in almost all kinds of soil-ranging from sandy to clay loam with good drainage and rich in organic matter. However, well-drained, deep, sandy loam soil having high moisture-holding capacity, rich in organic matter and calcium content are ideal for litchi cultivation. The rich soil with good moisture-holding capacity facilitates better growth and fruiting. The well-drained soil in north Bihar rich in calcium content is suitable for better growth and quality fruits. The rolling uplands of Chotanagapur are also highly suitable for the good crop.Mild acid soil of Chotanagpur is ideal for association of mycorrihza in the litchi rhizosphere. The soil having a pH of 6.0 - 8.5 with abundance of soil moisture is suitable for proper growth and fruiting. Soils of poor physical condition, lacking in available nutrients can be improved for litchi cultivation by adding sufficient quantity of rotten farmyard manure /compost and green manuring. An adequate infrastructure facilities like cold storage, transport, electricity, etc. must also be available near the production sites.

Land Peparation and Layout

Before layout, the land should be cleared of bushes, weedy vegetation and ploughed deeply. Further, the surface should be leveled with mild slope in opposite direction of the water source. To improve fertility of the soil organic matter should be added, green manure crop such as dhaincha (*Sesbania aculeata*) or sunhemp (*Crotalaria juncea*) may be grown and incorporated into the soil which improves fertility, moisture-holding capacity and physical condition of soil.

Planting

Litchi should be planted during rainy season which provide optimum soil moisture and better atmospheric humidity for survival of the plants. Litchi is an evergreen plant and atmospheric humidity helps in better establishment and survival of the plants. Hence in north India planting may be done from mid-June to August-end avoiding peak rainy period, if there is problem for waterlogging in the field. Early planting provides longer rainy period for initial establishment and growth. About one-year-old air-layered plants are ideal for planting in the field.

Litchi is an evergreen, spreading plant attaining the height of 10-12 m at its fully grown stage. The light penetration on its canopy is also desirable for proper fruiting, hence planting in square system at the distance of 9-12 m, within and between rows is advised. This also helps in cultural operations to

be performed conveniently. However, planting in double hedge row system of planting at a distance of 4.5 x 4.5x 9 m, accommodating 329 plants/ha is ideal to get high yield of quality fruits up to 16 years of plantation.

The pits of 90 cm x 90 cm x 90 cm size are dug during summer season in April-May. During this process, harmful insects and pests are minimized/controlled. Further pits should be filled with top soil mixed with 40 kg decomposed farmyard manure/compost, 2 kg neem/karanj cake, 1 kg bonemeal/ single superphosphate and 200-300 g muriate of potash, just before the onset of monsoon. If available, about 2 baskets of soil from the root zone of old litchi tree also may be added which is helpful for mycorrhizal growth. Then the soil may be allowed to settle properly during first few rains and get levelled properly. During planting time a hole about the size of ball of the earth should be made in the centre of the pit at marked point and planting is done. After proper fixing of the plant watering is done immediately for proper establishment of the plant. Further plant is regularly watered till it is properly established.

Orchard Management

The orchard management includes management of canopy architecture, nutrient, water, field sanitation and plant protection.

Young non-bearing orchards : Management and upkeep of young non-bearing orchards is essential which accelerates growth of young plants and minimize juvenile period. The main aim for the litchi orchard management up to 3 years is to accelerate the plant growth and develop better framework which makes platform for higher production throughout the life span. Generally young litchi plant sprouts 5 times in a year to form canopy with a certain quantity of vegetative growth (Zhang *et al.*, 1999). Therefore, newly-planted young saplings should be properly nourished to promote better vegetative growth during this period. After attaining the age of 3 years, plants develop good canopy and become ready for bearing a few fruits. Weeding, hoeing, cleaning of plant basins, plant protection and water management should be done time- to- time to facilitate better growth.

Young bearing orchard : This is a very delicate stage of orchard management where more visionary approach should be followed in skillful manner. During this stage (3-10 years) plants need more nutrient for proper growth and bearing. At this stage, trees keep enlarging canopy and also produce fruits. Therefore, management should be aimed to balance both vegetative and reproductive growth. It is important that at this stage of plant growth there must be optimum balance between vegetative growth and fruit production. Over vegetative growth adversely affects fruit setting while excessive fruit load reduces development of tree canopy. Skillful orchard management at this stage includes maintenance of optimum number of bearing branches as per the nutritional status and health of plants. Young trees tend to have more vegetative growth, therefore, it has been observed that sometimes fruit production is suppressed by excessive vegetative flushing particularly during autumn. Therefore, ringing, girdling, fostering of winter shoots and use of paclobutrazol, can be applied for proportional crop production.

Junior-adult bearing orchards : After attaining the age of 10 years , litchi trees enter the phase where vegetative growth and fruiting remain relatively balanced and the phase is called as junior-adult bearing phase. The main aim of orchard management at this state is to maintain a prescribed plant nutrient status so that tree can produce constantly high yield throughout the bearing age. Various agro-techniques like rational fertilization, timely fostering of bearing mother branches, strengthening of

nutrition accumulation in trees and plant protection are applied to ensure optimum flowering and fruiting at this stage.

Senior-adult bearing orchard : In this phase, trees reach to their full yield potential. The age of tree may range from 20-100 years and can bear heavy fruits. The main aim of orchard management is to produce maximum yield with maximum feeding. At this stage, different fertilizers should be applied at different periods of cycle. Foliar sprays of nutrients and plant growth regulators are also essential to ensure higher production. Timely plant protection, shoot treatment, interculture operations, water and canopy management for higher production should be judiciously followed.

Renewal of old bearing orchards : Litchi trees have strong renewal ability. Therefore, old and unproductive orchards can be rejuvenated for further higher production. Heavy reiterative pruning followed by optimum fertilizer and moisture management near feeding root zone are main management practices for such orchards.

Training and Pruning

Management of optimum stature of litchi tree with compact and stereo bearing canopy is an important aspect of orchard management. Generally litchi trees grow unstopped and allowed to form larger canopy but in present days of systematic orcharding, promotion of large bearing area, accommodation of more number of plants/unit area, management of tree height, canopy concentration to provide more fruiting branches and penetration of more light to inner portion become more relevant. Hence, more shaping of tree from initial stage and pruning of branches after harvesting in bearing tree is essential . Since more shoot sprouting takes place in young plants, shaping is quite convenient at this stage. However, annual pruning at different severity after harvesting is practised in most of the litchi-growing countries. Reiterative pruning to rejuvenate old orchards needs to be adopted to bring orchard in productive stage.

Training of young plants : Pruning is an important operation. It should be initiated at the nursery stage itself. Single stem air-layered plants should be raised in bags and allowed to grow up to 40-50 cm. The layered plants have strong tendency to produce branches at the ground level which should be pinched or pruned. Further, strong, well- spaced out shoots should be allowed to form the main branches. It is necessary to continue shaping by removing all the branches forming crotches with main branches (Cull and Paxton, 1983) as and when grow.

The main aim of pruning and frameworking is to develop sufficient fruiting terminals. Compact and stereo-bearing canopy should be achieved by pruning at early stage and shaping of young tree. The canopy should have well-illuminated and sufficient number of strong and healthy branches for stereo- bearing. To develop good and compact canopy, 25-30 cm fruit bearing shoots at the time of harvesting should be removed. In this way, 2-3 new terminals develop which consequently develop into fruiting branches next season. As principle, young trees are lightly pruned to provide larger area for photosynthesis. Severe pruning at young stage should however be avoided as it hinders tree development and increases the period of juvenility.

Pruning of bearing plants : The recent findings advocates pruning of litchi to facilitate healthy growth and better yield. However, in the past litchi trees were never pruned. Only at the time of harvesting, a small portion of branches were used to be lopped off along with fruit bunch (Singh and Singh, 1954). This practice was considered to be helpful in improving subsequent fruiting by encouraging terminal shoot production. Besides, removal of dead and diseased shoots, small internal branches

which prevent the sun rays to penetrate the tree are generally removed. Although, removal of branches along with the bunch has shown its promise, but no standard techniques have been evolved for annual pruning of litchi. Recently, Zhang *et al.* (1999) have described the methods for culturing compact canopy. The techniques includes, more pruning at top (open window) and outer parts of the tree canopy and less at bottom and inner side of the canopy which promotes stereo fruiting. In Israel however, Goren and Gazit (1993) maintained dwarf stature litchi tree by topping and hedging.

The main objective of annual pruning is to control growth of trees as in case of high-density planting (Goren and Gazit, 1993) and/or promoting the flowering (Galan-Sauco and Menini, 1989). Sometimes root pruning and exposure also improve the flowering in adult trees. Time of annual pruning is very much important for the next year cropping. The severity of the pruning varies according to cultivar, however it should be done just after harvesting. As soon as fruits are harvested, the plants put forth new growth, therefore pruning must be completed before initiation of new growth. Pruning after initiation of new flush results in production of unhealthy shoots which do not mature for flower-bud differentiation during next fruiting season. The method involves regulating canopy structure, reiterative pruning, thinning, removal of dried, diseased and pest damaged branches. During pruning tree vigour should be taken into consideration. Winter pruning should be strictly avoided. However, unproductive shoots arising from the main branches under the canopy should be removed as and when they appear. Rational supplementary pruning (light pruning) can be done after flower bud formation in spring depending upon the requirement. Reiterative pruning is done to one-year-old bearing mother branches by removing one-third or four-fifths of the main branches.

The damaged shoots due to severe cold, also need to be removed just before the new growth initiation. Unproductive trees with uneconomical yields are pruned heavily to develop new fruitful shoots. In such cases, heavy reiterative pruning, usually up to limbs at a height of 4-5m is commonly followed, supplemented with heavy application of nutrients. Further supplementary pruning is done to retain 4-6 healthy, well-placed shoots in each limbs. These new shoots start fruiting from 2-3 years after pruning. Thereafter, general principle of pruning should be followed to maintain ideal vigour and productivity of the tree.

Nutrient Management

Inadequate nutrition is often attributed for low yields in litchi (Menzel and Simpson 1987). Therefore, balanced nutrition is important, both for young growing plants and grown-up productive trees. However, a bearing tree requires balanced nutrient application for maintenance of vegetative growth along with fruit production. A fully grown-up litchi tree gives an average yield of 80-120 kg depending upon varieties. Apart from fruits, a considerable amount of macro and micronutrient is removed from soils through annual pruning of shoots. Hence, the application of manure and fertilizer in the required doses is therefore, of paramount importance for sustaining the regular production of the crop. The nutritional requirement in litchi plants depends upon the soil fertility condition. However, in the initial stage of establishment, application of 30 kg well-decomposed farmyard manure, 2 kg karanj cake, 150 g urea, 150 g SSP and 150 g muriate of potash per plant is optimum. As the plants advances in age, an additional dose of manure @ 5 kg farmyard manure, 150 g karanj cake, 150 g urea, 100 g SSP and 50 g muriate of potash per plant should be added each year with the dose of previous year. Thus, a 16 year- old, fully- grown up tree should be supplied with 80-100 kg farmyard manure 4 kg karanj cake, 2 kg urea, 1.5 kg SSP and 0.8 kg muriate of potash (Table 1).

Table 1. Fertilization schedule for litchi

Age of plant (year)	Manures and fertilizers/plant				
	Farmyard manure (kg)	Karanj cake (kg)	Urea (g)	SSP (g)	Muriate of potash (g)
At planting	30	2.00	150	150	150
1	30	2.00	150	150	150
2	35	2.15	300	250	200
3	40	2.30	450	350	250
4	45	2.45	600	450	300
5	50	2.60	750	550	350
6	55	2.75	900	650	400
7	60	2.90	1050	750	450
8	65	3.05	1200	850	500
9	70	3.20	1350	950	550
10-15	75	3.50	1500	1200	650
> 15	80-100	4.00	2000	1500	800

Application of organic manure in litchi improves the yield and quality of fruits. Application of lime in Chotanagpur region @ 10 -15 kg /tree at 3 years interval increases the yield. Since litchi is a highly sensitive plant to micronutrients, application of zinc, boron, magnesium, iron and copper in appropriate doses along with calcium is necessary for proper health, flowering and fruiting. Application of farmyard manure, potassic and phosphatic fertilizer in general in major litchi-growing areas of the country should be done during June-July, just after harvesting. However, in early and heavy rainfall area like West Bengal, Uttaranchal and Uttar Pradesh, manures and fertilizers are applied in September-October just before the end of monsoon. The application of annual requirement of nitrogen is done in 2 equal spilt doses, first dose is applied after fruit set in March-April, while the remaining half dose is applied immediately after harvesting.

After application of fertilizer irrigation of the tree is essential and proper soil moisture should be maintained. The total requirement of nitrogen, phosphorus and potash is applied through basal application. However, spraying of 2% urea once or twice during fruit growth is practised. Two foliar applications of zinc sulphate (0.1%) should be done 10-15 days before flowering for improving sex ratio. In case of zinc and magnesium deficiency, application of 150-200 g $ZnSO_4$ and 150-200 g $MgSO_4$, respectively per plant during September is beneficial. Foliar application of 0.1% borax 2-3 times during fruit growth and development on trees enhances fruit retention, minimize cracking, improves fruit colour, sweetness and enhances maturity. Other micronutrient like Fe (Ferrous sulphate), Cu ($CuSO_4$). Mg (magnesium sulphate) should be applied if deficiency symptom is observed. Two to three sprays in a year are sufficient to maintain the trees in good health. Two to three foliar application of plant bio-regulator (20 ppm), NAA at 10-15 days interval during of fruit growth and development fruit drop effectively. IAA may be substituted for NAA if the later is not available. Spraying plain water 4-6 times in early morning of the day during the advanced stage of fruit growth and development are highly effective for better growth of fruits and minimizing fruit cracking.

Water Management

Litchi being an evergreen plant, optimum soil moisture and humidity are of outmost importance for proper growth, development and fruit production. In the places receiving about 1,000 mm annual rainfall distributed for longer period, litchi can be grown successfully and supplementary irrigation is required only during fruit development and maturity of the crop. However, during the initial 3-4 years of the establishment of the plant, much care is needed to protect the plants from extreme weather conditions. Protection of young plants from extreme temperature during summer and winter months is very essential in the initial stage of establishment. Young litchi plants must be irrigated at weekly interval for better establishment. Desiccating winds during summer and frost during winters are most damaging. Further, young plants should be irrigated during dry period and winters at 10-15 days interval. Weeds in basin should be removed and soil should be loosened. For young plants, mulching with dry local weeds in the basin help in better moisture conservation. *In situ* water harvesting through full-moon-terrace during rainy season and mulching with paddy straw in October helps in maximum soil-water retention, improving yield and quality in grown-up plant. The land should be ploughed time-to-time to minimize weeds and to improve soil physical condition.

Irrigation at 2-5 days- interval maintains atmospheric humidity during fruit development and maturity. Irrigation at alternate day, 6 weeks before harvesting improves fruit retention, minimizes cracking and improve quality of fruits. Moisture conservation through mulching with dried weed or black polythene sheet is useful. Certain physiological disorders like poor sex ratio, poor fruit set, heavy fruit drop and high fruit cracking, besides sun-burning of the fruits can be minimized with proper water and nutrient management. Thus, light irrigation at 2-3 days interval during April and May promotes aril development, checking fruit cracking. Irrigation of litchi tree through drip system from first week of April under Ranchi condition is highly beneficial in minimizing cracking, improving fruit quality.

Orchard Floor Management

Litchi is a slow-growing plant and takes about 15-16 years to develop canopy and cover the area. During initial period of establishment, space between plants can be utilized for planting of filler plants/intercrop. The planting of guava, custard-apple, lime/lemon at the centre, between and within rows of litchi gives additional income in the initial stage of planting. Papaya can also be planted as filler plant at the spacing of 2.5cm x 2.5 m. Further, in between the plants in the initial stage, cowpea, Frenchbean, okra and kulthi can be grown as intercrop. In the grown-up orchard, cultivation of partial shade-loving plants (ginger, turmeric and elephant-foot yam) can be done successfully which provides additional income.

Litchi takes about 15-16 years to develop canopy and cover the area. During initial period of establishment, the space can be utilized by planting filler crop/intercrop. Guava, custard-apple, lime/lemon and papaya can be used as filler crop at a spacing of 5m x 5 m between rows of litchi and cowpea, French bean, okra and kulthi, as intercrop in the orchard provide sustainable return from the initial stage of planting.

Maturity Standard and Harvesting

Litchi is a non-climacteric fruit and harvesting is done when fruits are fully matured on tree. At the time of harvesting development of colour on fruits, flatness of tubercles, smoothness of epicarp and TSS : acidity ratio may be taken into consideration in addition to number of days taken from fruit set to maturity. However, colour development is major criteria to decide the harvesting stage. The red pigmentation in litchi is associated with anthocyanin pigments, viz. cyanindin-3-glucoside, cyanindin-3-galactoside, pelargonidin-3-glucoside and pelargonidin-3, 5-diglucoside. The fruits are harvested in

bunches along with portion of branch and a few leaves. At the time of harvesting care should be taken to harvest the selected bunch which has attended desirable maturity stage. The fruits should be harvested early in the morning when temperature and humidity are congenial which gives longer shelf- life of fruits. At the time of harvesting, fruits should be collected in bag and should not be dropped on the ground. The fruit should be precooled to remove the heat which extends the shelf-life. Further, fruits should be brought to cold storage within 2-3 hours. The yield of fruits varies according to the age of the tree, agroclimatic condition and maintenance of the orchard. Usually, 80-120 kg fruits/tree are obtained from 14-16 years old trees. However, fully-grown trees yield 80-120 kg fruits/tree.

Plant protection

Eriophid mite, litchi bug and fruit-borer are major pests which require serious attention for an effective control. Powdery mildew (*Oidium* spp.), anthracnose or leaf-spot (*Botryodiplodia theobormae* Pat, *Collectotrichum glocosporioides* Penz) and red rust (*Cephalexros mycoides*) are only diseases which cause damage to litchi crop. Control measures consist of 1-2 applications of proper fungicides against fungal diseases, while for the Red Rust sulphur wash in September-October and February-March is sufficient.

Litchi mite: In litchi, Eriophid mite (*Aceria litchi*) is a serious pest causing immense damage to litchi crops. The small tiny nymphs and adults stick to under surface of leaf and suck the cell sap. Consequently, young leaf turns yellow to greyish-yellow, along with velvety growth on lower surface which subsequently turn brown. The affected mature leaf develops continuous to scattered brown patches with curling, twisting and leathery structure which ultimately result in gall formation. Usually attack is seen on young and grown-up trees. It reduces the photosynthesis, increases leaf drop and tree become weak resulting in low yield. Pruning of affected twigs/branches and burning minimize the problem. Two spray of karathene or phosmid or nuvacron (0.05%) at 7-10 days interval is effective to control mites.

Shoot-borer: The caterpillar bore inside the newly-growing shoots and feed inner parts resulting in drying of twigs. In severe infestation, sap movement is interrupted and the tree ceases to flush. Pruning and burning of affected twig minimize the infestation. Two sprayings of 0.02% cypermethrin or 0.1% padan at 7 days interval can effectively control the insect.

Bark-eating caterpillar and trunk-borer: The caterpillar (*Inderbela* sp.) bore inside the trunk/main stem. During night they come out and feed on the bark protected by the large silken webs usually during July-September. The branch cease the growth, stem becomes weak and may ultimately fall on the ground. The presence of the insect can be known by seeing excreta and silky web. To control, the infested area needs to be cleaned and cotton wool soaked in petrol or nuvacron or formalin should be inserted inside the hole and sealed with mud.

Fruit-borer: The small caterpillar bore through the stalk end of the fruits, feed on the seed and skin of the fruit. As a result fruits become unfit for consumption. The excreta of the caterpillar are seen near the stalk end of the fruits. High humidity and intermittent rains favour the infestation. Two sprayings of cypermethrin (0.02%) or nuvacron (0.04%) at an interval of 15 days starting from 40 days before anticipated harvesting is recommended.

Litchi bug: This is a common pest of litchi particularly during spring season. It sucks sap from tender leares, shoots, newly emerging panicles and even from young fruits. The insect gives foul smell after touching by which it can be identified. It can be controlled by 2-3 sprays of 0.025% methyl demeton or 0.03% dimethoate or 0.05% phosphamidon at 15 days interval during spring season (Anon. 1984-85)

TIPS FOR HIGHER PRODUCTION

Litchi plants put forth 4-5 continuous flushes in a year, however, it needs a period of dormancy to initiate floral buds (Young and Harkness, 1961). The autumn flush which remain dormant up to November-December and attains physiological maturity, bears profuse inflorescence in spring season. Whereas plants with continuous vegetative growth do not bear flowers and fruits. In India, vigorous shoots from flush produce mixed inflorescence (panicle) terminally as well as axillary. Atmospheric temperature, air humidity, inherent nutrient status of shoot (C:N ratio) and cultural operations are the important factors for reproductive growth in litchi shoots. Zhang *et al.* (1999) described some mechanical practices which are useful in promotion of growth in litchi.

Fostering Strong and Healthy Bearing Branches

This is a composite but important mechanical and cultural practice for bumper litchi production. Timely fostering of strong and healthy shoots gives healthy inflorescence which is a key for higher production. Restrictions in winter flushing through mechanical means helps reproductive bud formation. The practice also increases the ratio of female to male flowers in cluster and fruit set rate. The package of fostering includes:

* Timely application of quick-acting fertilizers immediately after fruits, harvest for recovery of tree vigour after harvest.
* Timely and adequate pruning after harvest.
* Shooting control and flowering enhancement in last autumn branches through binding, ringing and spiral barking of main trunk or chemical sprays.
* Artificial or chemical killing of winter sprouts by manual removal or chemical sprays.
* Use of plant growth regulators (paclobutrazol) for maturation of shoots and flower promotion.

Improving Fruit Retention

In litchi heavy fruit drop has been observed at different stages due to the formation of abscission layer (Stern *et al.*, 1995; Stern and Gazit, 1999). Although fruit drop continues up to maturity but most of the flowers and fruits drop during the first month after pollination (Joubert, 1986; Stern and Gazit, 1999). The main cause for flower and fruit drop in litchi is imbalance of nutrients and hormones needed for embryo and fruit development, lack of pollination/fertilization and environmental factors in certain cases. Therefore, fruit retention in litchi cannot be achieved by nearly one or two simple measure but a comprehensive set of practices to be attended stepwise throughout the season. Zhang *et al.* (1999) have suggested a comprehensive measures for fruit retention in litchi.

High fruit retention in litchi can be ensured by controlling winter shooting, improving flowering period and flower quality. Timely treatment of plants for strong and healthy shoot production delays flowering phase and increases female flower ratio and finally fruit setting rate. Honey bees are main

pollinating insects in litchi (Stern and Gazit, 1996). Increasing the bee population in orchard ensures better pollination and fertilization which increases the fruit retention. If necessary, artificial hand pollination can also be done for high fruit retention. In vigorous litchi cultivars, young bearing trees produce more vegetative flush and less flowers. Under such conditions, girdling of flowering shoot after 10-15 days of pollination is very effective practice for higher fruit retention. Application of growth regulators particularly auxins (2,4-5-trichlorophenoxy acetic acid and 3,5,6-trichloro-2-pyridinoxy acetic acid) have been found much effective in controlling the abscission and enhancing the litchi fruit production in Israel (Stern *et al.*, 1995) and are being used as routine practice.

Managing Fruit Cracking

Fruit cracking is a developmental disorder which occurs mainly during last phase of fruit development when rapid growth in aril takes place. The disorder is associated with a number of factors including genetical, anatomical, environmental, hormonal, nutritional and soil moisture. Late-maturing cultivars like China, Swarna Roopa, CHES-2, Purbi and Kasba are least affected, whereas early-maturing cultivars like Shahi, Ajhauli and Muzaffarpur show high fruit cracking (Chadha and Rajput, 1969). Dry, desiccating and hot winds at the time of ripening favours high degree of fruit cracking. The fruit cracking in late-maturing cultivars is less due to onset of monsoon and availability of soil moisture. An imbalance between auxin, Gibberellin and cytokinin (Sharma and Dhillon, 1986;1988) has been reported to occur in the cracked fruits. Application of 10-20 ppm of 2,4,5-T and NAA has reduced the fruit cracking (Prasad and Jauhari, 1963; Chandel and Sharma, 1992). Foliar spraying of 0.5% $ZnSO_4$ reduces fruit cracking (Awasthi *et al.*, 1975), whereas Mishra and Khan (1981) reported maximum reduction in cracking by the application of 0.4% boric acid at pit hardening stage. Lal and Kumar (1997) reported that loss of soil moisture and prolonged irrigation interval during fruiting season has been associated with severe fruit cracking in litchi. Application of 8 irrigations at 15 days interval between February and May reduces the extent of cracking.

APPROACHES FOR POST-HARVEST HANDLING AND MARKETING

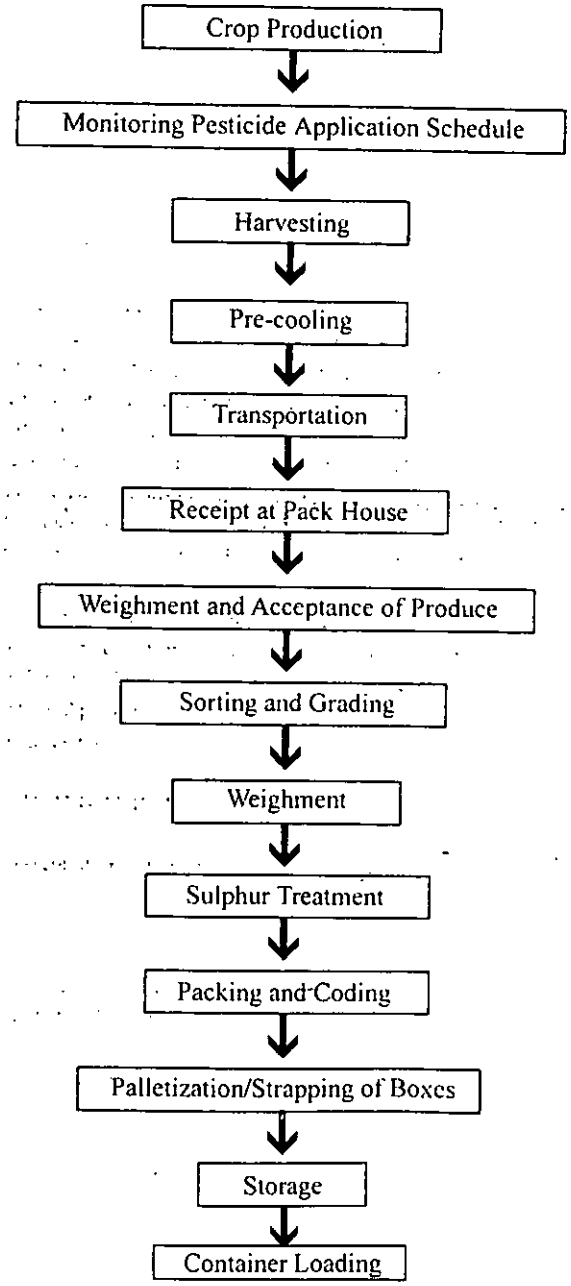
It is advisable to follow the following essential operations for marketing of produce in the national and international market.

Sorting and Grading

Fruits are graded according to their size and quality. Inferior (culled, discolored, splitted and spotted) fruits are separated and the produce is graded in different classes:

Extra class : Super class grade fruits which are uniform in shape, colour and have typical character of the variety .The fruits must be free from the defects and disorders and must contain the described dimension and biochemical parameters.

Class I : Good quality fruits with described external characteristics of the variety are graded in this class. However, slight defects are admissible provided they do not affect the general appearance, quality and shelf- life of the produce.



Class 2 : A few defects are admissible provided the fruits retain their original characteristics particularly the quality and shelf-life.

Control of Browning

Brown discoloration of the pericarp in fruit starts just after harvesting and fruit appearance deteriorates rapidly within hours. A wide range of factors such as climatic conditions prior to fruit maturity, desiccation, fruit senescence, heat injury and diseases are associated with this problem. It has also been found that rapid degradation of phenols by the activity of polyphenol oxidase causes the degradation of skin pigments. Acidification by dipping in H_2SO_4(pH 0.2) and HCl (1N), sulphur treatment by dipping in sodium metabisulphite(4%) followed by acidification, salting (2% NaCl), waxing (9% wax emulsion + 0.5% sodium orthophenol phenate) and fungicide treatment (benomyl 0.5 - 1.0% and bavistin 100 ppm) coupled with storage at low temperature is effective to control browning of fruits for a considerable period (Ray, 1989).

Packaging and Transportation

Litchi fruits should be packed in wooden cartoons with sufficient cushioning for distant transportation; however, for local market its fruits are packed along with the stalk and few leaves in gunny sheets with litchi leaves as cushioning material. For export market the fruits are packed in well-perforated CFB boxes and transported in refrigerated van after proper pelletting.The fruits are packed loose as well as in bunches in the packs.

Marketing

Litchi possesses short shelf-life at ambient condition. Inadequate storage, transport facilities, lack of processing unit and vulnerability to temperature and humidity conditions prevailing during harvesting pose threat in fruit quality. Hence, careful post-harvest techniques should be adopted particularly for grading, packing and transportation under controlled condition for an effective marketing. The marketing of litchi is not well-organized and therefore suffers from a number of problems. At present the litchi fruits in India are marketed through some channels. They are :

Producer – pre-harvest contractor – commission agent – retailer – consumer

Producer – village trader – wholesaler/commission agent – retailer – consumer

Producer – retailer – consumer

For an efficient marketing some points needs to be looked into. They are :

- Establishment of cooperative marketing system.
- System of pre-harvest contract selling must be strengthened to avoid loss during the peak harvesting period.
- Training of the people for right method of harvesting, packing and grading which improve quality of the produce.

- Strengthening of infrastructural facilities such as cold storage, cool chain units, transportation, etc.

POSSIBILITIES OF AREA EXPANSION

Keeping in view the increasing demand of litchi in the domestic as well as foreign markets, there is a tremendous scope for its area expansion in the sub-Himalayan tract of the country where climate is most appropriate for its successful cultivation. It may, therefore, be wiser to utilize the area available in the subtropical climatic zones of the country for its cultivation instead of other crops. Based on the fruiting behaviour, quality development and area under cultivation, litchi-growing districts have been grouped as concentrated, medium concentrated and sporadic regions (Table 2). The concentrated area is already exploited for its cultivation, however scope exists for increase in area in the region of medium concentrated and sporadically cultivated area. The Ranchi, Hazaribagh and Gumla districts of Jharkhand; tarai region and valleys of Pithoragarh in Uttaranchal; Sarguja district of Chhattisgarh and Kushinagar, Gorakhpur, Basti districts of north-eastern Uttar Pradesh have been endowed with favourable soil and climatic conditions and offer rich potential to increase the area under litchi cultivation as it has better demand and provide high return in comparison to other crops.

The foothills in the Himalayas are free from frost and receive early rain and hence offer good scope for its plantation. The experience has indicated that litchi cultivation up to 4,000 m above mean sea-level is endowed with most favourable climatic and soil condition for production of quality fruits which mature late and ensure availability of fruits during late season. Litchi in India matures early in comparison to other litchi-growing countries and offers better domestic and export market. According to a rough estimate, 40,000-50,000 ha additional area can be still brought under litchi cultivation in subtropical climatic zone of the country under judicious planning and management of natural resources.

Table 2. Distribution of litchi cultivation in India

Distribution type	Area of distribution (district/state)
Concentrated	Muzaffarpur, Samastipur, Darbhanga and Motihari in Bihar; Dehradun, Udham Singhnagar and valley of Pithoragarh in Uttaranchal; Saharanpur, and Kushinagar in Uttar Pradesh; Ranchi and Hazaribagh in Jharkhand; Murshidabad, Maldah and Coochbehar in West Bengal
Medium concentrated	West Tripura in Tripura; Ghorakhpur and Basti in Uttar Pradesh; Gumla and Lohardaga in Jharkhand; Sarguja in Chattisgarh; Kangara valley in Himachal Pradesh
Sporadic	Gurudaspur in Punjab, Kachhar in Assam, Garhwal in Uttar Pradesh, Ootty and Nilgiri in Tamil Nadu; North and South Tripura in Tripura and Nadia in West Bengal; Panchmarhi in Madhya Pradesh

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STRATEGIES FOR DEVELOPMENT OF LITCHI TO MEET DOMESTIC AND EXPORT NEEDS

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Litchi does not rank very high in area, production or economic importance compared to mango, banana and citrus fruits. Owing to delicacy and nutritional value, it is a favoured fruit in all sections of the society. In fact, litchi, in its fresh or processed forms is very popular among the social elite. India ranks first in the world in area (48,570 ha) and production (3,64,610 tonnes) followed by China. Taiwan, Thailand, Madagaskar, Mauritius, South Africa, Reunion, Australia and Vietnam are some other important litchi producers (Table 1). The data show that India leads other countries not

Table 1. Area and production of litchi in some countries

Country	Area (ha)	Production (tonnes)	Average production (tonnes/ha)	Reference
India	48,570	3,64,610	7.51	Singhal (1999)
China	39,700	61,820	1.56	Menzel and Simpson(1986)
Taiwan	-	1,31,300	-	Tindal (1994)
Thailand	13,350	8,401	0.62	Menzel and Simpson (1986)
Madagaskar	-	35,000	-	Tindal (1994)
Mauritius	-	1,000	-	Tindal (1994)
South Africa	-	5,687	-	Tindal (1994)
Reunion	-	1,000	-	Tindal (1994)
Australia	1,800	300	1.67	Menzel and McCounchie (1998)
Vietnam	10,000	42,000	4.2	Menzel (1992)
Total	-	**6,50,827**	-	

only in total production, but also in productivity (7.51 tonnes/ha). This productivity figure should not leave us complascent because production methods in some countries, where litchi industry is comparatively young, have undergone a change and their productivities are higher than India at much younger tree age.In South Africa, an yield up to 12 tonnes/ha is obtained through high-density planting (Roe, 1993).

State-wise productivity data show that there is too much variability in different litchigrowing

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*Table 2. State-wise area and production of litchi in India (1995-96)**

State	Area (ha)	Production (tonnes)	Average production/ha
Bihar	22,508	2,77,000	11.9
Uttar Pradesh	8,774	13,297	1.5
Assam	4,026	15,867	3.9
Tripura	3,495	22,650	6.5
West Bengal	3,400	17,500	5.1
Punjab	1,990	11,940	6.0
Orrisa	1,637	6,000	3.6
Arunachal Pradesh	275	125	0.45
Mizoram	72	259	3.6
Nagaland	30	37	1.2
Maharashtra	17	10	0.59
Karnataka	16	160	10.0
Total	**48,570**	**3,64,613**	**Range=(0.45-11.9)**

**Source:* National Horticultural Board, Govt. of India, Gurgaon

regions of the country (Table 2). It varies from 0.45 tonnes/ha in Arunachal Pradesh to 11.9 tonnes/ha in Bihar, the principal litchi-producing state in the country. It is followed by Karnataka (10 tonnes/ha), Tripura (6.5 tonnes/ha) and Punjab (6.0 tonnes/ha).

For increasing and sustaining production in litchi multipronged approach should be adopted to fulfill the domestic and export needs. That needs :

MULTIPRONGED APPROACH

Increase in Area Under Litchi

Litchi is a heat loving plant, yet, cool winter temperature is necessary to bring its trees into bearing. Such climatic conditions are available along the foothills in the north, north-western, north-eastern and specific locations in the south Indian hills. These are vast stretches of area which are suitable for litchi cultivation wherever irrigation facilities are available. In most suitable areas, the maximum temperature, preferably, should not be higher than 38°C but it is also equally true that, quite frequently, maximum temperature rises to 43°C or so for shorter periods during May and June, causing sunburn and cracking of fruits in the north and north-western India. Therefore, while selecting a locality for litchi planting, this fact must be kept in mind.

Increasing Productivity per Unit Area

Identification of high-yielding varieties: Although about 50 litchi varieties are known in India, yet the commercial cultivation revolves around only a few of them such as Dehra Dun (Shahi), Calcuttia (China), Bombai, Purbi, Rose Scented and Seedless Late (Late Bedana, Bedana). Litchi trees produce 3 types of flowers, viz. staminate, functionally female and functionally male. Out of these, only functionally female flowers produce fruits. Other 2 types do not produce fruits. There is a lot of variation in the occurrence of functionally female flowers in different varieties (Table 3). This range varies from 20 to 49%. Therefore, to ensure high fruit set and heavy yield varieties with a high percentage of functionally female flowers like Calcuttia, Seedless No2, and Early Large Red should be encouraged to be multiplied and planted to obtain high yields.

Table 3. Percentage of functionally female flowers in different litchi varieties

Variety	Functionally female flowers (%)	Reference
Early Large Red	30.8	Chaturvedi (1965)
Dehra Dun	19.8	Chadha and Rajput (1969)
Muzaffarpur	29.2	Chadha and Rajput (1969)
Calcuttia	48.7	Chadha and Rajput (1969)
Seedless No.1	27.3	Chadha and Rajput (1969)
Seedless No2.	38.2	Chadha and Rajput (1969)
Purbi	21.75	Hoda and Syamal (1975)
Range	19.8-48.7	

Promising exotic varieties: Improvement of litchi, like any other fruit crop, is a continuous work. Apart from indigenous superior genotypes, some promising exotic genotypes should also be introduced and evaluated to enrich the existing germplasm. Some of the suitable varieties having wide adaptability - as tested in China and Australia are briefly detailed below along with their salient features.

Fay Zee Siu: An early-maturing, large fruited (30 g), it provides excellent quality fruits with 96% shrivelled seeds.

Feizixiao: Early-maturing, stable yield, large-fruited (up to 60 g), seed small, with excellent quality fruit, fruits do not crack in China, trees sensitive to Ca deficiency.

Fengli: A highly productive Chinese variety, it yields 11.6 kg fruits from a 4-year old trees.

Kwai May Pink: A promising mid to late season variety, its fruits weigh 22 g each, yielding 72% flesh, good flavour and 15-40% shrivelled seeds.

Kwai May Red: A promising mid to late season variety, its fruits weigh 18 g each, yielding 72% flesh of excellent quality, sweet, aromatic, 40-60% shrivelled seed. It is suitable for export.

Liquili: Precocious, yields 8-10 kg fruits after 3 years. Fruits mature in early August in China. Average fruit weight is 16-21 g and TSS 15-18%. It is known for high production and yield stability, lateness and wide adaptability to adverse environmental conditions.

Songmei 5: Fruits are large, 39-50 each, and strongly aromatic.

Songmei 12: A dwarf variety, 7 year-old trees are 35% smaller than standard Noumizi.

Ziniangxi: A seedling selection with 39-60 g fruit size. Rated as very good.

Production Technologies

High productivity is a function of superior genotypes, uniform planting stand at optimum density, judicious fertilization and irrigation supported by adequate plant-protection practices.

High Grade Planting Material

The contribution of high grade planting material in increasing productivity needs no emphasis in litchi. Plant must be healthy and vigorous at planting. Plants propagated from diseased, old and exhausted mother tree, never develop into good nursery plants. To catch attention of prospective growers, some unscruplous nurserymen use branches of old trees in the air-layering process. Such branches root readily and the plants so raised look big. But when such plants are transplanted in the orchard, they do not make good start and many of them die in the establishment process. The resulting gaps are filled up by the farmers year after year and finally it results in an orchard with plants having a range in vigour rather than all plants having uniform vigour. Farmers achieve all this at a high cost.

Preferably, nursery stock should be raised from true-to-type, healthy and vigorous young mother trees planted in separate block and used exclusively for propagation work. Such trees, when they lose vigour due to continuous use for a number of years, should be invigorated by pruning practice. 'Goottees' should be made from vigorous 1-2 years old branches which do not bear fruits in the preceding fruiting season.

Sometimes grafted trees are recommended to be used for planting new orchards because of their easy establishment and better growth than the layered plants. But after 4-years of field life growth differences are eliminated Between the two kinds of plants and 10-year-old marcotted trees give higher yield than grafted trees in South Africa (Bolt and Joubert, 1980)

Planting Density

Other factors remaining constant, total yield per unit area depends largely on number of trees planted. Litchi can be planted by square, quincunx, hexagonal or rectangular methods. The planting distance varies from 8 m x 8 m to 10m x 10m depending upon variety, which could accommodate 100 trees/ha respectively. Planting densities are higher in some other countries. Most of the litchi orchards in subtropical South Africa are planted at 5m x 5m to 7m x 7m without any tree manipulations (Roe, 1993). In Israel, current practice is to plant litchi in a rectangular system at 10m x 5m, accommodating 200 trees/ha. Plant population has been further increased to 400 trees/ha and by following pruning as a regular orchard practice to control tree size. By doing so yield up to 10 tonnes/ha has been reported

from 10-year-old trees of Mauritius and Flordian cultivars (Goren and Gazit, 1993). We must also try shorter planting distances along with pruning to control tree size and increase productivity.

Age of Trees at Planting

Commonly one-year-old trees are used to plant litchi orchards. Since such trees have limited volume of roots, they do not stand transplanting shock well and many of them die soon after transplanting or in the following winter and summer seasons. To overcome this problem and to ensure uniform stand of trees, 2-3 years old plants should be planted with-bigger earthballs during September-October when weather cools down sufficiently. Proper balance between root system and leaves on these plants should be ensured by judicious pruning, if required.

Protection of Young Trees Against Frost and Hot Winds

Young litchi plants are quite sensitive to low and freezing temperatures during winter and high temperatures during summer. While in winter temperature falls down quite frequently to freezing level, it rises to about 43°-44° C during May and June. Both of these extremes are injurious to litchi plants and they must be protected by either growing a protective crop of *pigeon pea (Cajanus cajan* L), or *dhaincha* (*Sesbania* sp.) around them up to 3-4 years. The plants of these crops grow quickly to provide protection to young trees against hot sun and desiccating winds during summer. In winter, tops of these plants are brought together and tied at the top to form a cone. A window may be created on south-eastern side to facilitate the entry of sunlight.

Manuring and Fertilization

According to Singh and Singh (1954) one tonne of fresh litchi fruits removes 2.2 kg N, 2.2 kg P_2O_5, 6.6 kg K_2O, 1.6 kg CaO and 1.1 kg MgO from the soil. Thus 8.0 tonnes of fresh fruits remove from one hectare of land 17.6 kg each of N and P_2O_5, 52.8 kg K_2O, 12.8 kg CaO and 8.8 kg MgO (Table 4). It is quite evident that nutrient needs are quite high and if these are not applied regularly, the growth and fruit yields are likely to suffer in the long run. Studies by Menzel *et al* (1988) have quite aptly demonstrated that not only should be nutrient needs be satisfied fully, but there must also be in sufficient quantities throughout the period of fruit growth and development. All fertilizers should be applied well before fruit set to build up the reserves for flowering and fruiting. But the fertilizer applications differ from this recommendation in many parts of India. Every litchi-growing state in India

Table 4. Nutrient removal by litchi fruit

Nutrient	Quantity removed (kg)	
	One tonne fresh fruits	Eight tonnes fresh fruits
N	2.2	17.6
P_2O_5	2.2	17.6
K_2O	6.6	52.8
CaO	1.6	12.8
MgO	1.1	8.8

Source: Singh and Singh (1954)

has a package of fertilization schedule for litchi trees which has been developed out of the experience of farmers and extension workers (Table 5). Till the time research based recommendations become available, these recommendations should be followed meticulously. It is always better to apply some fertilizers than applying no fertilizer. Apart from N,P,K usefulness of zinc sulphate applications (0.5-

Table 5. Recommended fertilizer doses for 10-year-old tree in selected states of India and some foreign countries

State/ country	Dose (g/tree)			
	N	P_2O_5	K_2O	FYM(kg/tree)
West Bengal	500	750	750	80
Uttar Pradesh	1000	500	500	-
Punjab	736	360	360	60
Jammu and Kashmir	800	130	165	50
Haryana	900	350	350	60
Himachal Pradesh	900	350	350	60
Bihar:				
Bhagalpur	200	320	500	40-60*
Muzaffarpur	210	420/160	500	--
Ranchi	210	160	500	--
South Africa	1120	160	600	--
Australia	552	192	90-120	--

Source: Tandan, H.L.S. (1987)

1.5%) and borax (0.5%) has been reported particularly to reduce fruit drop (Hoda *et al* 1973; Awasthi *et al* 1975; Pujari and Syamal, 1977). Planned studies running over a number of years are quite few. Some work on Calcuttia Late from Gurdaspur in Punjab is reported here. Sharma and Mahajan (1997) reported the results of 20 fertilizer trials involving N, P and K. Maximum average tree height (4.37 m), stem girth (56.1 cm), yield (42 kg/tree) and fruit weight (20.5 g) were recorded from trees fertilized with 1.0 kg N + 0.5 kg P_2O_5 + 0.5 kg K_2O.

Leaf Analysis Standards

Since leaf is the principal site of metabolic activity in the plant and changes occurring in this leaf metabolic activity are reflected in plant performance, emphasis is now placed to adopt leaf analysis as a tool to assess nutrient needs of fruit plants including litchi. Preliminary studies have been conducted in India on the age, position and number of leaves to be collected for diagnostic work but acceptable recommendations have not come through. There is lot of variation in this regard from region to region. However, these standards have been worked out in Israel and Australia where they are adopted for managing litchi (Table 6).

Table 6. Adequate nutrient ranges in the leaves of bearing litchi trees.

Element	Israel	Australia
N	1.5-1.7%	1.46-1.94%
P	0.15-0.30%	0.10-0.18%
K	0.70-0.80%	0.36-1.11%
Ca	2.00-2.30%	0.41-0.96%
Mg	0.35-0.45%	0.25-0.66%
Fe	40-70 ppm	37-153 ppm
Mn	40-80 ppm	177-425 ppm
Zn	12-16 ppm	1-21 ppm
B	45-75 ppm	16-50 ppm
Cu		10-25 ppm

Sources : Kadman and Slor (1982), Menzel *et al.* (1984)

Irrigation

In China, where annual rainfall ranges between 1,250 and 1,550 mm, litchi cultivation is done without irrigation. But such conditions do not exist in India. In north India, where litchi is mainly cultivated annual rainfall is about 750 mm and most of it falls from July to September when litchi crop is over. In north and north-western India, conditions of high temperature, low humidity and high speed winds occur during the period of flowering, fruit growth and development between April and June-end. This is also the period of high evapatranspiration demand. Therefore, litchi requires abundant moisuture during this period both in the bearing as well as young non-bearing trees. The only time of less water requirement is the period before flowering when relatively dry conditions are required to restrict vegetative growth to encourage floral initiation. Excessive moisture supply during flowering may reduce fruit setting. Too high or too low moisture conditions during fruit development and maturation may cause skin cracking.

Apply water when 30-45% of the available soil moisture has been depleted in the root zone (Abbu Hassan and Chatopadhyay (1990). This treatment gives highest yield. When irrigation is applied at 60% available soil moisture depletion, yield decreases by 40-44% compared to wetter treatments. Moisture needs of litchi trees are more critical between fruit set and fruit maturity. Moisture shortage during this period, which extends for 16-17 weeks in north India, leads to excessive fruit drop, low yield, poor fruit quality and excessive fruit cracking and sun-burn.

Fruit Drop

Litchi trees suffer a heavy fruit drop between fruit set and maturity so that only a small proportion of it (2-18%) is carried to maturity in different cultivars (Table 7). The quantum of fruit drop varies with variety and season (Kanwar and Kahlon, 1985) and tree age. The younger tree suffers less drop

Table 7. Fruit drop in different litchi cultivars

Cultivar	Fruit drop (%)	Reference
Dehra Dun	83.46	Singh and Dhillon(1981)
Muzaffarpur	96.12	Singh and Dhillon(1981)
Calcuttia	93.55	Singh and Dhillon(1981)
Calcuttia	60.0	Sharma and Roy (1987)
Rose Scented	96.00	Singh and Dhillon (1981)
Seedless Early	97.54	Singh and Dhillon (1981)
Seedless Early	54.45	Singh and Lal (1980)
Seedless Late	84.25	Singh and Dhillon (1981)
Seedless No.1	92.55	Singh and Dhillon (1981)
Seedless No.1	96.40	Chadha and Rajput (1969)
Seedless No.2	98.00	Chadha and Rajput (1969)
Seedless No.2	97.73	Singh and Dhillon (1981)
Purbi	97.0	Sharma and Roy (1987)

than older trees (Misra *et al.* 1973). Fruit drop control recommendations differ with states and varieties. They are given in Table 8.

Table 8. Control of fruit drop in litchi

Cultivar	State	Best treatment	Time of application	Reference
Dehra Dun	Uttar Pradesh Punjab Himchal Pradesh	NAA: 35-100 ppm 2,4,5-T 30-35 mm NAA: 20 ppm 0.5 to 1.5 percent zinc sulphate	April 1-16 March 30, May. 6	Prasad and Jauhari (1963) Misra *et al* (1973) Awasthi *et al* (1975)
Purbi	Purbi Bihar 0.5% borax	1.5% zinc sulphate + NAA 10 ppm 2,4,5-T, 25 ppm and	Zinc sulphate in mid February and NAA on March 30, April 6 and 13	Hoda *et al* (1973) Pujari and Syamal (1977)
Calcuttia	Uttar Pradesh	2,4-D:2ppm	First fortnight of April at 50-100% flower opening	Singh and Lal (1980)
Rose Scented	Uttar Pradesh	NAA: 20 ppm GA_3: 100 ppm 2,4,5-T:10 ppm CCC: 250 ppm Alar: 250 ppm	April 10-16	Khan *et al* (1976)
Bombai	West Bengal	NAA: ppm	Second week of March	Ghosh *et al* (1987)

Irregular Bearing

For sustaining commercial cultivation of litchi in India and elsewhere, varieties chosen for planting must be regular in bearing, apart from other desirable characters like heavy yield, intense red colour of skin, high fruit quality, long shelf-life at ambient conditions and good transportation and storage characteristics. In India, litchi industry depends largely on Shahi, Dehra Dun, China (Calcuttia), Purbi, Bombai and Rose Scented varities. While Dehra Dun is a regular-bearing, Calcuttia, Seedless Late and Rose Scented are irregular bearers. Usually a heavy crop is followed by a light crop in latter varieties; while in former production is quite consistent. Irregular bearing is a serious problem in other litchi-growing areas like Israel, South Africa, Hawaii, Australia and Florida. Kanwar and Nijjar (1985) were the first to demonstrate that flushing habit of litchi varieties was closely connected with irregular bearing (Table 9). The data show that capacity of litchi shoots to bear is varietal in nature. While non-

Table 9. Growth and fruiting behaviour of bearing and non-bearing terminals in litchi in subsequent year

Cultivar	Type of Terminal	Terminals (%) which grew				Fruitful shoots in subsequent year (%)
		Once	Twice	Thrice	Four times	
Dehra Dun	Non-bearing	100.0 (Feb)*	100.0	Nil	Nil	95.0
	Bearing	100.0 (July)	Nil (Sept.)	Nil	Nil	65.0
Calcuttia	Non-bearing	100.0 (Feb.)	65.0 (July)	35.0 (Sept.)	Nil	70.0
Seedless Late	Non-bearing	100.0 (Feb.)	100.0 (July)	10.0 (Sept.)	90.0	
Bearing	100.0 Bearing (July)	90.0 100.0 (Sept.)	Nil 65.0 (Dec.)	Nil 100.0	10.0 Nil	--

*Months in brackets indicate time when new growth flush appeared.

Source: Kanwar and Nijjar (1985).

bearing terminals of current year are more productive (70-95%) in the next year, it was 65% in Dehra Dun compared with Calcuttia (10%) and Seedless Late (25%). Individual shoot records in Calcuttia and Seedless Late show that floriferous condition of shoots is determined largely by presence or absence of crop in previous year, rather than by how many times a shoot grow vegetatively before its differentiation into a floriferous condition.

Sun-burning and Cracking in Litchi

These disorders are a serious handicaps in litchi-producing areas throughout India, Pakistan, China, Australia and Israel. In India, damage due to sun-burning occurs up to 0.9-19.13% and from cracking up to 20.74% in different varieties. The collective damage ranges from 2.39 to 36.96% to in different varieties (Table 10). Apart from environmental factors, varietal, hormonal, nutritional and soil moisture factors are associated with these disorders. Irrigation at 20-40% depletion of available

Table 10. Varietal variation in extent of sun-burning and cracking of litchi fruits

Cultivar	Sun burnt (%)	Cracked (%)	Total damage (%)
Muzaffarpur	16.22	20.74	36.96
Dehra Dun	17.15	16.04	33.19
Calcuttia Late	4.46	8.42	12.88
Seedless Early	6.67	6.35	13.02
Seedless Late	12.24	5.56	17.80
Bedana	0.90	0.69	1.89
Bombai	2.33	1.06	2.39
Deshi	15.52	11.55	27.07
Early Large Red	19.13	10.29	29.42
Elachi	7.83	1.68	9.51
McLean	3.88	0.97	4.85
Muzaffarpur	5.27	6.86	12.13
Nafarpal	5.59	3.12	8.71
Range	0.90-19.13	0.69-20.74	2.39-36.96

soil moisture is quite helpful in reducing cracking of fruits (Chandel and Sharma, 1992). Kanwar and Nijjar (1975) recommended 2 irrigations per week between April to June-end to control these disorders at Gurdaspur in Punjab.

Plant -Protection Technology

About 40-50 insect and mite pests cause damage to litchi trees (Hameed *et al*, 1992) and if they are not managed in time, some of them can ruin well-established orchards. Some of them like mites may become so endemic that even the best level of management may find difficult to eradicate them. The most widespread litchi pests in the world are listed in Table 11.

Table 11. Most widespread litchi pests

Pest	Control measures
Aceria (Eriophyes) litchi (mite)	Chemical spray
Lyramorpha rosea (*Tessaratoma* spp. (pentatonid plant bug)	Idem
Various species of fruit fly	Idem
Various species of beetle	Idem
Crystophlebia spp. (fruit-borer)	Idem
Epiphyas postvittana (leaf-eating catterpillar)	Idem
Deodorix epijarbas (fruit-borer)	Idem
Various birds	Non-chemical
	rather difficult
Fruit-eating bats	Idem
Caphaleuros virescens (alga)	Chemical spray

Of these pests, litchi mite, species of fruit fly, fruit-borer and leaf-eating caterpillar are more important. Their control measures are available and they must be followed vigorously to save trees and fruits.

Mites: Preventive control measures are always better than to allow a build-up of the pest in the orchard and then to control it. Layered plants should be dipped in a mixture of 50 ml dimethoate and 50 ml of a moistening agent dissolved in 50 litres of water when they are sold from the nursery. Older infested trees in orchard should be treated before flushing with 0.05% dimethoate either alone or in combination with 0.12% dicofol. Repeat spray two weeks and montly thereafter until the new growth is free of all symptoms of infestation. Wettable sulphur (100 g/20 litres water) is also recommended after harvesting once or twice in winter.

Fruit- borers

Cryptophlebia ombrodelta, C. carpophaga, Argyroploce illepida, A.peltastica, Canopomorpha cremerelle, Blastobasis sp. and *Gatesclarkeana erotias* are serious pests on litchi plants, causing losses up to 60-95% (Khangura *et al.* 1992). *Blastobasis* sp. is a serious pest in Punjab and it can be controlled by spraying of 0.025% Sumicidin 20 EC at fruit-setting stage (two time) followed by another spray after 20 days. Thiodan 35 EC @ 0.05% is also effective. *Gatesclarkeana erotias* can be controlled with 3 sprays of 50 g a.i/ha of fenvelrate and 500 g a.i. of quinalphos starting from fruit set at 15 days interval.

Fruit flies

Fruit fly damage does not seem to have been recorded in India. However, it is widespread in South Africa. Use of eco-friendly calico bags is recommended for its control.

Leaf-eating Catterpillars

This insect can become serious during July-August when new shoots emerge after harvesting. If this growth is damaged, next season's crop is likely to be reduced because, all litchi varieties are affected by this pest. A single application of 0.02% quinalphos eradicates its larvae from shoots within 2 weeks of treatment (Mann and Singh, 1984).

DEVELOPMENT OF POST-HARVEST HANDLING PRACTICES

Preservation of skin colour

The litchi fruit is non-climacteric and cannot be picked early to ripen off the tree like mango and banana and when it ripens on tree, picking cannot be delayed. For these reasons when the fruit is harvested, it has to be consumed/used within the next few days otherwise it deteriorates in quality and loss of skin colour is the first victim. Colour is an important quality parameter which is closely associated with maturity and eating quality and its loss results in the market value of fruits. Loss of moisture from litchi fruit skin and colour are closely linked. It is common practice to maintain freshness of litchi fruits during transport by some kind of cushioning material along with packing material (Moreuil, 1973). The browning of litchi fruits is perhaps due to anthocyanin degradation, brought about by polyphenol oxidase and hydrogen peroxide enzymes synthesized under conditions of high temperatures (Underhill and Critchley, 1993). The degree of tissue browning is proportional to rate of pericarp desiccation (Underhill and Critechley, 1994).

The treatments which usually maintained the hydration of cells of fruit skin are also useful in maintaining the fruit skin colour. Peel browning is prevented by packing the fruits in small punnets and over-wrapping them with a cling plastic film (Bain *et al.*, 1982). Dipping fruits in low pH solutioins (particularly HCl at pH 0.3 or 0.5) prior to storage at 22°C, retains their red colour and does not develop browning upto 6 weeks and low pH treatment does not have adverse effect on fruit quality (Zuberman *et al*, 1990). The low pH treatment could replace fumigation with SO_2 as a method for preventing browning in litchi after harvesting. But Fuchs *et al* (1993) suggested that SO_2 treatment significantly increases permeability of plasma membrane, enabling penetration of the acid dip to cell vacuoles where anthocyanins are located. Underhill *et al* (1992) reported that fumigation of litchi fruits with 1.2% SO_2 inhibited polyphenol oxidse activity. This treatment also causes a rapid bleaching of pericarp due to formation of a colourless anthocyanin. Acidification of fruits with 1 N HCl results in an immediate improvement of pericarp colour of SO_2 treated fruits of Tai So (Mauritius).

Acidification is suggested to reverse the bleaching effect by promoting SO_2 dissociation from pigment complex. They also proposed increased pigment stability caused by acid-induced structural charges and possible Cl-ion inhibition of PPO (polyphenol oxidase) may also contribute to colour development. Acidification does not reduce eating quality of fruits. Treatment of fruits of Mauritius and Chennai cultivars with 6.0% solution of sodium-metabisulphite for 10 minutes, followed by a dip in 4.0% hydrochloric acid for 2 or 5 minutes or 10.0% acetic acid for 5 minutes or vinegar for 5 minutes increases their storage life for 28 days at 1°C, followed by 3 days at 20°C. Sodium metabisulphite treatment results are comparable to sulphur dioxide treatment in both cultivars (Duvenhage, 1994). Pericarp colour retention of litchi fruits can also be extended by a combination of vapour heat and low pH treatment followed by cold storage at 1.0°C up to 28 days (Kaiser *et al.*, 1995) Jiang and Fu (1998)

were also able to control pericarp browning of Huaizhi fruits by dipping them in 10 m.mol glutathion/ litre+100 m.mol citric acid/litre for 5 minutes within 3 hours of harvesting followed by air drying and packing in polythene bags (20 fruits/bag) and finally storing for 6 days without loss of colour or quality.

Packaging practices

Pre-cooling: Litchi fruits, after harvesting, may be cooled immediately to remove their field heat. It is very important to extend their shelf- life. It can be done by air cooling, hydrocooling or vaccum cooling. Freshly harvested fruits when cooled rapidly and maintain at -25°C for 12 months remain in excellent condition.

Packaging: For the maintenance of freshness, quality and freedom from decay etc. proper packaging of fruits is a prerequisite. A good package ensures looseness of fruits and free circulation of air. Different types of containers like wooden boxes, bamboo baskets, jute bags and corrugated fibre boxes (CFB) are quite popular these days. Corrugated fibre boxes (CFB) have advantages of light weight, less damage to fruits, ease in handling and printing, attractiveness of the product, reduced freight cost, high quality retention of fruits during transport and suitability for export market etc. Leaves of litchi or *shisham* (*Dalbergia sissoo*) or paper clippings are often used as lining materials in the packaging boxes. Packaging can be done in bunches or as single fruit. But Thompson (1954) observed that single fruit packing was superior than cluster packing. Although, internationally, cluster packaging and single fruit packaging are both acceptable, the later method appears easy in handling the fruits during marketing process. In Australia, litchi is packed mostly in volume filled bulk packing. The packings used are detailed in Table 12.

Table 12. Bulk packages used for litchi in Australia

Package	Material	Internal base diameter	Palletization	Fruit weight(kg)
AUF litre**	Fibre board	380 x 285 mm	12/layer	4.5-5.0
12 punnet package	Fibre board	470 x 360 mm	Not suitable	5.0
Standard tray pack	Fibre board	485 x 325 ± 5mm	8/layer	4.5/5.0
Fragile styrobox	Polystyrene	470 x 350 mm	8/layer	4x1.04x1.5

Source: Ledger (1986)
**: Recommended

Cold Storage

The ambient conditions at the time of harvesting in India are not conducive to longer storage. The storage life of fruits at room temperature is not more than 3 days. This necessitates the storage of fruits in cold storage to increase their shelf- life and to spread the marketing period. Storge period varies considerably depending on maturity level of fruits, time gap between harvesting and storing, storge temperature, relative humidity, pre-storage and pre-harvesting treatment to fruits and materials and method of packing etc. Under ambient conditions shelf -life of fruits could be increased up to 6 days by coating them with 6 and 9% wax emulsion containing 0.5% SOPP (sodium ortho-phenylphenate) and storing them at 30-35°C and 59-60% relative humidity (Garg and Ram, 1972). Tongdee *et al.* (1982) dipped litchi fruits in benomyl, packed them in clear plastic punnets, covered with polyvenyl chloride film and held them in glass jars at 20°C. Such fruits maintain their freshness for 11 days with about 3% weight loss.

The cold stored fruits show longer shelf- life but major problem in this case is rotting. Various treatments have been developed to increase cold-storage life of fruits. These are given in Table 13.

Table 13. Cold storage treatments to enhance life of litchi fruit

Variety	Pre-storage treatment	Storage Temperature (°C)	Relative humidity (%)	Storage duration (days)	Reference
-	-	0-7.2	-	90	Shukla(1964)
Muzaffarpur	Wire netting boxes	1.1-3.3	80-85	30	Choudhury and Banerjee (1959)
	8 minute dip in 5% thiourea solution+ venyl bags	8.0	-	60	Chang (1969)
	Benomyl+plastic punnets+ polyvenyl chloride film	5.0	--	40	Tongdee *et al.* (1982)
Wai Chee	0.1% benomyl at 52°C for 2 minutes or Prochloraz at 0.055% for 30 seconds + packing in plastic punnets, over wrapped with a film	5.0	--	15	Wong *et al.* (1990)
Wai Chee Tai So Kwai May Pink	0.1 benomyl for 1-3 minutes at 48°C and 1-2 minutes at 50°C	5.0	-	15	Wong *et al.* (1991)
Dehra Dun	Two minutes dipping in 125, 500 or 1000 ppm Bavistin +perforated polythene bags containing quarter size Dual Release (DR), sulphur dioxide generator+cardboard boxes	0.0-3.0	-	14	Sandhu and Randhawa, (1992)
Calcuttia	Two minutes dipping in 2000 ppm Bavistin + DR sulphurdioxide generator +perforated polythene bags+ cardboard boxes	0.0-3.0	-	14	Sandu and Randhawa, (1992)
Seedless Late	Dipping in 2% sodium hypochlorite for 2 minutes + DR Sulphur dioxide generator	0.0-3.-	-	19	Sandu and Randhawa, (1992)
Dehra Dun	Wrapping in perforated polybags+packing in wooden boxes	0.0-2.0	85-95	10	Mahajan (1997)

Export Strategies

Litchi fruit is quite popular in most Asian countries and significant quantities are traded in each season. It is quite popular in the Gulf and European countries as well as in America. India produces the largest quantity (3,64,610 tonnes) of litchi in the world but most of it is marketed locally in fresh form. A recent study conducted by National Council of Applied Economic Research (NCARE) under the aegis of APEDA shows that litchi is export competitive in international market (Ghosh 1995).

For economical marketing of litchi in the international market farmers/traders must know about major competing nations and their seasons of production. These information are given in Table 14. It is quite apparent that India faces competition for marketing fruits in the international market from

- *Table 14. Litchi marketing season in northern and southern hemispheres*

Marketing season	Producing countries
May to July	China, Taiwan, India, Thialand, Israel, Pakistan, Vietnam, Indonesia, Philippines, USA (Florida), Kenya, Honduras, Martinique, Ivory Coast, Jamaica.
December to late January	Madagaskar, Mauritius, Reunion, Zimbabwe, Brazil, Australia, New Zealand and South Africa

China, Taiwan, Thailand and vietnam where production is substantial (Table 1). In fact, they are already in the international litchi market.

It must be remembered that Hong Kong and Singapore, where litchi market in well established, are highly competitive and have very high standard for imported produce. Only large, highly coloured litchis with small seeds and firm flesh are preferred by consumers. In 1983, Hong Kong imported 7,500 tonnes of litchi of which 80% came from China and remaining from Taiwan. Most of this requirement is received between June and July. Singapur imported 4,400 tonnes with 90% coming from China and 10.0% from Taiwan. Prices ranges between 1 and 11 Australian dollars a kg depending upon cultivar, fruit quality and time of supply. The comparative physico-chemical characteristics of major litchi varieties in world are given in Table 15. The data show that in China the major shift is toward developing large-fruited varieties to meet the international market demand. The UK, France and Federal

Table 15. Physico-chemical characteristics of Indian and exotic litchi varieties

Variety	Fruit yield (kg/tree)	Fruit weight	Flesh (%)	TSS(%)	Acidity (g)	Period of Fruit Maturity
Dehra Dun, Muzaffarpur, Calcuttia, Seedless Late, Rose Scented, Bombai	90-130	15.2-27.0	62-79	16.5-21.0	0.32-0.76	End of May to end of June
Groff, Brewster, No Maichee, Tai So, Hoak Yip, Kwai May Red, Salathiel, Kwai May Pink	--	12.0-24.0	70-84	--	--	--
Fay Zee Siu, Feizixiao, Sougmei-5, Ziniangxi	--	30.0-60.0	--	--	--	--

Republic of Gennany import about 10,000 - 12,000 tonnes of fruits, mainly from Madagascar and South Africa where harvesting season extends from November to March but peak supply period is from December to late-January. These countries can be a ready market for Indian litchis from May to July. The prices in Europe range from 4 to 10 Australian dollars/kg (Menzel *et al.*, 1993). Markets in Australia, New Zealand, South Africa can also be explored by Indian producers.

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STRATEGIES FOR DEVELOPMENT OF MANGO

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India produced 12 million tonnes of mangoes in 1999 according to FAO estimate (2001). However, ever-growing population (about 103 crore) of our country makes per capita availability of mango quite insufficient. The fast-vanishing seedling trees from rural scene making sucking type mangoes scarce and contractual auctioning system of commercial orchards resulting in the soaring prices of improved varieties in the market leave a chunk of rural population beyond the reach of mango even during the season of bumper harvesting. The proper development of mango industry depends on sound and dynamic research base, transfer of technology to end-user at right time and creation of efficient transport and marketing facilities. Thus, keeping in view the target of making healthy growth of mango industry with bounty harvest for fresh consumption and processing into various products both for domestic as well as export markets, commercial viability of orchards and availability of quality mangoes in plenty within the reach of the poorest of the poor, it is high time to adopt proper strategies for overall development of mango in India to increase and sustain production and productivity, take advantage of value-addition and minimize pre-and post-harvest losses for ushering into prosperity through mango industry.

R&D STRATEGIES FOR MANGO

While the research strategies should apply bottom-up approach, the technology transfer and developmental activities need to percolate from top to bottom with full participation of Government and NGOs, extension and developmental agencies, financial institutions, traders, consumers and growers. The major strategies are :

Enriching germplasm by introduction and collection of cultivars, superior clones of commercial cultivars, cultivable seedling elite types, wild types and Mangifera species and their evaluation, characterization,registration, utilization and conservation for posterity .

Diversification of Mango

Mango has as many as around 1,595 cultivars of different shapes, sizes, colours, tastes, maturity periods and uses, growing in several countries from foothills to the sea-shore. In India, a large number of un-named sucking types are also available, some of them have delicious taste and flavour. Such types are totally neglected and uncared for. Mango orchard should include more than one variety, preferably of diversified use. To create variability for effective selection and protect orchard from wind and vagaries of weather, it is advisable to grow seedling trees on border lines of the orchard. The commercial cultivars are characteristically specific in location and use (Tables 1 and 2).

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Table 1. Mango cultivars grown in different regions of India

Region	Commercial cultivars	Promising cultivars
North	Dashehari, Langra, Samarbehist Chowsa, Bombay Green, Ramkela, Lucknow Safeda	Amrapali, Mallika
South	Neelum, Bangalora, Mulgoa, Banganapalli, Suvernarekha	Arka Aruna, Arka Neelkiran, Arka Anmol, Arka Puneet, Manjira, Au, Rumani
West	Alphonso, Kesar, Pairi, Goa Mankurad, Jamadar, Rajapuri	Ratna, Sindhu
East	Himsagar, Fazri, Zardalu, Kishenbhog, Gulabkhas,Ashwina	Jawahar, Provasankar, Mahmood Bahar,Al-fazali

Table 2. Mango cultivars suitable for processing

Product	Cultivars
Pickles	Ramkela, Pulian, Chandrakaran, Karanjio, Ashwina
Beverage	Amrapali, Gaurjit, Jauhari Safeda, Arka Puneet
Nectar	Dashehari, Amrapali, Saheb Pasand
Pulp	Bangalora
Juice	Sukul
Slice in syrup	Mallika, Dashehari, Banganpalli, Nazuk Pasand, Anderson,
Blending juice	Amrapali, Benazir, Nisar Pasand

Although a number of cultivars such as Elaichi and Bhadauran of India (resistant to malformation), 13-1 of Israel and Kurukan of India (resistant to salt) and Creeping, Malviya Bhog, Naspati, Kerala Dwarf and Mahmooda Vikarabad of India, Brooks of Florida, Julie of Jamaica and Divine of Puerto Rico (dwarf growth habit) are also available, but their proper utilization as rootstock or breeding material has not yet been done. Madoe, of course, is used as a vigorous rootstock in Java. The salt tolerant rootstock 13-1 developed in Israel should be tried in India along with Kurukan for extending mango cultivation to the salt problem soils.

Similarly, Alphonso and Amrapali of India; Irwin, Davis Haden and Zill of Florida and Blanco of Puerto Rico have good shelf-life. Ramkela of Uttar Pradesh and Ashwina of West Bengal and Bangala Desh are ideal cultivars for pickle-making. Alphonso, Dashehari, Alampur Baneshan, Mallika and Nazuk Pasand from India and Anderson of Florida are suitable for canning. Carabao of the Philippines is a suitable cultivar for processing. Puerto Ricon cv. Divine is free from fruit fly. These varieties can be utilized as parents for incorporating their desirable traits in hybrid.

Delicious mangoes of sucking types like Mithwa Ghazipur and other unnamed types, which could have been useful for processing in the form of juice, nectar and mango leather (amawat) and many other types suitable for pickling are fast vanishing in India due to their old age leading to

unproductiveness and tree felling. The collection, characterization, evaluation and utilization of such vulnerable types need greater attention.

Neelum, a regular-bearing cultivar from South India, has more frequently and successfully been used as a parent in mango breeding in India for transmitting its regularity in bearing character to the hybrids. Recently, Amrapali is now being used as a parent for incroporating its regularity in bearing coupled with dwarf tree strature, high TSS content and attractive deep orange pulp colour in hybrid at different centres.

Characterization and Registration of Cultivars

Characterization consists of recording those characters which are highly heritable, can easily be seen by the eye and are expressed in all environments. Some of the useful characters for this purpose are fruit shape, size, shoulder, apex, beak, sinus, peel colour, thickness, lenticells, adherence to pulp, pulp colour, taste, flavour; stone size, shape, veination and fibreness. Molecular biology techniques are useful for taxonomic characterization.

Mango cultivars reported from different places, consists of several synonyms and homonyms thereby creating confusion in cultivars nomenclature. International Registration Authority for Mango Cultivars under operation at the Division of Fruits and Horticultural Technology, IARI, New Delhi, as an organ of the International Society for Horticultural Science Commission for Nomenclature and Registration is to take the work of registering the names of newly-evolved cultivars following the rules of the International Code of Nomenclature for Cultivated Plants. Internatinal Check List of Mango Cultivars consisting chief characteristics of 793 cultivars and a list of 1,595 cultivars with standardized spelling of their names have been published for checking cultivar name.

Evolving/Selecting/Identifying New Cultivars

All commercial mango cultivars arose as chance seedling selections from known mother trees. Mango breeding is a dificult task programme due to long juvenile phase, high level of hetrozygosity, presence of one seed per fruit, heavy fruit drop and polyembryony in some cultivars. The low hybrid population is inadequate for selection and hence not many outstanding hybrids have been obtained. However, in recent years improvement in pollinating techniques and more rapid screening of hybrid populations have enabled release of many hybrid mango cultivars of commercial value. Intervarietal hybridization has resulted in about 20 cultivars, viz. Mahmood Bahar and Provasankar from Sabour; Swarnajehangir; Neeluddin; Neelgoa and Neeleshan from Kodur; Mallika and Amrapali from IARI, New Delhi; Arka Aruna, Arka Puneet, Arka Neelkiran and Arka Anmol from IIHR, Bangalore; Ratna and Sindhu (seedless) from RFRS, Vengurla; Au Rumani and Manjira from FRS, Sangareddy and Neelphanso, Neeleshan Gujarat and Neeleshwari from Paria, Gujarat.

Crop improvement necessitates biotechnological tools. Because of world market demand for mangoes with specific qualities, synthesis of new cultivars has become more imperative. Rapid stride in molecular biology and in other aspect of biotechnology have opened up new approaches in this respect. The recent development of genetic marker for mango and their application to classical breeding offers tremendous potential for mango improvement. The introduction of specific gene for disease and pest resistance into popular cultivars may help in saving crop losses tremendously.

Although genes coding for such horticulturally important traits as tree size, yield and fruit quality are not yet available, biotechnology has the potential to resolve some of the most serious production problems of mango cultivars by incarporating specific horticultural traits in existing cultivars without changing the integrity of clones and cutting juvenile period short tree evaluation. Although genetic

transofrmation of mango with selectable and scorable marker genes is not a limiting factor, very few genes have actually been isolated from mango.

Creating source of healthy scion mother plant for propagation, standardization/adoption of standardized methods of propagation in different locations and making healthy planting material available on a large scale for expanding area under mango cultivation.

Propagation and Rootstock

Currently most mango production areas rely on traditional methods of plant propagation such as by seedage, grafting (inarching, veneer, side, epicotyle, soft wood, cleft or wedge) and budding (shield, forkert, patch).

Mango is commercially propagated by veneer grafting and hanging inarching in north India, soft-wood grafting in eastern India, side grafting in central India and stone grafting in western India. Stooling can also be employed for the multiplication of rootstocks. Micropropagation, which has a tremendous potential for multiplying plants rapidly, has not yet succeeded due to the presence of high amount of phenols. The success in this area is restricted to the somatic embryogenesis only. Tissue culture technique is, however, currently being perfected and investigated for rapid multiplication of elite types.

In mango, non-descript monoembryonic seedlings are used as rootstock for propagation. It is imperative to use clonally propagated standard rootstock instead of non-descript rootstock. Polyembryonic rootstocks are genetically uniform. Some of common polyembryonic varieties tried as rootstocks are Pahutan Olour and Vellaikolumban for inducing dwarfing and Kurkan salt tolerance. These rootstocks are needed to be tried for commercial cultivars in different regions. Salt tolerant rootstock, 13-1, developed in Israel should be tried with different cultivars in salt-affected areas of the country. Some new rootstocks are also to be developed for inducing resistance to insect pests, disease and physiological disorders like black tip, spongy tissue, internal necrosis, fruit drop, gummosis etc.

Optimizing fruit production and productivity by efficient and judicious use of inputs like precious water, valuable nutrients, useful herbicides, eco-friendly pesticides and need-based plant growth regulators in commercial orchards; expanding area in problematic soils through developing selecting suitable cultivars/rootstocks; high-density plantation, and undertaking social plantation in homestead and public places including tribal belts.

Irrigation Aiming at Water-use Efficiency

Tree response to irrigation is influenced by rate, timing and method of application, tree growth stage, climate, and cultivars. Normally non-bearing trees up to 4-5 years of age are irrigated at weekly intervals during summer. In bearing orchards, irrigation should be stopped during winter months coinciding with flower-bud differentiation. In north India, 3-5 irrigations are required starting from February to May depending upon soil type and depth, rainfall and distribution and fertilizer practices. A number of irrigation methods like basin ring, furrow, flood, sprinkler and drip are being employed. To use water judiciously, drip irrigation is making inroads in mango growing. The young mango plants requires 9-12 litres of water/day/ plant, 3-6 years old trees 30-35 litres, 6-10 years old trees 50-60 litres, 9-12 year old trees 80-90 litres, while fully grown trees demand 120 litres of water/day/tree. Young mango trees requires 2 drippers at a distance of 1 m on lateral lines, while fully grown trees require 2 drippers with double lateral lines at 1-1.5 m distance. However, method needs to be standerdized for different types and depths of soil, varieties and season through location-specific trials. The effect of drip system of irrigation on the longevity, productivity, productive life of trees and their anchor to the soil should be investigated in detail.

Nutrition with Special Reference to DRIS

Application of balanced nutrients through addition of organic manure, recycling of organic matter in the field and major and minor mineral elements should find a place in orchard management of mango.

Soil testing as the sole basis for making fertilizer recommendations has limited applicability with fruit trees like mango due to their specific root distribution, perennial habit, rootstock effects and differential fruiting. Soil and leaf analysis should therefore, be complementary. However, leaf analysis is more useful. A considerable amount of research has gone in to the sampling technique. However, due to limitation of critical or balance ratio concepts, DRIS (diagnosis recommendations and integrated system) has been developed to fulfil predictive use of leaf diagnosis. Unlike other approaches, e.g. sufficiency of range method, DRIS is an integral approach that identifies the sufficiency of each nutrient in relation to others in the plant rather than a critical concentration of a specific nutrient. DRIS is used to identify mineral defficiency associated with mango decline in Tommy Atkins and observed that the nutrient imbalance index is higher for trees in orchard with the highest percentage of declined tree than generally healthy orchard. Maganese and iron concentrations are generally low in mango. Phosphorus has the most negative DRIS index. However, its concentration was above the critical value in an orchard with no declined trees. DRIS should be utilized in conjunction with critical value for nutrient concentration.

There is an urgent need to determine the rhizospheric effect of mango trees in priming the nutrients from passive soil pools. The role of mango rootstock with respect to tree nutrient status has not yet been addressed to. The relationship of nutrients applied to soil, their concentration in foliage and yield should be classified. The most common doses of nutrient need to be determined in terms of cost and benefit. The graded doses of nitrogen, phosphorous and potassium should be evaluated.

Vegetative Growth and Reproduction Manipulation

Ultimate mango tree size depends upon the variety, climate and edaphic condition and cultural practices. Mango tree requires new vegetative growth in order to produce fruits each year. The optimum temperature for vegetative growth is 24-30°C.

A cessation of vegetative growth is required to induce transformation from vegetative to reproductive phase. Canopy management and reproductive manipulation practices vary according to cultivars and climatic conditions. With decreasing cultivable land and increasing cost of orchard establishment and maintenance, the number of trees per unit land area has to be increased with smaller tree size. Currently an understanding of mango physiology along with advances in technology have allowed growers to manipulate to determine when flowering occurs.

Regularity in Bearing

Alternate-bearing is a common phenomenon in mango. There exist an antagonism between vegetative and reproductive phases which leads to bienniality in bearing. To manage the problem of alternate bearing steps should be taken to regulate vegetative growth and flowering. The suppression untimely vegetative flushes using growth retardant and reducing the magnitude of antagonism between vegetative and reproductive phases is necessory to help promote concomitant development of new shoots at the time of flowering. Deblossoming of early emerging panicles in north India, promotion of apical or lateral fruit bud differentiation on fruited shoots by use of bio-regulators and retardation of root activity to help suppress vegetative growth are some important operations for flower induction at proper time. The paclobutrazol @ 3.2ml/m canopy diameter applied in soil induces 80-90% flowering in Samarbehist Chowsa and Langra during off year.

High-density Plantation

Amrapali sustained high productivity of quality mangoes yielding 24 tonnes/ha at 21 years of age with annual pruning after harvesting even with the, minimal use of fertilizers and other chemicals in a high-density plantation (1,600 trees/ha) at IARI, New Delhi. On the other hand, a drastic decline in yield (5.52 tonnes) is noticed on unpruned trees due to over-crowding and dense canopy at 12 years of age with this density. Pruning in this case is aimed at containing open tree canopy to the workable height of 4 - 4.5 m from the ground level. Dashehari, which is genetically-biennial bearer, does not respond to pruning for bearing in the same year at IARI, New Delhi. At CISH, Lucknow, pruning of Dashehari by retaining 45cm long shoot from distal-end in December gives maximum yield in the next year and thus helps in rejuvenation of old and unproductive trees with dense canopies. However, cultivar performs well under high-density plantation (1,600 trees/ha) with soil application of paclobutrazol (3.2 - 4.0 ml/m tree canopy diameter) coupled with foliar spray of urea (1%) and annual pruning after harvesting at Pantnagar. Tree paste prepared by mixing sand, Bentonite and cowdung (1:1:1) should essentially be applied on the pruned part to check disease infestation and gummosis.

Protection of mango nursery plants and trees from insect pests, diseases, physiological disorder and weather vagaries using IPM, IDM, physiological manipulation and weather data use.

Malformation: A Menace for Mango

Vegetative and floral malformation occur in mango thereby affecting the growth and yield adversely. Proliferation of shoots with very short internodes and leaves causes the vegetative malformation in small plants in the nursery. Likewise, proliferation of flowers with very short panicle laterals causes floral malformation. These two situations give bunchy-like appearance of affected parts. The malformed panicles contain predominantly male flowers and are thus devoid of fruit set. The causes and control of this disorder/disease are still the subject of investigation. However, removal of early emerging panicles at emergence (1cm length) and application of ethephon, malic hydrazide and gibberellic acid in combination and leaf extract of *Ruellia tuberosa* give encouraging result in controlling floral malformation in different cultivars. Reduction of auxin and increased level of inhibitors are found in the malformed panicles. Increased incidence of floral malformation even in resistant cultivate Bhadauran with the application of Dormex (hydrogen cyanamide) and creating malformatin like appearance with morphactin treatment suggest future line of physiological research in this respect. The association of *Fusarium moniliforme* fungus and mites with this malady presents a scope for work in detail on the causes and control of malformation.

Mango suffers a colossal loss regularly due to malformation and thus it appears to be a serious threat to mango industry. This malady is most destructive in nature because its causes and control are not yet well understood and economic losses faced each year vary between 5 and 30%. The malady has a special significance as there is a restriction on the export of mango sapling from India. Causes which have been suggested for malformation include mites, nutritional problem, physiological or hormonal imbalance and viruses. Many treatments have been suggested for its control including spraying of $CuSO_4$, removal of affected shoot, deblossoming at bud stage (1.0 cm long) alone or in combination with spray of 200ppm NAA during fruit-bud differentiation. Methanol extract of leaf of *Ruellia tuberosa* reduces floral malformation in Dashehari. There is an urgent need to identify effective chemical for deblossoming. The study on role of fungus, mites malformin-like substances, phenol compound, enzymatic activity and phytohormones need to be strengthened. Mango grafts should be supplied after fumigating and treating with fungicide. Bhadauran and Elaichi are reported to be free from this malady.

Integrated Pest Management (IPM)

Due to rapid change in agro-ecosystem, advancement in orchard management practices and indiscriminate use of chemicals, insecticides and pesticides, many of the major insects and pests have developed resistance. This has led orchardist to use high dose of toxic insecticides, thereby causing imbalance in population dynamics of pollinators and other useful fauna and incorporating high toxic residue in the fruits. Therefore, it had become necessary to bring out modern concepts of IPM.

Management of Important Mango Pests

Mango is mainly attacked by mango hopper (*Ameritodus atkinsoni, Idioscopus nitidulus* and *I. clypealis)*, mealy bug (*Drosicha mangiferae)*, stem-borer (*Batocera rufomaculata* and *B rubus)*, shoot-borer (*Chlumetia transversa)*, bark-eating caterpillar (*Indarbela* sp.), leaf- webber *(Orthaga euadrusalis)*, leaf-cutting weevil (*Depraus marginatus)*, shoot-gall maker (*Apsylla cistellata)*, leaf-gall maker (*Procontarinia matteiana*), oriental fruit fly (*Bactrocera dorsalis*), stone weevil (*S.ternochetus mangiferae* and *S. gravis)*, blossom midge (*Erosomyia indica*) and red ants (*Oecophylla smaragdina*).

Mango hopper attacks during flowering season. Nymphs damage more than adults by sucking sap from tender shoots and panicles. The panicles wither away resulting in no fruit set. The honeydew secreted by hoppers enables sooty mould fungi to develop on leaves and panicles. Over-crowding and neglect of orchard results in more severe infestation by hopper. A number of insecticides like monocrotophos (0.054%), quinalphos (0.05%), carbaryl (0.15%), dimethoate (0.06%) and chlorpyriphos (0.04%)as spray at panicle emergence and fruit set stages are effective in controlling this pest. However, lately this pest is reported to have developed resistance to some of these pesticides and therefore, needs further investigation on its control measures through IPM.

The efforts on biological control of insect pests is under progress in India and some encouraging findings have been reported. To cite a few, jumping spiders minimize the losses due to hopper. *Chrysopa* sp. preys on *Amritodus* and *Idioscopus* species of mango hopper. *Verticillium lacanii* fungi attack on hoppers. These can be controlled using predators (spiders), parasite *(Pipunculus* sp.) or biological control or by chemicals. Alcoholic acetone and hexane extracts of neem kernel (2%) are effective and recommended for control of hoppers.

Mealy bug lay eggs under soil clods up to a depth of 5–15cm around tree trunk during May. Female can be identified by their flat shape covered with white mealy powder. Destroying eggs through ploughing is a very effective control measure. The nymphs emerge in December-January and climb the tree by crawling and suck juice from young shoots, panicles and flower pedicels. Banding of tree trunk with alkathene (400 gauge 25 cm wide and tied with string around trunk (30-45cm above ground level) in December to check nymphs from climbing the tree. The nymphs will be collected at lower side of the base of the stem band and may be killed with application of chlorpyriphos dust (1.5%) @ 200-250g tree around tree trunk..

Beauvaria passiana (107 conidia/m) when applied in soil before emergence of first instar for nymphs are also found effective. The mortality of third instar larvae of leaf webber (*Othaga euadrusalis*) was cent per cent within 2 weeks by application of Naturalis-L (4%).

Stem-borer makes tunnel through the main trunk and branches. Its presence can be identified by dry hard balls of excreta on affected part. Clearing tunnels with hard wire, pouring kerosene oil or petrol or Dichlorovos (0.05%) followed by closing the entry of tunnel with mud, control the pest effectively. Shoot-borers caterpillars enter the young shoots from the terminal end and bore down to a depth of 8-10cm causing wilting and drying of shoots. One to two sprays of carbaryl (0.2%) or 0.04% monocrotophos during vegetative flush emergence controls this pest effectively.

Bark-eating caterpillar bores into the bark and makes a tunnel through the stem or the branch. Its presence can be identified by dark brownish ribbon of excreta. This weakens the affected branches and leads to their drying. This pest can be controlled by the measures applied for stem-borer.

Leaf-cutting weevil cuts the newly emerged leaves at the base of lamina. Leaves get defoliated and weakened. The pest can be checked by carbaryl (0.2%) sprays .

Shoot-gall maker is prevalent in tarai region. It lays egg in rows of two on underside of the leaf of new flush along the midrib in March-April. The nymphs on emergence, 5-6 months after egg laying, enter the axillary and terminal buds turning them into hard conical galls through their secretion. Monocrotophos (0.05%) spray during September is effective against this pest.

Leaf-gall maker is characterized by the presence of round and raised galls of various colours on the leaves. The eggs are laid on the underside of the leaf during March, July and October. The maggots, on hatching, bore into the leaf tissues giving rise to galls on the upper surface of the leaf. Monocrotophos (0.04%) sprays during egg-laying period controls this pest.

Fruit fly lay its eggs in clusters of 150-200 under the peel of the fruit just before the ripening. The affected fruits begin to rot and drop down. The hanging bottle of traps [methyl euginol (0.1%) +malathion (0.1%) + 100 ml water] @ 10 traps/ha during April - June check fruit fly effectively. Adults can be controlled by sprays of carbaryl (0.2%) + protein hydrolysate or molasses (0.1%) at preoviposition stage. Vapour heat treatment (VHT) at 52° C temperature is necessary for exporting frits to foreign markets.

Stone or nut weevil affects mostly sweet cultivars. Grubs damage both the pulp and cotyledons. The eggs are laid in partially developed fruits. The grubs travel through the pulp and enter the seed, where these pupate and the adults come out piercing through the stone and pulp. It can be controlled by destroying the adults in the bark crevices and holes during August. Spraying of tree with fenthion (0.01%) during oviposition period is effective in controlling this pest.

MANAGEMENT OF IMPORTANT DISEASES AND DISORDERS

DISEASES

Mango suffers mainly from anthracnose, powdery mildew and stem-end rot (fungal) and bacterial canker diseases. Anthracnose (*Colletotrichum gloecosporioidies*) causes blackish spots on shoots, leaves, panicles and fruits and show its severity during rainy season, when the atmosphere is hot and humid and fruits are in the last stage of maturity. This disease also expresses itself during storage of fruits. The affected young shoots show die-back symptoms. The fungus survives on dried twigs, hence these should be pruned quickly and destroyed. Blitox (0.3%), Bavistin (0.1%) and Phytolan (0.3%) spray controls this disease.

Diseased leaves, twigs and fruit lying on the floor of the orchards must be removed. Pre-harvest spray of Captan (0.3%) at flowering, Zineb (0.2%) or Bordeaux mixture (4:4:50) twice at flowering and 15 days later controls this disease. Powdery mildew (*Oidium mangiferae*) is active under atmospheric condition of high humidity (62.5-64%) accompanied by cloudy weather and maximum (33-35°C) and minimum (11-14°C) temperatures during panicle development and fruit set during third and fourth weak of March. The flowers and fruitlets show the appearance of greyish-white powdery growth. Affected panicles ultimately turn black and die out rapidly. Wettable sulphur (0.2%), Karathane (0.1%), Bavistin (0.1%) and Bayleton (0.05%) are reported effective against this disease.

Mango suffers collosal losses every year due to many disease. The control measures of some important diseases developed at CISH, Lucknow is briefly described.

Punch (0.04%), SUFFA (0.2%) or karathane (o.1%) was found effective in controlling the disease. Three sprays of these fungicides at 15 days interval starting from fourth week of February were found ideal.

Mango bacterial canker disease or bacterial spot (*Xanthomonas campestris pv.mangiferaeindicae*) shows it earliest symptoms as small dark green water-soaked spots on the leaves and fruits which finally assume the shape of raised dark brown to black lesions. Affected fruit area show longitudinal crack and oozing out of bacterial exudate, making fruits unattractive and unmarketable and ultimately fruit drops down from the tree. Streptocycline (100-200ppm), Agrimycin-100 (100ppm) and Copper oxychloride (0.3%) are reported effective against bacterial canker.

Bacillus coagullana (BC) has been found to antagonise this disease 24 hours after inoculation of host bacterium.

Sooty-mould

Black mildew is also known as sooty-mould or sooty blotches. It is very common where honey dew or sugary substances secreting insects, viz. mango hoppers, scales, coccid and mealy bugs are found. The insect must be destroyed in order to control the mould. Spraying of Elosal at 10-15 days intervals proved to be quite effective. Spraying of wettable sulpher + methyl parathion + gum Accacia (0.2% + 0.10% + 0.3%) in Indian oil formulation No.1 and 2 at 15 days interval could control sooty-mould.

Disorders

Black tip

Small etiolated area develops at the distal end of the fruit, which gradually spreads and turns nearly black and covers the tip completely. Smoke emanated from the brick kiln located in the vicinity of 1.6 km is the causal factor for this malady. Borax (1%) and caustic soda (0.8%) control this disorder.

Leaf Scorch

Old leaves show scorching at the tip and margin, a characteristic of potassium deficiency. The affected leaves fall down thereby adversely affecting the health and vigour of the tree. Excess of chloride ion appears to make potassium unavailable to the tree and thus this disorder is more prevalent under saline soil/water logged condition. The potassium fertilizer application should be in the form of potassium sulphate not in the form of muriate of potash under such situation. Foliar application of potassium sulphate (5%) on newly emerged leaves is effective in controlling this disorder. Fallen leaves should be collected and burnt.

Spongy Tissue

'Alphonso' fruits suffer most from this disorder. During ripening, mesocarp of the fruit develops a non-edible, sour, yellowish and sponge-like patch with or without airpockets. External appearance of the fruit looks quite normal and the malady is not visible unless the fruit is cut open. Affected fruits give unpalatable odour. Fruits should be harvested at three-fourth maturity stage since the incidence of this disorder takes place at full maturity. The heat emitted from the soil causes this disorder by disturbing the histological and biochemical processes, resulting in non-hydrolysis of starch and fruit pulp thus remains unripe. Sod culture should therefore, be practised in 'Alphonso' orchard.

Minimiszing post-harvest fruit losses through creating infrastructure and employing scientific management in post-harvest handling and storage of fruits and standardizing cost-effective processing technologies. Diversification of processing units for making various products to avoid glut of fruits in the market and make products available round the year to consumers at a reasonable cost well with in the reach of common people.

Post-harvest Management

Mango fruits harvested with stalk with the help of harvester, show fruits with lesser blemishes and microbial development on fruit surface. Dipping fruits in 10 ppm chlorinated water after harvesting reduces surface microbial load. The techniques of handling, sorting, packaging, storage and value addition have been standardized. These technologies need to be taken to the field and the processing units for their proper utilization. The practice of auctioning orchard interferes with the proper cultural practices, which are left to the choice of contractor. Such auctioning practices need to be changed and proper marketing chains are required to be developed for harvesting the maximum benefit from this industry.

Processing and Export

India dominates the world trade of processed mango products. The total world volume of processed products is not known exactly. However, it is assumed that it does not exceed 180,000 tonnes valued at about US $.73,000,000. It is estimated that barely 1% of total mango production in India is processed and only 0.55% is exported as fresh fruit (Pruthi, 1992). During 1992-93, India exported about 36,000 tonnes of mango products valued at US $ 27,100,000. The major export product is canned mango pulp, which has increased over the past decade by about three times and five times in value.

India has a low profile in quality in the international market in terms of time and space. This is compounded by otherwise inherent strength being eroded by product and marketing choices for example, we lose the potential of our mango base in chooing to market chiefly the Alphonso variety to the near exclusin of other excellent varieties available. Alternatively, costs and price factors act as a constraints as in the case of north Indian varieties of mangoes in respect of which we are displaced in our principal market by Pakistan in the season for Langra, Dashehari and Chausa varieties where we otherwise have quantity and quality strength.

Packaging and Transport

There is a great loss of produce in post-harvest handling and distribution. Manual handling is the order of the day. Where the railway systems have to be used, the wagons are not designed for the purpose. It is difficult to expect refrigerated transportation system in all important mango producing belts. Timber and bamboo have been used in most part of India. But now alternative packaging material such as corrugated card board packages made from Kraft paper have offered themeselves as suitable alternative timber and bamboo. The polythene foam paper is being used for high value mango. Wrapping in tissue pap are quite useful. The mango products need special attention so far as packaging is concerned. For certain products, mangoes must be peeled and sliced, and the lack of mechanized equipment is a major handicap. Expansion of mango industry has therefore, been inhibited. Concerted efforts are therefore, needed to overcome these various constraints to the processing industry.

Export-oriented organic farming for producing mangoes free from any injurious residues

Organic farming with nutrient management through the application of farmyard manures, compost and other organic manure preparations like NADEP, vermicompost, biodynmic compost, cow

pat pit (CPP), vermivash and liquid manure and pests and disease management with biopesticides like liquid pesticides, neem preparation and bio-agents like Trichoderma and Trichograma should find a place in future orcharding for export. Vapour heat treatment (VHT) at 52 ° C is necessary to check the introduction of oriental fruit fly to other countries through export of fruits. Memorandum of Understanding (MOU) has been signed between Govt. of Uttar Pradesh and APEDA to recognize Lucknow area as mango export zone which has a target of exporting 2 lakh tonnes of mangoes worth Rs 135 crores in 5 year time. Many such possibilities exist in other mango-growing states of our country.

Mango export during 1995-96 stood at 21,857 tonnes valued at Rs 37.84 crores. Contract farming may be adopted to make right type of fruits available to processors.

Developing sufficient storage capability and marketing infrastructure with cool chain through cooperative societies or in public sector for fresh fruits and processed products to make it available to consumers for a longer period and remunerative price to growers.

Development of R&D Infrastructure

The research infrastructure in mango is very sound under National Agricultural Research System (NARS); ICAR institutes like IARI, New Delhi; IIHR, Bangalore; CISH, Lucknow and 10 multilocational Centres of All India Coordinated Research Project on Subtropical Fruits and 7 centres of AICRP on Post-Harvest Technology of Horticultural Crops. In addition, SAUs and State Research Stations are also engaged in mango research. The research is focussed on the problems of national and regional importance involving multidisciplinary aspects like management of genetic resources and varietal evaluation, propagation, rootstock, planting distance, pruning, fertilizer trial, effect of paclobutrazol on growth, flowering and fruiting, survey and surveillance of pest complex and their natural enemies, crops loss assessment and bioecology, integrated pest management, epidemiological status of powdery mildew and its chemical control and malformation. Similarly researches on the problems of post-harvest management and processing are undertaken through harvesting, post-harvest handling, storage, ripening, processing of raw and ripe mangoes into various products, packaging of mango and its products, transportation and marketing.

The APEDA (Agricultural and Processed Food Products Export Development Authority), NHB (National Horticultue Board), NCDC (National Cooperative Development Corporation) and NAFED in the public sector and cooperative societies like Mahamango in private sector may play a great role in the post-harvest management of mangoes including marketing in domestic as well as export markets. The network comprising these agencies ought to be strengthened.

Technology transfer to growers' fields and processing units through technology assessment and refinement (TAR), institute village linkage programme (IVLP) and other extension methods.

Technologies Generated and Ready for Transfer to Field/Processing Units

Some of the technologies developed in mango are:

- Amrapali and Mallika, newly-evolved varieties can be taken up for commercial cultivation in north, east and south India.
- Neeleshan, Neeluddin, Neelgoa, Vashibadami and Neeleshwari have been recommended for commercial cultivation in western India especially Gujarat.
- Ratna and Sindhu varieties have been recommended for commercial cultivation in Maharashtra.
- Banglora of south India also shows great potential under north Indian conditions.

- Banglora, Neelum, Mallika, Suvarnarekha, Vanraj and Benishan have been recommended for south Telengana region.
- Dashehari 51, a regular bearing superior clone of Dashehari, has been recommended for growing in Uttar Pradesh.
- Sunderja prfoms very well in Madhya Pradesh.
- Veneer grafting technique is recommended for Madhya Pradesh, Andhra Pradesh, Uttar Pradesh and Bihar and epicotyle grafting for Konkan region of Maharashtra.
- Rejuvenation of old and dense unproductive orchard by pruning/top-working.
- Pruning after harvesting for sustainable high production of Amrapali in high-density plantation.
- High-density planting of Dashehari with regular prunuing after harvesting followed by application of paclobutrazol in tarai region of Uttar Pradesh.
- Use of paclobutrazol (5-10g a.i./m canopy diameter) 3 months before bud-burst applied through soil drenching for obtaining regular bearing.
- Application of 400g N, 200g P_2O_5 and 400g K_2O/ grown up tree of cv. Dashehari (placed in 40 cm deep trench and 2m away from tree trunk) is recommended for north India.
- Rootstock Vellaikolumban is recommended for Alphonso in Bangalore and Maharashtra and Rumani for Dashehari in north India for dwarfing.
- Fabrication of mango harvester, semi- automatic raw mango peeler and motorised raw mango cutter for making pickle.
- Pulp liquefication by adding enzymes without significant changes in nutritional quality and flavour.
- Limgo, a mango and lime based carbonated drink.
- Method of making oil-less pickles.
- Post- harvest losses of fruit from anthracnose and stem-end rot by spraying Topsin-M (0.1%) or Bavistin (0.1%) thrice at 15 days interval before harvesting.
- Delaying ripening of fruits with GA_3 (10-15 ppm) application at marketable stage.
- Storage life, marketability and colour development improves with application of Ca Cl_2 (0.6%) 20 and 10 days before harvesting and pre-transit wrapping of mangoes with HM film. Dipping mangoes in Fruitox (10%) for one minutes delays ripening of fruits.
- CFB boxes with ventilated partitions and wrapping in tissue paper are ideal for packaging and transportation
- Alphonso mangoes can be stored up to 34 days with minimum incidence of spongy tissue (5%) if hydoro-cooled in combination with Bavistin treatment followed by storage at 12 °C with 85% relative humidity.
- Storage rot could be minimized with hot water (50 °C) + 1%) common salt for 5 minutes.

INTEGRATED DEVELOPMENT OF VEGETABLES IN INDIA

U.B. Pandey*

Vegetables occupy an important place in diversification of agriculture, playing a pivotal role in food and nutritional security. India is largely a vegetarian society solely depending on vegetables for bulk of their nutritional requirement. With the green revolution, India has been able to achieve self-sufficiency in food supply quantitatively but qualitatively still much has to be done. Vegetables are very valuable for adding quality component to the food as they are rich source of minerals, vitamins and other nutrients. Increasing vegetable production will promote higher farm income and greater opportunity of rural employment in addition to nutritional security. India bestowed with variable soil and climatic conditions, has an excellent potential for growing both tropical and temperate vegetables.

AREA, PRODUCTION AND PRODUCTIVITY

Since independence, India has emerged as the second largest producer of vegetables in the world with a total production of about 90.83 million tonnes from about 5.9 million ha, contributing more than 2.5% of the total cropped area. China having about 278.59 million tonnes production is largest producer of vegetables. With 2.6% annual growth rate in vegetables, West Bengal, Uttar Pradesh, Bihar, Orissa and Karnataka are leading vegetable producers in India. Potato, brinjal, tomato, cabbage, onion, cauliflower, okra and peas are grown on a large scale in the country. Maharashtra, Gujarat, Karnataka, Uttar Pradesh and Andhra Pradesh are leading states in onion production, whereas West Bengal, Uttar. Pradesh and Bihar are leading potato-producing states. West Bengal, Orissa, Bihar and Assam are leading brinjal-producing states. Area under cabbage has increased rapidly after seed policy came into force in 1998. Area, production and productivity in vegetables have shown an increasing trend from 1991-92 to 1999-2000. The production of vegetable, which was 58.5 million tonnes during 1991-92 has increased to 90.83 million tonnes during 1999-2000. Productivity increase though has resulted in increased production, India's productivity of vegetables still is lower than the world average productivity of about 15.7 tonnes/ha. Experimental yield in vegetables are, however, much higher which means that there is a scope for increasing production of vegetables further.

State-wise area and production of vegetables in India are given in Table 1. Production trends of vegetables have been given in Fig.1. Crop-wise area, production and productivity of major vegetables are given in Table2 and Fig. 2 respectively. Comparative data for production of major vegetable crops including potato for world and India are given in Table 3. Average yields of important vegetable crops in developed countries, developing countries and India are given in Table 4.

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Table 1. State wise area, production and productivity of vegetables in India

State / UT	Area ('000'ha)				Production ('000'tonnes)			
	1991-92	1997-98	1998-99	1999-00	1991-92	1997-98	1998-99	1999-00
Andhra Pradesh	155.2	179.8	249.3	230.1	1452.6	2252.2	3541.2	2839.1
Arunachal Pradesh	17.1	16.7	16.7	16.9	79.9	80.9	80.9	80.9
Assam	222.4	223.8	245.9	255.9	2132.3	2180.2	2834.8	3089.4
Bihar	843.3	603.6	616.6	626.0	8643.1	8266.2	9418.4	9548.8
Delhi	55.0	83.8	45.5	45.7	627.8	329.0	652.0	652.0
Goa	NA	7.5	7.6	7.6	NA	69.4	70.0	70.0
Gujarat	114.6	153.0	189.9	201.0	1667.9	2176.9	3255.0	2647.0
Haryana	60.8	96.8	120.0	135.0	877.0	1290.4	1850.0	2094.5
Himachal Pradesh	38.7	45.8	45.8	40.6	476.0	606.4	606.4	660.9
Jammu & Kashmir	180.3	28.0	41.2	41.4	745.0	395.1	606.9	584.4
Karnataka	351.1.	294.8	309.7	361.6	3673.2	4944.9	4944.9	6796.9
Kerala	202.1	243.9	159.7	159.7	3229.1	2789.5	2857.2	2857.1
Madhya Pradesh	176.4	206.0	234.0	258.7	2221.0	2748.7	3276.2	3632.0
Maharashtra	241.1	276.0	341.2	385.3	4171.3	3317.2	4479.5	4828.6
Manipur	11.8	8.0	8.5	9.0	50.3	53.1	45.0	60.8
Meghalaya	25.9	36.6	36.6	29.2	219.2	308.6	308.7	252.9
Mizoram	6.0	7.0	8.4	8.3	31.8	47.5	62.4	56.3
Nagaland	8.2	20.1	15.1	20.9	66.9	204.2	313.3	235.7
Orissa	710.3	882.7	883.9	788.1	7275.0	9656.6	10087.1	9096.0
Punjab	84.5	120.1	117.1	135.4	1450.0	1634.6	1906.3	2285.0
Rajasthan	62.9	80.2	99.3	98.7	307.0	321.9	396.1	472.6
Sikkim	7.6	12.6	9.4	9.6	46.1	57.6	42.2	43.0
Tamil Nadu	889.3	177.0	206.7	209.1	3796.9	4085.4	5704.8	5660.3
Tripura*	30.3	32.0	18.4	18.4	306.8	358.6	232.8	232.8
Uttar Pradesh(Hills)	57.1	91.3	91.5	81.9	617.6	792.6	840.7	733.2
Uttar Pradesh(Plains)	576.7	638.2	640.7	688.9	9627.3	8623.4	12680.6	13842.4
West Bengal	456.0	1034.3	1100.0	1122.3	4680.0	15016.0	16367.4	17413.8
Andman & Nicobar*	3.4	3.1	3.1	3.1	13.2	15.8	15.8	15.8
Chandigarh	0.3	0.4	0.4	0.1	11.1	11.5	11.5	1.2
Dadra&Nagar Haveli*	1.5	1.5	1.5	1.5	13.6	13.5	13.5	13.5
Daman and Diu*	0.1	0.1	0.1	0.1	0.3	1.0	1.0	1.0
Lakshadweep	0.4	0.2	NA	0.3	0.4	0.7	NA	0.2
Pondicherry	2.3	2.2	2.2	2.6	22.3	33.5	33.5	32.6
Total	**5592.7**	**5607.1**	**5866.0**	**5993.0**	**58532.0**	**72683.1**	**87536.1**	**90830.7**

*: Previous year data.
Source : National Horticulture Board, Gurgaon

Table 2. Crop-wise area, production and productivity of major vegetables in India (1999-2000)

Crop	Area ('000 ha)	Production ('000 tonnes)	Productivity (tonnes/ha)
Brinjal	500.3	8117.2	16.2
Cabbage	258.3	5909.4	22.9
Cauliflower	248.3	4717.8	19.0
Okra	348.8	3419.1	9.8
Onion	493.3	4899.5	9.9
Peas	272.6	2712.0	9.9
Potato	1340.9	25000.1	18.6
Tomato	456.5	7426.8	16.3
Others	2074.0	28628.8	-
TOTAL :	5993.0	90830.7	15.2

Source: National Horticulture Board, Gurgaon

Table 3. Production of major vegetables and tuber crops

Vegetable	Production (tonnes)		% of world	Position of India
	World	India		
Brinjal	17.41	7.77	44.63	I
Cabbage	50.71	5.31	10.48	III
Cauliflower	13.42	4.46	33.20	I
Onion	38.15	3.14	8.23	II
Peas (green)	7.21	2.42	33.58	I
Potato	295.41	17.65	5.90	-
Tomato	88.22	6.22	7.00	-
Others	85.03	25.86	30.41	-
Total	595.56	72.83	12.22	II

Table 4. Average yield of important vegetable crops

Crop	Developed countries (tonnes/ha)	Developing countries (tonnes/ha)	World (tonnes/ha)	India (tonnes/ha)	
				On-farm trials	Coordinated trials
Beans (green)	15.9	6.7	8.2	2.0	7.5
Cabbage	25.2	17.6	21.6	14.3	36.0
Cauliflower	16.8	10.6	13.6	14.2	26.6
Chilli	15.1	13.9	14.5	6.4	13.6
Cucumber	33.7	18.9	25.0	15.8	30.0
Onion	7.2	3.7	6.0	14.3	16.5
Peas (green)	18.3	11.6	13.7	11.3	34.0
Tomato	12.9	15.8	14.7	12.7	17.6
Watermelon	7.6	6.2	6.9	2.5	11.5

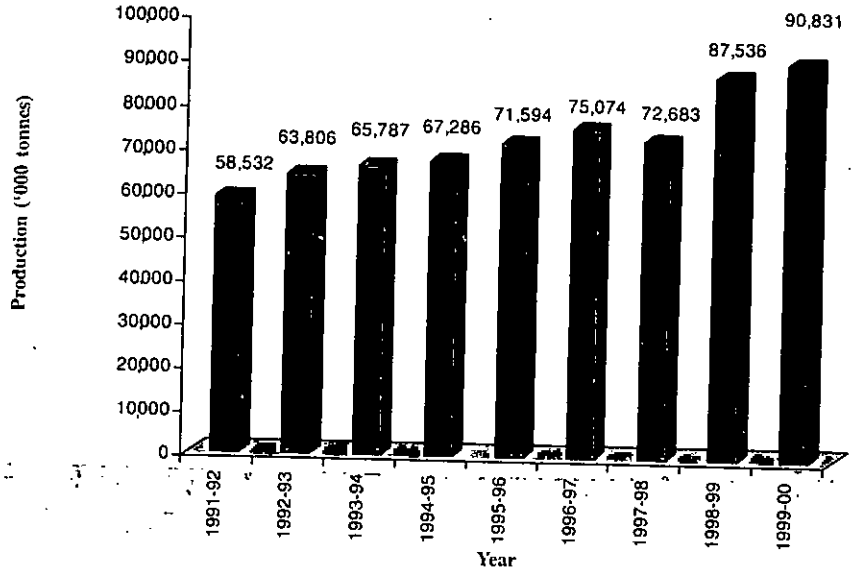

Fig. 1. Production trend of vegetables in India

Source : NHB, Gurgaon

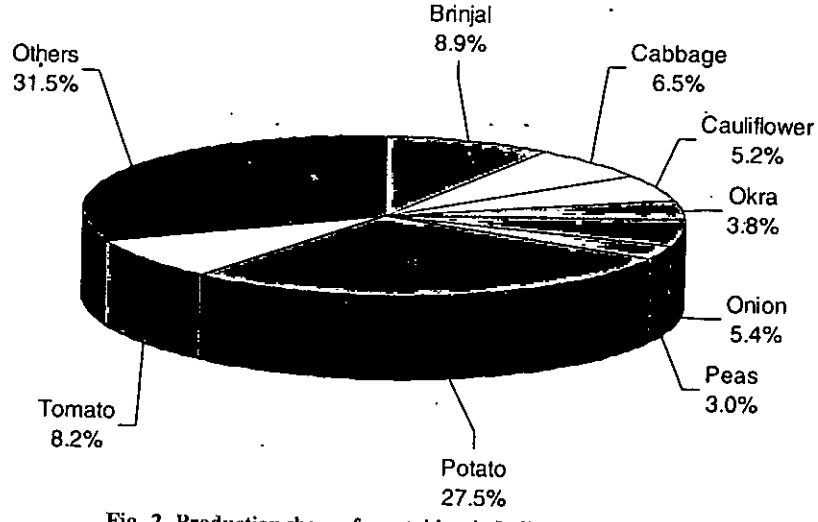

Fig. 2. Production share of vegetabless in India (1999-00)

Source : NHB, Gurgaon

The increase in area and production from 1980-1999 works out to be 3.2 and 2.6% respectively with a population of 950 million (1999). It is estimated that per capita availability of vegetables is about 175 g/day after deducting the quantity exported (about 0.5 million tonnes) and post-harvest losses of about 30%, which is very low compared with recommended dietary allowance of about 280 g/ capita / day for a balanced diet. The vegetable requirement of our country is estimated at 108 million tonnes by the end of 2001-2002, 185 million tonnes by 2009-2010 and 220 million tonnes by 2020. Over the years, there has been an increasing trend in vegetable production in view of increased urbanization, thus more demand and also more awareness about balanced diet. Main reason for low production is low productivity of vegetables (15.2 tonnes/ha). It is worth mentioning here that the world average productivity of vegetables is about 15.7 tonnes / ha. Keeping in view the fast growing population and shrinking land resources, increasing productivity is thus an important task to be tackled. It is also necessary to reduce post-harvest losses which vary from 15 to 30% depending upon the storage period and self-life of vegetables commonly grown in India.

EXPORT

India is exporting traditional vegetables to Malaysia, Singapore, Gulf countries, Sri Lanka, Bangladesh, Pakistan and Nepal. Non-traditional vegetables are exported to European countries and Australia in addition to Gulf and South-East Asian countries. Onion, potato, okra, bitter gourd and chilli in traditional vegetables and asparagus, cabbage, sweet pepper, sweet corn, baby corn, green peas, frenchbean, cucumber, gherkin, cherry and tomato are non-traditional vegetables which have good export potential. Fresh vegetable exports have increased from Rs 175.31 crores in 1991-92 to Rs 455.10 crores in 2000-2001. Onion accounts for more than 70% share in fresh vegetable export. Good scope exists for increasing export of vegetables. Quality, however, needs to be improved and prices are to be competitive.

DEMAND PROJECTION FOR VEGETABLES

The population of India has crossed one billion. According to Recommendatory Dietary Allowance (RDA) of the Indian Council of Medical Research, per capita consumption of vegetables must be 280 g. The total requirement of vegetables including processing, export seed, post-harvest losses etc. has been estimated to be 146.5 million tons. The vegetable production as per the NHB estimates for 1999-2000 is about 90.8 million tonnes. The target for 2001-02 had been fixed as 108.00 million tonnes.

Demand projection for 2009-10 has been worked out to be 185 million tonnes and that for 2020-21, 220 million tonnes. Since growth of vegetable crops is economically rewarding, the production is expected to increase and contribute nutritional security provided integrated approach for development is followed. The sector has now received attention in the formulation of policy of Govt. of India, which aims at systematic development of vegetable crops as a whole.

CONSTRAINTS IN PRODUCTION

Despite the progress shown in many areas of the vegetable production, further development needs to be taken up to tackle many problems which still continue to be there. The productivity and quality of many vegetable crops are much below the potential demonstrated. Yields are much below the world average. Poor management, technique and post-harvest handling system contributes to low quality of the final produce and high losses.However, major constraints are :

Narrow Spectrum of Improved Varieties

Improved high-yielding varieties with wider adaptability, tolerance / resistance to biotic and abiotic stresses still too narrow. Institutes / universities have developed promising varieties of tropical

vegetables but their effective adoption and further improvement to fit local agro-ecological conditions is often weak.

Limited Availability and High Cost of Good Quality Seed for Small Farmers

Good quality seed in adequate quantities is still lacking. In tomato, cabbage and many other vegetables, hybrid seeds are being supplied by private sector the cost of which is not affordable for the small farmers. Seed production of public sector bred hybrids is not yet organized. This is one of the major constraints even today.

Plant Protection

Most farmers living in unfavourable environment do not have improved varieties for their ecosystem. When varieties not suitable for their conditions are planted, crop failure or devastation from pests and diseases occurs. Many a times farmers are not aware about the appropriate plant-protection measures or even if they are aware, they are not able to procure the chemicals in view of high cost. Effective IPM methods are also not developed for all the crops.

Non-availability of Cost-effective Technology

Vegetable cultivation is highly labour intensive. Cost of cultivation is thus very high. Further, many a times labourers are not available in time for sowing of seed, transplanting or weeding / harvesting.

Slow Pace in Adoption of Improved Technology

The substantial yield gap between potential yields of developed technology and the yield attained by farmers efforts is testimony to the fact that one of the principal factors could be poor extension support as a result of weak research extension linkages. Further, trained extensionists in olericulture also lack.

Increased Post-harvest Losses

Due to perishable nature of most of the vegetables, losses are inevitable when produce remains physiologically active even after harvesting. Marketing system do not cater to the special needs of handling perishables. Losses are at farm level also when adequate precautions in pre-harvest and post-harvest practices are not taken by the farmers. Losses vary between 15 and 30% depending upon the period and type of vegetable.

Human Resource Factor

Training of farmers and trainers are not adequate. This has been due to low priority given to HRD in vegetable cultivation till Eighth Plan.

Natural Resource Constraints in Production

The levels of production, efficiency and productivity are mainly dependent on natural resource base and the interaction of farming practices with the environment. There are many a times adverse weather conditions like high temperature, shorter days, high humidity and torrential rains, waterlogging conditions and characteristic growing conditions. Due to lack of appropriate technologies or awareness for such conditions, farmers are forced to use own seed without application of any fertilizer etc.

Inadequate Infrastructure

There has not been adequate support for market infrastructural development, which is causing enormous post-harvest losses in various process of handling. Proper facilities for storage, grading, packing and disposal are not available.

Insufficient Information Database

There is no proper system so far for collection of data on area and production of vegetables. In some crops like onion and potato though some system has been there, but that is also not appropriate. In absence of authenticated data, planning of developmental programme is very difficult. Authenticated data on arrivals and prices of vegetables is also not available which does not allow farmers to select a market where he can sell his produce at a remunerative price.

THRUST AREAS

Since increase in production of vegetables is a must for nutritional security and for increasing income of farmers so also for helping in increased rural employment, it is necessary to identify the thrust areas of development and prioritize the same for effective achievement of the goal at a faster rate. Some thrust areas have been identified. They are :

- Improving the availability of quality seed by increasing production of quality seeds of improved varieties / hybrids.
- Area expansion under improved varieties / hybrids and diversification from low-value cereals and other crops to vegetables. Emphasis needs to be given on the popularization of high-yielding hybrids / disease resistant varieties bred by ICAR institutes and universities wherever the same are available.
- Reduction in post-harvest losses by creating infrastructural facilities thereby improving the facilities for storage, grading, packing and also for transport as also by popularizing use of improved pre-and post-harvest technologies.
- Development of diseases and insect pests forecasting technique for major vegetables and providing guidance, technical know-how to farmers, extension workers and all others concerned with the same.
- Development of area-specific package of practices and intensification of transfer of technology programme on latest available production and post-harvest technologies.
- Development of IPM and IPNM technique for cultivation of major vegetables and extension education of farmers for proper crop management and stress on water management through use of drip and sprinklers.
- Introduction of mechanization in cultivation of vegetables like seed sowing, planting, irrigation, weeding, hoeing, harvesting etc. so as to reduce cost.
- Human resource development in vegetable growing.
- Encourage captive farming for export and processing.
- Expansion of riverbed cultivation and emphasis on cultivation of vegetables in backyard, school and community gardens.
- Emphasis on off-season cultivation of vegetables.
- Development of suitable database.
- Product diversification and value-addition in vegetables.
- Establishment of plant health clinic.
- Efficient monitoring of different programmes.

RESEARCH ACHIEVEMENTS IN VEGETABLES

For promoting productivity, the major emphasis is being laid on promoting F_1 hybrids in vegetables by IIVR, Varanasi; IIHR Bangalore; IARI, New Delhi and All-India Coordinated Vegetable Improvement Project Presently, there are 7 main, 18 sub and 31 voluntary centres under the coordinated project. In the past 30 years, more than 180 improved varieties / hybrids have been developed. Besides, over 90 recommendations have been made in crop production, and disease and pest management. The improved varieties and hybrids as also recommendations in production have significantly contributed in increasing production and productivity of vegetables inspite of adverse weather conditions. It is, however, felt that vegetable production in India is still dominated by the locally available genotypes or 2OPs. Hybrid varieties in India are of recent origin. Hybrids are now popular in tomato, brinjal, capsicum, cabbage, cauliflower and okra. Work on popularization of hybrids has also been initiated in gourds, melons and chilli. With an awareness of advantage of cultivation of F_1 hybrids already there, area and production are bound to increase further. It is estimated that under egg plant approximately 32.20%, cauliflower 46.71%, chilli 60%, gourds 77.56 %, melons 70%, okra 14.62% and tomato 18.49% is under unidentified or local varieties (Table 5). Great scope exists to replace local cultivars with improved cultivars being high yield and quality.

Table 5. Estimated share of hybrid, open pollinated and local or identified varieties in total cropped area in India (1997-98)

Crop	Total area (ha)	Area under F_1 hybrid (ha)	Share of area (%)	Share of OP varieties (%)	Share of unidentified (%)
Eggplant	479095	85300	17.80	50.00	32.2
Cabbage	242140	76000	31.39	68.61	0.0
Cauliflower	304156	10000	3.29	56.00	46.71
Chilies	573529	14000	2.24	37.56	60.00
Gourds	409270	10000	2.44	20.00	77.56
Melons	169350	6800	4.02	25.98	70.00
Okra	371665	20000	5.38	80.00	14.62
Tomato	485520	153000	31.51	50.00	18.44

Source : SeedAssociation of India

Breeding of disease resistant varieties is the need of the hour to avoid the excessive use of chemicals and to reduce the growers' burden on cost of production. A good work in this direction has been done by the ICAR Institutes and SAUs.

Fusarium wilt, bacterial wilt, early blight, root-knot nematode, tomato leaf curl virus and spotted wilt virus resistant varieties of tomato have been developed. HS-110 and Sel-28 are resistant to fusarium wilt; BT-1, BT-10, BWR-1 and BWR-5 are resistant to bacterial wilt. Sel-120 is resistant to root-knot nematode. H-44, H-36, H-86 and H-88 are resistant to tomato leaf curl virus. In brinjal, BB-7, BWR-12 and SM-6-7 have been found resistant to bacterial wilt. In chili, Punjab Lal a variety resistant to TMV, CMV and leaf curl virus, has been developed. In peas, JP-4, JP-93, FC-1, PRS-4 and NDVP-4 have been recommended as powdery mildew resistant varieties. Varieties P-7, Arka Anamika, Arka

Abhay, Hissar Unnat and Varsha Uphar have been developed in okra which are resistant to yellow-vein mozaic. Arka Rajhans, a powdery mildew resistant variety, has been developed in muskmelon. In watermelon, Arka Manik, has been developed which is resistant to anthracnose, downy mildew and powdery mildew. Though in tomato, okra and peas, disease resistant varieties have reached in many areas and good impact has been obtained, there is still a need to produce adequate seed of disease resistant varieties and distribute the same so as to increase vegetable production further. A list of improved high-yielding varieties / F_1 hybrids is given in Annexure I.

Annexure I. High-yielding vegetable varieties/hybrids

Crop	Improved varieties / hybrids
Potato	Kufri Jyoti, K.Badshah, K.Bahar, K.Sindhuri, K.Lalima. K.Chipsona-1 and K.Chipsona-2 (processing varieties), K.Megha, K.Giriraj (resistant to late blight). K.Sherpa and K.Kanchan (resistant to wart disease). Kufri Swarna (resistant to golden nematode and late blight), Kufri Pukhraj (early maturing), Kufri Anand, Kufri Ashoka, Kufri Satlaj.
Tomato	Arka Abha, Arka Alok, Pant Bahar, LE-79 and BT-1 (resistant to bacterial wilt). Sel-120 (resistant to root-knot nematode). F/1 Hybrids- Pusa Hyb-1, Hyb-2, MTH-6, Arka Vardan, Pant Hybrid-1 and 2, Pusa Sheetal (cold set), Pusa Hybrid-1 (hot set).
Brinjal	F1 Hybrids – Arka Navneet, Pusa Ankur, Pusa Hyb-6, Pusa Hyb-5, Azad Hybrid, ARBH-201, NDBH-1, ABH-1, MHB-10 and MHBN-39 KKM (KSM-107) Pusa Purple Long, BWR, Pusa Purple Cluster, Pant Samrat, (resistant to bacterial wilt).
Capsicum	Arka Mohini, Arka Gaurav, Arka Basant, KT-F/1 hybrid Arka Gaurav (tolerant to bacterial wilt).
Chilli	Arka Lohit (bright red retentive pigment), Pusa Jwala-resistant to leaf curl (CMV and PVY disease). PLR-1, Jawahar Mirch 283, Gujarat Chilli-1.
Okra	Arka Anamika, Parbhani Kranti, Pb.Padmini, Sel-2 (YVMV resistant), Co3 (Hybrid-8), Arka Abhay, Varsha Uphar, Hissar Unnat.
Onion	Arka Niketan, Pusa Madhavi, N-2-4-1, Pusa Red, Agrifound Light Red (*rabi* varieties). Agrifound White, Pusa White Flat, Pusa White Round, Phule Safed (white).Arka Bindu, Agrifound Rose (for export). Arka Pitamber, Arka Kirtiman, Phule Suvarna (yellow skin-good for export). Agrifound Dark Red, Arka Kalyan, Baswant-780 and N-53 (for *kharif*). Spanish Brown (intermediate day).
Garlic	Agrifound White, Yamuna Safed, Yamuna Safed-2 and Yamuna Safed-3 (short day) and Agrifound Parvati (long day).
Radish	Pusa Chetki, Pusa Reshmi, Japanese White, Pusa Himani.
Turnip	Purple Top White Globe, Pusa Kanchan.
Carrot	Pusa Yamdagni, Ooty-1.
Cabbage	Pusa Mukta (resistant to black rot disease), Pusa Synthetic.
	F1 hybrids-Shri Ganesh Gol, Nath 401.

Cauliflower	Pusa Early Synthetic, Pusa Synthetic (for early-and mid-season).
	F/1 hybrid- Pusa Hybrid-2 (for mid season).
	Pusa Subhra, Pusa Snowball-1 and Pusa Snowball K-1 (resistant to black rot).
Pea	Arkel, Pusa Pragati, Azad Pea-1 and Azad Pea-3 (early varieties).
	PM-2, PRS-4, FC-1, JP-83 (resistant to powdery mildew).
	Bonneville, GC-141, JP-4 (resistant to both powdery mildew and rust).
French bean	VL Boni, Arka Komal, Pant Anupama.
Cow pea	Pusa Komal (resistant to bacterial blight), Deepaliwal.
	Birsa Sweta (for Bihar).
Dolichos	Pusa Early Prolific, Co-8, Co-9 (bush type). Kalyanpur T-2, Rajni (pole type).
Watermelon	Arka Manik (resistant to multiple disease).
	Durgapur Meetha, Sugar Baby (northern and eastern states), Arka Jyoti F/1.
Muskmelon	Hara Madhu, Pusa Sharbati, Arka Jeet, Pusa Madhuras MHY-3, Arka Rajhans (resistant to powder mildew). Punjab Hybrid, Pusa Rasraj (Hybrids).
Bottle gourd	Co-1, Kalyanpur Long Green, Punjab Long, Pant Shankar Lauki-1, Arka Bahar. F1 hybrids-Pusa Meghdoot, Pusa Manjari. Pusa Naveen, Pusa Hybrid-3.
Cucumber	Kalyanpur Green, Pusa Sanjog F1, Poinsette, Himangi.
Pumpkin	Arka Chandan, Arka Suryamukhi, CM-14, Pusa Viswas
Sponge gourd	Pusa Chikni, Pusa Supriya.

Another striking development is identifying the cultivation technologies for non-traditional zones and season resulting in area expansion and prolonged availability. Introduction of *kharif* onion cultivation in northern India is one such example. More than 30,000 ha area is being covered now in *kharif* season in non-traditional pockets which is helping in stabilizing the onion prices in north during November-December and January. Further, development of varieties tolerant to stresses from heat and cold in tomato as Pusa Hybrid 1 (hot set) and Pusa Sheetal (cold set) respectively have made it possible to produce and make available tomato in winter and also in summer. Cultivation of cauliflower, radish and onion is also possible out of the season as suitable varieties have been developed. Post-harvest technologies for different crops have been developed. Zero energy cool chambers for vegetables and ventilated onion godowns are new innovations in this direction.

GOVERNMENT INTERVENTION

With a view to increase production of vegetables, the Central Sector Scheme on Development of Vegetables and Development of Root and Tuber Crops was implemented in Eighth Plan. The significant achievements are:

- Area under vegetable crops increased from 5.14 million ha in 1991-92 to about 6.00 million ha in 1999-2000.

- Production increased from 56.5 to 90.8 million tonnes.
- Productivity increased from 11.3 to 15.2 tonnes/ha.
- Availability of quality seed and planting material / improved varieties / hybrids to farmers have also increased from organized sector.

Ninth Plan intervention for development of vegetables

An outlay of Rs 1.30 crores was allocated to NHRDF supplementing to the programmes under Macro Management to states during 2000-2001 (Ninth Plan). The objectives of the scheme and components are:

Objectives

- To improve production and productivity of vegetables by adoption of high-yielding cultivars, hybrids and improved technology.
- To improve the availability of vegetables all the year round by utilizing climatic variability and production technology.
- To improve the availability of quality seeds of high-yielding varieties of onion and potato.
- Disseminate improved technology through farmers participatory demonstration, training and visit, publicity and media support.
- To reduce cost of cultivation by farm mechanization.
- To reduce post-harvest losses through on-farm post-harvest management.

Scheme Components

The approved programmes for Ninth Plan, which are being continued during 2001-2002 are:

Production of Seeds/Planting Material

Onion and potato having more importance in our daily diet have been included in the programme. The assistance is given for production of breeders' seed, foundation and certified / quality seed. The ICAR institutes and other research organizations responsible for developing varieties for breeders' seeds, NSC, SFCI and NHRDF for certified and quality seeds are being provided the assistance. Rs1,000/kg for breeders' seed of onion, Rs 25,000/g for foundation seed of onion and Rs 62,500/tonne for certified and quality seed are the assistance. In case of potato, an assistance is Rs 30/kg for breeders' seed, Rs 15,000/tonne for foundation seed and Rs 5,000/tonne for certified seed. Assistance is also provided for establishment of production centres for TPS in public sector @ Rs12.5 lakh/centre and Rs 2 lakh/center in private sector.

Seed Village Concept

For ensuring the availability of quality seeds in required quantity of a variety, the assistance is being provided for creating infrastructure for production of seed as one-time grant. It will be credit-linked programme with back-ended subsidy @ 25% with a maximum limit of Rs 4 lakhs/unit. This is being disbursed through bank only. Private entrepreneurs like NGOs, Cooperative Societies and farmers' groups are being considered for the assistance.

Development of Irrigation Source/System

Since drip irrigation has given good result in tomato, onion, potato, cucurbits, etc. an assistance up to Rs 26,750/ ha is being given for installing drip irrigation system.

Disease Forecasting System

Vegetables are highly susceptible to insect pests and diseases which affect the production adversely under favourable weather conditions.Disease forecasting units against blight in potato, purple blotch and stem-phylium blight in onion will help in taking up preventive measures against diseases. For this, since costly equipments are required, an assistance of Rs7.5 lakhs/unit is being given to public sector organizations / NGOs. The assistance includes equipments, its establishment, maintenance and forecasting.

Integrated Pest and Disease Management

Excessive use of insecticides and fungicides to protect against the insect pests and diseases has become a cause of concern not only from point of health hazards but also crop failure due to development of resistance against particular insecticide or fungicide. Integrated management of pests and diseases have been worked out for many vegetables. In order to get the technology adopted at a faster rate, assistance is being provided @ Rs1,500 ha for integrated pest management.

Mechanization in Vegetable Production

To increase production and productivity of vegetables and reduce cost of production, mechanization has become necessary. It is necessary to use ridger, transplanters, digger or other such implements, which speed up cultural operations and are more effective than traditional farm implements. Credit linked assistance is being provided to a group of farmers /cooperative societies at 20% at the cost of machinery subject to ceiling of Rs 20,000/group.

Farmers' Participatory Demonstration

Demonstration on any new technology is the best way to popularize the same for adoption by farmers at a faster rate. Assistance is being given to farmers for frontline demonstrations at their fields. The assistance of Rs 10,000/ha. This includes cost of inputs, consultancy / visit of experts, publishing of handbills and field days etc.

Training of Farmers/Visits in Groups

New technologies are being developed by SAUs and ICAR institutes. It is necessary to upgrade the knowledge and skill of farmers regularly. Assistance is being provided for training and visits in group of 50 farmers for 3-5 days @ Rs1,500/farmer. The idea behind this is to give exposure to farmers to new technologies developed and being followed in other states.

Publicity and Media Support

Farmers also need to be made aware of the latest advancements in the production and post-harvest management technologies of onion, potato and other vegetable crops by publicizing through advertisements in radio and TV, video films, exhibitions, meetings, festivals etc. Literatures also need to be prepared in different languages. Assistance is being given for this. The amount is being decided on case-to-case basis.

Workshop/Seminar

A workshop / seminar required to be arranged wherein scientists, farmers and all others concerned are to take part in deliberations and bringing out certain recommendations. Assistance is being given for this also to institutes involved in research in vegetables including potato.

Technology Development and Application

Many a times the technology developed for one pocket cannot be popularized in other pockets and thus location-specific technology need to be developed and applied. Assistance is being provided for this to ICAR Institutes and other reputed private institutes having necessary infrastructure.

On-farm Zero Energy Cool Stores/Ventilated Onion Godowns

Post-harvest losses in vegetables range from 15 to 30% depending upon vegetables and period stored. Adequate cold storage facility is not available. Zero energy cool stores have been developed by IARI and ventilated onion godowns have been developed by NHRDF. These storages if constructed by farmers even for short-term storage will go a long way in reduction of post-harvest losses in vegetables. Assistance is being provided @ 30% of the total cost limited to Rs 50,000.

Development of Information System

Regular information on crop prospects, prices, arrivals, etc. on vegetables especially on onion and potato is required for policy, planning and also help farmers and others for marketing of their produce economically. Information Centre is established at NHRDF's Registered Office at New Delhi. Assistance is being provided to NHRDF to meet the cost of hardware, software, technical service, etc.

Monitoring and Evaluation

The NHRDF is a nodal agency for implementation and monitoring of project. Assistance is being provided to NHRDF @ 5% of the total assistance. Assistance for external evaluation is also being given.

Progress of Schemes During 2000-2001

The Ninth Plan could commence only from 2000-2001. Major programmes were given directly to states under the programme on macro management in agriculture so as to enable them to take up the developmental programmes which are relevant to their needs. DAC approved Rs 1.30 crores for different schemes to supplement the programmes in the state. National Horticultural Research and Development Foundation, an Autonomous Society, which is already engaged in development programmes in onion at national level was nominated as nodal agency for implementing the programmes. Details of the targets and achievements of different programmes are given in Annexure II. Programmes are further continued during 2001-2002 with an outlay of Rs 7.48 crores. Details of the progress of the on-going programmes on vegetable development through NHRDF are given in Annexure III.

Agency	Sanctioned (Rs.lakhs)	Expenditure (Rs.lakhs)	Balance (Rs.lakhs)
NHRDF and other Central agencies	130	109.97	20.03

Annexure II. Component-wise allocation of physical and financial targets to central agencies and achievements under central sector Scheme of Integrated Development of Vegetables including root and tuber crops during 2000-01 up to September 2001

Component/Agency	Target		Achievement	
	Physical	Financial (Rs. lakh)	Physical (q)	Financial (Rs. lakh)
1. Production of planting material				
(A) ONION				
i. Breeder seed (q)				
IIHR	0.25	0.25	0.125 q	0.25
IARI	0.25	0.25	**	---
NRC on O&G	0.25	0.25	0.25 q	0.25
NHRDF	1.75	1.75	1.75 q	1.75
ii. Foundation seed(q)				
NSC	1.00	0.25	1.00	0.25
SFCI	1.00	0.25	**	---
Maharashtra	1.00	0.25	---	---
NHRDF	7.00	1.75	8.00	2.00
iii. Certified seed (q)				
NSC	50.00	3.125	50.00	3.125
Maharashtra	20.00	1.250	---	---
NHRDF	250.00	15.625	250.00	15.625
(B)POTATO				
Breeder seed (q)				
CPRI	41.50	1025	41050	1025
Foundation seed (q)				
NSC	200.00	3.00	200	3.00
SFCI	200.00	3.00	200	3.00
NHRDF	100.00	1.50	100	1.50
Certified seed (q)				
SFCI	250.00	2.50	250	2.50
NSC	650.00	6.50	650	6.50
NHRDF	100.00	1.00	100	1.00
(C) TRUE POTATO SEED				
Public sector (Rs 12.5 lakhs/ centre)				
Private sector (Rs 2.00 lakhs per centre from NHRDF directly as part of expenditure	1	2.00	1	2.00
2. Seed village concept (Rs5.00 lakhs/unit)				
NHRDF	1.00	5.00	1.00	5.00
NSC	1.00	5.00	1.00	5.00

3. Improvement of production and productivity				
Disease forecasting system-NHRDF (Part of exp. against Rs7.5 lakhs/unit	1	3.75	In progress	----
4. Technology transfer (a) Demonstration (Rs1000/ha)	37.50	3.75		
NHRDF (In West Bengal, Gujarat, Rajasthan, Uttar Pradesh and Punjab)	13.50	1.35	13.50	1.35
(b) Training and visit (Rs 1.500/training) (One group of 50 farmers				
NHRDF Training to be arranged for Andhra Pradesh, Assam, Bihar, Madhya Pradesh, Uttar Pradesh and West Bengal, Orissa and Karnataka farmers	20	15.00	11*	8.25
(c) Publicity and media support				
NHRDF for literature/ folders in different languages		2.50	----	2.50
(d) Workshop/seminar		0.19	----	0.19
NHRDF (e) Technology development and application (Rs10 lakhs/project part of project cost)				
IIVR		1.75	----	1.75
NRC on O & G		1.00	----	1.00
NHRDF		1.00	----	1.00
5. On-farm post-harvest handling (Rs.50,000/unit)	10	5.00	10.00*	
Zero energy cool chambers and onion storage structure in Haryana, Punjab, Uttar Pradesh, Bihar, and West Bengal NHRDF				

6. Development of Information system (Part of expenditure) NHRDF		30.00	—	30.00
7. Monitoring & Evaluation				
(a) Assistance to nodal agency		7.50	7.50	
(b) External evaluation / Technical services		3.75	----	
Total		**175.06**		**109.97**

Annexure III. Progress of component-wise allotment of programme and financial achievements for programme of Centrally Sponsored Scheme-during 2001-2002

Component	Agency	Target		Progress
		Physical (Rs. lakhs)	Financial	
1. Planting material				
A. Onion				
Breeder seed	NHRDF	1.75 q	1.75	Allotted and arranged
	IIHR	0.25 a	0.25	Allotted and arranged
	NRCOG	0.25 q	0.25	Allotted
	IARI	0.25 q	0.25	Allotted
Foundation seed	NSC	2. 0 q	0.50	Allotted
	NHRDF	15.5 q	3.875	Allotted
Certified seed	NSC	75 q	4.1875	Allotted
	NHRDF	325 q	20.3125	Allotted
B. Potato				
Breeder seed	CPRI	41.5 q	1.25	Allotted
Foundation seed	NSC	200 q	3.00	Arranged
	SFCI	200 q	3.00	Arranged
	NHRDF	100 q	1.50	Arranged
Certified seed	NSC	600 q	6.00	Arranged
	SFCI	600 q	6.00	Arranged
C. True potato seed	Public and private sector through NHRDF	4	15.00	----
2. Seed village concept	NSC	2	10.00	----
	NHRDF	6	30.00	----

3. Improvement of production and productivity	NHRDF	200 ha	53.50	
(a) Development of irrigation source system	CPRI	2 units	7.50	In progress
(b) Disease forecasting system	NHRDF	2 units	7.50	
(c) Assistance for adoption of IPM	NHRDF	5300 ha	82.50	In progress
(d) Mechanization in vegetable cultivation	NHRDF	400 groups	80.00	In progress
4. Technology transfer	NHRDF	500 ha	50.00	Arranged
(a) Farmers participating demonstration	NHRDF	133	100.00	In progress
(b) Training and visit	NHRDF	133 groups	33.45	In progress
(c) Publicity and media support	NHRDF	2	10.00	Being arranged
(d) Workshop and seminar	IIVR	1	10.00	
(e) Technology development and application	NRCOG	1	10.00	
5. On-farm post harvest handling, zero energy cool chamber and onion storage structure	NHRDF	1	10.00	
6. Development of information centre	NHRDF		80.00	In progress and continued
7. Monitoring and evaluation	NHRDF		55.83	
	Total		**747.905**	

Rounded - 748.000

APPROACHES FOR PRODUCTION AND MARKETING OF POTATO

Prem S. Dahiya and G.S. Shekhawat

Potato is principal horticultural crop grown commercially in India, occupying 0.6 % of the total cropped area. The Indo-Gangetic region comprising Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal and Union Territory of Delhi is truly the potato bowl of India, accounting for 78.4% area and over 86% production. Root and tuber crops, including potato, have been identified as most important group of staple food in the tropical countries of the world (Govt. of India, 2001a). During 1999-2000, India produced 25 million tonnes of potatoes from 1.34 million ha, providing 186 q/ha of potato (Govt. of India, 2001b). After China and Russian Federation, India achieved the unenviable rank of being the third largest potato-producing country in the world during 1999 relegating Poland to fourth position. The country excelled the world average yield of 164 q/ha, attaining 173 q/ha (FAO, 2001).

The farmers invest heavily in potato cultivation in terms of both capital and labour. To run his farm enterprise successfully, farmers are primarily concerned to ascertain this costs and returns on potato cultivation. The marketing of agricultural products begins on the farm itself, with the planning to meet specific demands and market prospects. As such, production and marketing of farm products are treated as part and parcel of one continuum under the systems approach of market analysis (Dahiya, 1995).

REGIONAL PRODUCTION PATTERNS AND GROWTH RATES

The heartland of potato production is the Indo-Gangetic region and it crossed the targeted yield mark of 20 tonnes/ha set by the National Commission on Agriculture (1976) to be achieved by 2000 AD. Gujarat, which has specialized in riverbed cultivation of potato also registered a remarkable productivity of 22 tonnes/ha in 1999-2000. On an average basis for 1995-96 to 1999-2000, Gujarat (22.7tonnes/ha), Punjab (18.7 tonnes/ha), Tamil Nadu (20.2 tonnes/ha), Tripura (18.0 tonnes/ha), Uttar Pradesh (20.5 tonnes/ha) and West Bengal (23.4 tonnes/ha) have recorded higher productivity than the average national productivity of 17.5 tonnes/ha for this period. However, Andhra Pradesh (6.1 tonnes/ha), Arunachal Pradesh (7.2 tonnes/ha), Assam (8.2 tonnes/ha), Bihar (9.2 tonnes/ha,), Haryana (15 tonnes/ha), Himachal Pradesh (10 tonnes/ha), Jammu and Kashmir (5.5 tonnes/ha), Karnataka (12.2 tonnes/ha), Madhya Pradesh (13.4 tonnes/ha), Maharashtra (4.7 tonnes/ha), Manipur (9.3 tonnes/ha), Meghalya (6.8 tonnes/ha), Mizoram (5.6 tonnes/ha), Nagaland (8.6 tonnes/ha), Orissa (10.4 tonnes/ha), Rajasthan (7.5 tonnes/ha), Sikkim (4.6 tonnes/ha) and Delhi (9.7 tonnes/ha) lagged much behind.

The north-eastern hills region including Sikkim claimed 8.7% share in area and 4.2% in national production with a low productivity of 9.1 tonnes/ha in 1999-2000. The Deccan plateau accounted for 2.8 and 2.0% of area and production respectively with a yield of 14.4 tonnes/ha. Tamil Nadu has almost consistently recorded over 21 tonnes/ha since 1987-88 but surprisingly the state has witnessed over 50% reduction in area and production over the last decade, indicating the need to investigate the comparative economics of competing crops (Shekhawat and Dahiya, 1997). The performance of the western Himalayan region comprising Himachal Pradesh and Jammu and Kashmir is far from being satisfactory in terms of attaining higher yields. During 1999-2000, this region accounted for merely 1.0 and 0.7% area and production in the country.

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Potato crop has excelled rice, wheat and all principal crops in the country in terms of registering higher compound growth rates for area, production and yield during 1967-68 to 2000-2001 (Table 1). It shows that only wheat recorded higher growth rates for the yield parameter only. The potato revolution has gone unnoticed in a way since the cereals predominate our food basket.

Table 1. Compound growth rates of area, production and yield of rice, wheat, potato and other major crops (1967-68 to 2000-2001)

Crop	Area	Production	Yield(%per annum)
Rice	0.68	2.80	2.16
Wheat	1.40	4.41	2.96
Potato	3.31	5.61	2.22
Major crops	0.36	2.82	1.92

Source: *Agricultural Statistics at a Glance*, pp 210-11 Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi.

Uttar Pradesh is the number one potato-growing state in the country both in terms of area and production accounting for 35% area and 41% production in the country, followed by West Bengal (21.3 % area and 31.8% production) and Bihar (14.1 % area and 7.4% production) respectively. The data show that all the states and regions registered increase in area and production during the second phase (1995-96 to 1999-2000) over the first phase (1990-91 to 1994-95) (Table 2). The highest increase (43.6%) in potato area was reported in Haryana but West Bengal recorded the highest increase (39.8%) in production. The lowest increase both in area (7.6%) and production (6.8%) was registered in Bihar. However, discrepancies in potato crop estimates in respect of Bihar have been observed. Bihar (0.6%), Haryana (6.4%) and Punjab (0.9%) showed decline in potato productivity during the second phase of potato growth over the first phase.

Table 2. Change in area, production and yield in principal potato-growing states and regions in India during 1990-91 to 1999-2000

State/ Region	Average area ('000ha)			Average production ('000tonnes)			Average yield (q/ha)		
	First phase	Second phase	Change (%)	First phsae	Second phase	Change (%)	First phase	Second phase	Change (%)
Bihar	164.3	176.8	**7.6**	1517.2	1620.4	**6.8**	92.3	91 7	**-0.6**
Haryana	10.1	14.5	**43.6**	162.0	216 9	**33.9**	159.8	149.6	**-6.4**
Punjab	42.9	54.6	**27.3**	808.0	1020.3	**26.3**	188.5	186.7	**-0.9**
Uttar Pradesh	372 4	435.2	**16.9**	6805.3	8933.5	**31.3**	182.8	205.3	**12.3**
West Bengal	221.5	297.7	**34.4**	4984.9	6970.8	**39.8**	225.0	234.2	**4.1**
Indo-Gangetic Region	811.3	981.0	**20.9**	14277.9	18783.3	**31.6**	176.0	191.5	**8.8**
North-Eastern Sates	101.5	116.4	**14.7**	767 3	983.1	**28.1**	75.6	84.4	**11.6**
Rest of India	126.9	157.3	**24.0**	1515.8	2123.4	**40.1**	119.4	135.0	**13.1**
All India	1039.7	1254.7	**20.7**	16560.6	21889.8	**32.2**	159.3	174.5	**9.5**

* First phase average: 1990-91 to 1994-95 ; Second phase average: 1995-96 to 1999-2000

The compound growth rates for area, production and yield for the principal potato-growing states and regions are given in Table 3. All states and regions recorded significant growth during the last decade (1990-91 to 1999-2000). In terms of production, north-eastern states recorded highest compound growth rate of 7.95%/annum. Haryana and Punjab showed negative growth rates of 1.03 and 0.30%/annum in yield.

Table 3. Annual compound growth rates for area, production and yield of potato in principal potato-growing states and regions in India (1990-91 to 1999-000)

% per annum

State/Region	ACGR		
	Area	Production	Yield
Bihar	1.21*	1.24**	0.02**
Haryana	6.75*	5.64*	-1.03**
Punjab	6 99*	6.66*	-0.30**
Uttar Pradesh	3.06*	4.99*	1.87**
West Bengal	5.57*	5.88*	0.30**
Indo-Gangetic Region	3.67*	5.06*	1.33**
North –Eastern States	2.65*	5.07*	2.35*
Rest of India	4.44*	7.95**	3.40**
All India	3.71*	5.28*	1.51**

* Significant at 5% level of probability

** Non-significant at 5% level of probability

POTATO IN NATIONAL ECONOMY

The contribution of potato to India's farm economy and national economy is manifold. The importance of potato in agricultural economy can be judged from the fact that in 1970-71 potato was cultivated on 0.3% of total cropped area in the country but it contributed 1.4% of the total value of output from agriculture. In contrast paddy and wheat, occupied 22.7 and 11.0% of the total cropped area, contributing only 26.2 and 10.4% of total value of agricultural output. The scenario has not changed during the last two decades and a half, and potato has continued to contribute significantly to the national economy (Shekhawat and Naik, 1999). During 1997-98, potato was cultivated on 0.6% of total cropped area but it, contribution was 1.9% of total agricultural output vis-à-vis rice and wheat for which the corresponding figures were 22.8% and 14.0% for area, and 19.0 and 10.8% for total value of output from agriculture. Moreover, potato accounted for about 30% of the total 87.53 million tonnes of vegetables production in the country during 1999-2000.

While potato requires an input of 250 mandays for cultivation in one hectare, rice and wheat need 101 and 48 days of labour (Shekhawat and Dahiya, 1997). The potato area has increased from 0.24 million ha in 1950-51 to 1.34 million ha in 1999-2000, adding 275 million, additional mandays of employment annually. Potato is a short-duration crop and it fits in will in several multiple, relay and cropping systems. The mandays requirement per hectare in different crop sequences is highest when potato included in crop rotation. It is 313 mandays/ha in rice–potato–okra rotation in the central region and 488 days in maize–potato–greengram in the north-western region (Swaminathan, 1978). Potato

also adds to employment generation in post-harvest phases of production of processed products, marketing and utilization of potatoes in the country

POTATO-GROWING ZONES AND VARIETIES

Potato has wide adaptability as it grows in almost all states and under various diverse conditions. Nearly 80% of potatoes are grown in the vast Indo-Gangetic plains of north India during short winter days from October to March. About 8% area under potato cultivation lies in the hills where the crop is grown during long summer days (April - October). Plateau region of south-eastern, central and peninsular India, constitutes about 6% area where potatoes are grown as a rainfed *kharif* crop during rainy season (July-October) or as irrigated crop during winter (November to March). In a small area of about 4,000 ha covering mainly Nilgiri and Palani hills of Tamil Nadu, the crop is grown round the year both as irrigated and rainfed crop (Shekhawat and Naik, 1999). As such one can find the potato crop under cultivation in one part or the other throughout the year. The country is divided 8 potato-growing zones (Table 4).

Table 4. Potato-growing zones and crop seasons in India

Potato-growing zone	Regions	Seasons
North-western Himalayan zone	Hills of Himachal Pradesh, Jammu and Kashmir and Uttaranchal	Summer crop April - September
North-eastern Himalayan zone	Hills of Meghalaya, Manipur, Tripura, Nagaland, Arunachal Pradesh and Mizoram	Two seasons: Jan-Feb. to May-June, Aug. Sept. to December
Sikkim and north Bengal hill zone	Sikkim and North Bengal hill zone	Two seasons Jan.-Feb. to July-Aug (ii) Sept - Dec
North-west plains zone	Punjab, Haryana, Rajasthan and parts of neighbouring states.	Three crop seasons Early (autumn), main, spring crop
North central plains zone	Western Uttar Pradesh and Madhy Pradesh	Three crop seasons Early—Sept-Oct. to Dec. Main—Oct.-Nov to Feb.-Mar. Late— Nov.- Dec. to Mar. -Apr.
North-eastern plains zone	Eastern Uttar Pradesh, Bihar, West Bengal, Assam and Orissa	Two crop seasons (I) Sept to Nov.-Dec (ii) Nov to Mar.
Plateau zone	Parts of Gujarat , Maharasthra, MP, Karnataka and Orissa	Two crop seasons (I) July to Sept. (ii) Nov. to Feb.
South Indian hills zone	Southern hills zone in Tamil Nadu	Potato grown round the year in three seasons Summer crop: Mar-Apr to Aug.-Sept. Autumn crop: August-Sept. to Dec.-Jan. Spring crop: Jan to May

The CPRI, Shimla, started releasing improved potato varieties from 1958 onwards. The first 2 varieties, viz. Kufri Safed and Kufri Red were clonal selections from indigenous Phulwa and Darjeeling Red Round, respectively. The remaining 33 varieties developed till date are hybrids. These varieties are suitable for cultivation under diversified agroclimatic conditions of the country. Salient characteristic features of these varieties are given in Table 5 (Gaur *et al.*, 1999)

Table 5. High-yielding varieties of potato, maturity levels, disease resistance and adaptability for cultivation in India

Variety	Year of release	Characteristic features		Adaptability
		Maturity level	Disease resistance, etc.	
Kufri Kisan	1958	Late-maturing		North Indian plains
Kufri Kuber	1958	Medium-maturing	Immune to PVY and resistant to PLRV	Punjab, Bihar and Maharashtra
Kufri Kumar	1958	Late-maturing	Moderately resistant to late blight	North Indian hills
Kufri Kundan	1958	Medium-maturing	Moderately resistant to late blight and good keeping quality	Himachal Pradesh and Uttaranchal
Kufri Red	1958	Medium-maturing	Good keeping quality	Plains of Bihar and West Bengal
Kufri Safed	1958	Late-maturing	Good keeping quality	North Indian plains
Kufri Neela	1963	Late-maturing	Moderately resistant to late blight	Nilgiri hills
Kufri Sindhuri	1967	Late-maturing	Red tuber moderately resistant to early blight and tolerant to PLRV	North Indian plains
Kufri Alankar	1968	Medium-maturing	Field immune to race "O" of late blight	North Indian plains
Kufri Chamatkar	1968	Late-maturing	Resistant to early blight	North Indian plains
Kufri Chandramukhi	1968	Early-maturing	Good for processing	North Indian Plains and plateau region of peninsular India
Kufri Jeevan	1968	Late-maturing	Moderately resistant to early blight, field resistant to late blight and resistant to wart	Himachal Pradesh
Kufri Jyoti	1968	Medium-maturing	Resistant to early blight, late blight and wart and tolerant to Viruses. Good for processing	Wide adaptability
Kufri Khasigaro	1968	Late-maturing	Resistant to early blight and late blight	Hill region of Meghalaya
Kufri Naveen	1968	Late-maturing	Resistant to late blight and immune to wart	Northern hill regions of West Bengal and Meghalaya
Kufri Neelamani	1968	Late-maturing	Resistant to late blight	Nilgiri hills of Tamil Nadu
Kufri Sheetman	1968 maturing	Medium to late	Resistant to frost	North Indian plains and tarai area of Uttar Pradesh
Kufri Muthu	1971	Medium-maturing	Resistant to late blight	Nilgiri hills of Tamil Nadu
Kufri Lauvkar	1972	Early-maturing	Rapid bulking under warmer conditions	Plateau region of peninsular India

Kufri Dewa	1973	Medium-maturing	Good keeping quality and resistant to frost	Tarai area of western Uttar Pradesh
Kufri Badshah	1979	Medium-maturing	Resistant to early blight and late blight and PVX	North Indian Plains & Plateau region of peninsular India
Kufri Bahar	1980	Medium-maturing	Heavy-yielder	North Indian plains
Kufri Lalima	1982	Medium-maturing	Red tuber moderately resistant to early blight and resistant to PVY	North Indian plains
Kufri Sherpa	1983	Medium-maturing	Resistant to late blight and Immune to wart	Hills of West Bengal
Kufri Swarna	1985	Medium-maturing	Resistant to late blight and cyst nematode	Southern hills
Kutri Megha	1989	Medium-maturing	Resistant to late blight	Hill regions of Meghalaya
Kufri Ashoka	1996	Short-duration (75 days)	Resistant to late blight	Plains of Central end Eastern Uttar Pradesh
Kufri Jawahar	1996	Medium-maturing	Resistant to late blight and ideal for Intercropping	Punjab, Haryana end the Plateau regions of Madhya Pradesh, Gujarat and Karnatka
Kufri Sutlej	1996	Medium-maturing	Resistant to late blight	Western and Central Indo-Gangetic region
Kufri Pukhraj	1998	Medium-maturing	Resistant to late blight	Northern plains and Plateau region
Kufri Chipsona 1	1998	Medium-maturing	Resistant to late blight and excellent for processing	North Indian plains
Kufri Chipsona 2	1998	Medium-maturing	Resistant to late blight and excellent for processing	Uttar Pradesh and Bihar
Kufri Giriraj	1998	Medium to late maturing	Resistant to late blight	North Western hills
Kufri Anand	1999	Medium-maturing	Resistant to late blight and tolerant to frost	North Indian plains
Kufri Kanchan	2000	Medium-maturing	Resistant to late blight and wart	North Bengal

Maturity periods **Plains:** Early (70-90 days), medium (90-110 days), late (110-120 days)
Hills: Early (120-125 days), medium (130-135 days), late (135-145 days)

During 1964-68, superiority of potatoes developed by CPRI, Shimla over European potatoes was demonstrated in different parts of the country. Despite short-growing period of 90 days, their productively is comparable or better than the European, American and Canadian varieties grown for 140-180 days under long days. Today, potato varieties released by CPRI, Shimla, occupy more than 90% of the area in the Indo-Gangetic plains (Shekhawat, 1998). Potato processing is one of fastest growing sectors of the Indian economy. Kufri Jyoti, Kufri Chandramukhi, Kufri Luavkar, Kufri Chipsona I, and Kufri Chipsona II released by CPRI, Shimla are suitable for processing. Chipsona I and Kufri Chipsona II have shown superiority in yield and processing quality over exotic processing

varieties – Frito-Lay- 1533, Atlantic, Agria, Cardinal, Diamant, Fresco, Sante, Anosta, Marfona and Ajex (Shekhawat and Naik, 1999; Gaur, Pandey, Singh and Kumar, 1999).

In India, potato processing takes place at modern organized sector, cottage industry and household levels. But still, we hardly utilize less than 1% of potato production for processing purposes. On the contrary, potato processing is a big industry in USA and Europe utilizing over 57.6% and over 30% of total crop for manufacture of starch and human consumption (Dahiya and Sharma, 1999a).

Agro-techniques for Potato Production

Seed, fertilizer and manure and labour account for the lion's share of total cost of cultivation for potatoes. In Farrukhabad district, a comprehensive study (Gupta *et al.* 1989) showed that these inputs together accounted for 81.4% of total cost of cultivation. Fertilizer-use efficiency and water management are very important parameters in improving productivity, particularly for irrigated crop. The standardization of agro-techniques, and development of mechanical equipments such as an oscillating tray type potato grader, fertilizer application-cum line-marker, potato digger, (2 row and 4 rows automatic and bullock-drawn) potato planter etc. have been instrumental in improvement of potato productivity. The recommendations for fertilizer use are presented in Table 6 (Sharma *et al.*, 1999)

Table 6. Fertilizer requirement of potatoes grown in different zones

Zone	Soil	Dose (kg/ha)		
		N	P_2O_5	K_2O
North-western hills zone	Acidic hill soil	120-150	100-150	120
North-eastern hills zone	Alluvial	100-120	120-150	60
North-western plains zone	Alluvial	180-240	80-100	100-150
North-central plains zone	Alluvial	180-240	80-100	100-150
North-eastern plains zone	Alluvial	180-240	80-100	100-150
Plateau zone	Black	100-120	60	60
Nilgiri zone	Acidic hill soil	90-120	135-150	90

A dose of farmyard manure @ 30 tonnes/ha can meet P_2O_5 and K_2O needs of potato crop. If the dose is less than 30 tonnes, the dose of P and K should be reduced accordingly. Application of farmyard mannues also meets need of secondary and micronutrient. Generally, 30-45 g of tubers are recommended for ware as well as seed production in plains. A seed rate of 2.5-3.5 tonnes/ha is recommended depending upon seed size of tubers. The best intra- row spacing is 15, 20, 30 and 40 cm for 20, 40, 60 and 80g seed tubers when inter-row spacing is kept constant at 60 cm. Irrigation in light soils should be given at 8-9 days interval and in heavy soils at 12-15 days. Potato-based cropping systems have been identified and their agro-techniques have been developed. (Lal *et al*, 1999).

Approaches for Seed Production

Potato is basically a vegetatively propagated crop. If the same stock is grown year after year, it gets riddled with viral diseases and the yield is reduced. Therefore, production of healthy planting material is a continuous requirement. Prior to the development of seed plot technique (SPT), the main sources of seed potatoes were the high hills, mid-hills and north-eastern plains. Though seed produced in high hills did meet the requirement of health standards, it was not physiologically suitable for planting

the main crop because of dormancy. The seed produced in the midhills and north-eastern plains is not healthy enough (CPRI, Shimla 1999).

The CPRI, Shimla, undertook a series of surveys over the years (1956-60) at different locations and identified low aphid period during October to December in north Indian plains. The seed produced through the Seed Plot Technique not only gave 30-40% higher yields but also was free from late blight infection and other soil-borne diseases and pests. The salient features of seed plot technique are: potato seed crop is planted in first week of October in western Indo-Gangetic plains and a week to fortnight later in the central and eastern Indo-Gangetic plains using indexed (virus-free) seed tubers; closely spaced seed tubers in moderately rich soil and use of optimum doses of NPK; roguing of unhealthy and off-type plants; irrigation is restricted after mid-December (12-15 days before haulm cutting) to check regrowth after haulm cutting; destruction of haulms before aphids reach critical level storage in cool place for skin curing and cold storage of seed potatoes (Shekhawat *et al.*, 1999; Singh *et. al.*, 2000).

The CPRI, Shimla, produces basic seed at its regional stations located at Kufri, Jalandhar, Modipuram, Patna and Gwalior. The trend in production and distribution of seed is presented in Table 7. During 1999-2000, the institute produced over 3,000 tonnes of seed potatoes. Of which, 68% were supplied to central and state government agencies for further multiplication and supply to the farmers. Ten varieties in plains, Kufri Badshah, Kufri Bahar, Kufri Chandrmukhi, Kufri Jyoti, Kufri Lalima, Kufri Lauvkar, Kufri Siddhuri, Kufri Ashoka, Kufri Sutlej and Kufri Jawahar, and Kufri Jyoti, Kufri Giriraj, Kufri Chandramukhi and Kufri Kanchan are included for breeders' seed production. The breeders' seed production of processing varieties, Chipsona I and Chipsona II, has also been taken up.

Table 7. Production and distribution of breeders' seed potato by CPRI, Shimla (1990-91 to 2000-2001)

Year	Production (tonnes)			Distribution	
	Hills	Plains	Total	Total quantity (tonnes)	Total production (%)
1990-91	87.7	1986.3	2074.0	1703.1	**82.1**
1991-92	135.8	2016.9	2152.7	1761.1	**81.8**
1992-93	128.7	1987.6	2116.3	1738.7	**82.2**
1993-94	155.2	2228.3	2383.5	1948.4	**81.7**
1994-95	122.7	2468.2	2590.9	2126.6	**82.1**
1995-96	116.8	2369.2	2486.0	1975.5	**79.5**
1996-97	134.1	2223.7	2357.8	1930.8	**81.9**
1997-98	127.2	2258.7	2385.9	1881.5	**78.9**
1998-99	125.9	2031.3	2157.2	1599.6	**74.1**
1999-2000	137.2	2955.9	3093.1	2103.0	**68.0**
Total	**1271.3**	**22526.1**	**23797.4**	**18768.3**	**78.9**
Average	**127.13**	**2252.61**	**2379.74**	**1876.83**	**78.9**

Source: Division of Seed Technology, Central Potato Research Institute, Shimla.

In addition to the traditional method of seed potato production, CPRI, Shimla has come out with several innovations to augment basic seed production. These include techniques like rapid multiplication through sprouts, micro tuber production using tissue culture, indoor mini tuber production for rapid multiplication of seed stocks.

True Potato Seed for Crop production

An alternative propagule to raise potato crop is true potato seed (TPS) also known as the botanical seed. The TPS has several advantages in terms of cost reduction, disease control, storage and transportation etc. About 100-150g of TPS costing Rs 3,000/ha is required for crop production against 2-3 tonnes/ha of seed tubers costing Rs 20,000-30,000/ha. On the basis of multilocational trials, hybrid populations (TPS C 3 and HPS1/13) have been recommended for release. These populations yield 26.8-33.7 tonnes/ha compared with 20.8-26.9 tonnes/ha from standard tuber varieties in eastern India, Madhya Pradesh and Gujarat (Shekhawat *et al.*, 1999). TPS is now being produced in bulk by the Tripura, Karnataka and West Bengal governments, NSC, SFCI, Centre for Technology Development, Bangalore, Kumaon Development Center and several private firms like Mahyco Seed Company, Microplantae, Pune etc. The TPS technology for crop production is suitable for certain areas in the country (CPRI, Shimla 1999).

There are two methods for crop production by using the TPS. In first method, tuberlets (small tubers) are produced in nursery beds and in the next cropping season, these are used as seed tuber for raising potato crop. This method is suitable for those areas where potato-growing season is short such as in north Indian plains where early low temperature restricts growth of seedlings in field. In this method 15-20 cm raised nursery beds of 3m x 1m size are made with the mixture of soil + farmyard manures (1:1) as per requirement. In second method, seedlings are raised from TPS in nursery beds and transplanted in field for potato production. In this method, 30% tuber produced are of large size (more than 30 g) that could be used as ware potato and 70% may be used as seed tuber for raising potato crop in next cropping season as in first method. (Singh, 1999).

National Potato Marketing System

In India, agricultural marketing system largely operates under the forces of supply and demand. Trade is mainly in the hands of private enterprise, with governmental intervention mainly limited to protecting the interests of producers and consumers and to promote organized marketing of agricultural commodities (Govt. of India, 1992). The annual area and production estimates for potatoes are reported by the Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India. The National Horticulture Board (NHB), Gurgaon, reviews research and development of horticultural crops, including potato, and collects and disseminates information, arrivals and prices data collected from 33 major potato markets. Besides, NHB also promotes cold storage industry in the country. The NAFED is the nodal agency, in cooperation with state agencies, for implementing market intervention schemes.

At the state level, State Agricultural Marketing Boards and Directorates of Agricultural Marketing develop and regulate the markets in the organized sector. They also collect and disseminate market arrivals and prices data under the Agricultural Produce Market (Regulation) Acts. The state seed certification agencies in Bihar, Haryana, Himachal Pradesh, Karnataka, Punjab, Tamil Nadu, Uttar Pradesh, and West Bengal certify seed potatoes. Cooperative marketing societies like LPS in Himachal

Pradesh, commission agents, cold storage associations, processing plants in organized sector and cottage industry level and the retailers put together make up the marketing system for potatoes.

Potato Storage Infrastructure like transportation and storage play a vital role in marketing of farm products. For potatoes, fruits, dairy products etc. cold storage facilities are very essential. In India, nearly 85% cold storages and 92.4% of their capacity are located in potato-growing states. The private sector owns over 85% of cold stores and 88% of the capacity, remaining being accounted for by public and cooperative sectors. The cold storage industry has been decontrolled in India with effect from 27 May, 1998.

Two types of storage practices for potatoes are in vogue in the country. Seed potatoes are exclusively stored in cold storages while potatoes for table purposes are stored in cold storages for longer periods. For shorter periods, indigenous storage systems are used by the farmers. The state-wise cold storage capacity and percentage of potato production that has such facilities are given in Table 8. At country level 45.6% of the production could be cold-stored in 1990-91 and it has gone up to 48.3% in 1999-2000, still short of 50-60% of the ideal requirement. Moreover, growth of cold storage industry is highly uneven, for instance in Bihar only 26.1% of production in 1990-91 and 23.4% in 1999-2000 could be cold stored. Only Haryana and Punjab have more than optimum cold storage requirement for potatoes. The indigenous storage systems for potato are practised widely in Madhya Pradesh, Bihar, Gujarat, Karnataka, north-eastern region, and also in Punjab, and Uttar Pradesh to some extent. In Madhya Pradesh, the farmers have adopted innovatively 5 types of indigenous storage systems. These are Katchi hodi (pit), Pakki hodi, on-farm heap storage (dher), Kotha (room storage) and talghar (basement store). The construction costs for these storages are Rs 3,418, Rs 28,391, Rs 938, Rs 32,500 and Rs 35,018 having the average storage capacity of 28, 42, 33, 15 and 34 tonnes respectively. The potatoes are stored for 3-4 months till June-end and some times beyond it also. The farmers earn remunerative net returns, which are Rs 900, Rs 2,390, Rs 850, Rs 1,260 and Rs 1,500/tonne (1995-96) depending upon the storage type and time of sale (Dahiya, Khatana and Hangantileke, 1997).

Table 8. Cold-storage capacity available for potato storage in principal potato-growing states, Indo-Gangetic region and India during 1990-91 and 1999-2000

State	1990-91			1999-2000		
	Potato production ('000 tonnes)	Total cold storage capacity ('000 tonnes)	Production having cold storage facility (%)	Potato production ('000 tonnes)	Total cold storage capacity ('000 tonnes	Production having cold storage facillity (%)
Bihar	1,482.2	430.4	26.1	1,720.2	448.2	23.4
Haryana	152.5	192.7**	101.1	260.0	274.3**	84.4
Punjab	359.5	572.8	143.4	1563.2	1275.0	73.4
Uttar Pradesh	6,603.0	3,554.3	48.4	10,455.3	5710.0	49.1
West Bengal	4,482.4	2,089 3	42.0	7,482.3	3,673 5	44 2
Indo- Gangetic region	13.080.0*	6,953.2*	47.8*	21,533.7*	11,281.1*	47.1*
All India	15,253.6	7,727.9	45.6	28,000.1	13,405.9	48.3

* Includes production and capacity of Union Territory of Delhi

** 80% capacity utilized for potato storage. For other states, Indo-Gangetic region and All India 90% capacity utilized for potato

Market Structure and Price Analysis

The different types of market structures impinge upon marketing efficiency differently. Fluctuations in commodity prices are taken for granted but the revolutionary increase in potato production has been plagued by recurrent gluts and consequent price crashes. About 3-4 year cycles have been observed in potato. A comprehensive study in Farrukhabad showed that the market structure slightly concentrated oligopoly (Diwakar, 1990). The market integration and competitiveness of producing markets such as Farrukhabad, Kanpur, Meerut and Karnal with Kolkata market have been studied. That the producing markets are not integrated with Kolkata market during price crash, price hike and normal years (for the period 1974-75 to 1985-86). The market structure is segmented mainly due to infrastructural bottlenecks (Dahiya, 1995). This has been confirmed by the Quick Surveys on potato outlook conducted by CPRI, Shimla, annually ever since 1986.

The seasonal variations in wholesale potato prices in Kolkata, Delhi, Kanpur and Patna are presented in Table 9. The prices ruled below the annual average price (average for 1996 to 2000) during December - May for Delhi and Kanpur markets (seasonal index below 100). In Patna, prices registered seasonal index below 100 up to May and in Kolkata till April. High fluctuations in potato prices cause a setback to potato farm economy. This happened during glut years of 1975, 1979, 1982, 1985, 1987, 1988 and 1997, causing a great economic deterrence to potato crop improvement in the country (Dahiya and Sharma, 1999b). The potato growers experienced a similar plight during 2000 as well.

Table 9. Seasonality in wholesale potato prices in Kolkata, Delhi, Kanpur and Patna in India.

Wholesale price (Rs/q)

Month	Kolkata		Delhi		Kanpur		Patna	
	Average Price	Index	Average Price	Index	Average Price	Index	Average Price	Index
January	304	81	235	53	189	54	286	74
February	208	56	229	52	212	60	229	59
March	259	69	275	62	244	69	266	69
April	324	87	313	71	268	76	295	76
May	385	103	354	80	310	88	343	89
June	402	108	473	107	354	101	392	102
July	430	115	628	141	374	106	421	109
August	409	109	649	146	372	106	506	131
September	416	111	653	147	488	139	418	108
October	444	119	708	160	644	183	468	121
November	459	123	520	117	509	145	607	157
December	447	120	289	65	258	73	399	103
Overall	374	100	444	100	352	100	386	100

* Average wholesale price = Average of 1996 to 2000 wholesale prices.

Price Spread and Marketing Channels

The price spread consists of margins and costs in respect of price paid by the ultimate consumer. Narrower the price spread, generally better it is. Numerous studies have been conducted over the price spread of potato. According to DMI 1984 study on price spread of potato, the producer's share on All India basis was 59.25%. It is highest (73%) in Karnataka while the lowest (42%) in Bihar. On the basis of the All India price spread, Karnataka (73.31%), Delhi (70.03%), Tamil Nadu (64.47%), Madhya Pradesh (67.28%), Himachal Pradesh (66.52%), Uttar Pradesh (64.12%) and West Bengal (63.12%) exceeded this level resulting in better returns to growers. Only Gujarat (58.74%), Haryana (56.41%), Punjab (48.12%) and Bihar (42.30%) fell short of it. The lowest share in Bihar could be attributed due to wholesaler's costs and margins and retailer's margins were relatively high. The producer's marketing costs were 6.36% and the transportation costs added up to 2.68%. While the wholesaler's marketing costs and margins were found to be 8.16 % and 11.16%, the corresponding figures for the retailer's were 1.38 and 10.99% respectively. The DMI study (1984) had identified as many as 12 marketing channels for potato disposal in 11 states of India (Govt. of India, 1984). But only 4 channels are most popular. They are:

(i) Producer → commission agent → wholesaler → retailer → consumer

(ii) Producer → commission agent → retailer → consumer

(iii) Producer → cold storage → commission agent → wholesaler → retailer → consumer

(iv) Producer → wholesaler → retailer → consumer

Price Support Policy for Potato

Agricultural commodity price support has been part of economic policy since 1960s. The Himachal Government initiated a price support policy for potatoes way back in1972-73 and it was continued on an basis for over 2 decades. At the national level, support to potato prices was provided only indirectly by influencing market prices through announcing or withdrawing of export quotas till 1974-75 (Kahlon and Chandra, 1982). The Agricultural Prices Commission (now Commission for Agricultural Costs and Prices) in its 1975-76 report considered it inadvisable to introduce any price support scheme for potatoes due to inadequacy of cold storage capacity and the potential of heavy financial losses and instead recommended market intervention scheme (MIS). Again in its 1976-77 report, besides recommending MIS, it also expressed the view that potato processing should be encouraged. A high powered committee under Dr M S Swaminathan in its report (1981) also supported MIS for horticultural commodities. It is now the public policy for such perishable and semi-perishable farm products. In order to protect the growers of these horticultural/agricultural commodities from making distress sale in the event of bumper crop during the peak arrival period when prices fall to very low level, government implements MIS for a particular commodity on the request of the state government concerned, while sharing losses on 50:50 basis. So far MIS has been implemented for over 22 horticultural crops, including potato. (Govt. of India, 2001c)

Export Competitiveness of Potato

Globally 2 - 3% of potato production is exported in the form of table potato for human consumption, seed potatoes and processed potato products. The export and import of potato mainly takes place within the European countries. The Netherlands, Germany, Belgium-Luxembourg, France, Italy, and Canada, USA, Egypt, Turkey and Cyprus account for 80% of export trade. India's share in world potato export has been insignificant ranging from 0.04 to 0.44% during 1986-1999 (Dahiya, 2001a). India's exports show that we think of exporting potatoes only when there is a glut in the

country. Exports cannot be based on periods of gluts only if we want to maintain a steady global market (Ezekiel, Shekhawat and Sukumaran; 1999). In this regard, it has been emphasized that in a competitive environment, capturing and retaining foreign markets needs an assured supply of quality products (Dahiya and Srinivas, 1994).

India has a great potential of potato exports (Dahiya, 2000). The export of a commodity is determined by export surplus, quality output based on sanitary and phyto-sanitary standards, infrastructural support, competitiveness and export policy. For various reasons, false or true, it is widely held that the farm produce coming from the developing countries falls short of international quality standards. True to this view, it is believed in certain quarters that, 'even if it were possible to export Indian potato, there would have been no takers for the produce because they are not of international quality' (Anonymous, 2001). Technologically, Indian potatoes are highly competitive in world market as the potato production is free from the prohibitive diseases like wart, black scab, ring rot, tuber moth and nematodes, which are the barometer to phyto-sanitary standards. The export competitiveness of potatoes is presented in Table 10. Gulati, Sharma and Sharma (1994), found that the nominal protection coefficients (NPCs) for potatoes were largely above one during 1986-87 to 1992-93 when official exchange rates were used. It indicated that potatoes do not have export competitiveness. But with shadow exchange rate (with 20% premium on official exchange rate), the average NPC is 0.86 for this period excepting 1991-92 indicating moderate competitiveness. Using the average domestic price for January to June period, the NPCs have been worked out for 1992 to 2000. The Indian potato export is competitive, with NPC of 0.72 excepting for 1992, 1993 and 1998 (Dahiya, 2001b) indicating moderate competitiveness. Using the average domestic price for January to June period, the NPCs have been worked out for 1992 to 2000. The Indian potato export is competitive, with NPC of 0.72 except for 1992, 1993 and 1998.

Table 10. Export competitiveness of ware potatoes from India

Year	International price (Rs/q) *	Adjustment on International price (Rs/q)	World reference price (Rs/q)	Domestic wholesale price ** (Rs/q)	Nominal Protection Coefficient (NPC)
	(1)	(2)	(3)=(1)-(2)	(4)	(5)=(4)/(3)
1992	184.8	52.5	132.3	171.3	1.29
1993	211.6	57.7	153.9	180.4	1.17
1994	300.7	62.6	238.1	188.8	0.79
1995	424.8	69.6	355.2	226.3	0.64
1996	NA	--	--	--	--
1997	688.0	79.4	608.6	207.7	0.34
1998	432.7	83.6	349.1	448.2	1.28
1999	659.7	87.6	572.1	276.3	0.48
2000	218.5	93.7	124.8	124.8	1.0
Average	**390.1**	**73.3**	**316.8**	**228.0**	**0.72**

Sources: * Government of India, Various volumes, *Monthly Statistics of Foreign Trade of India* (Exports), DGCIS, Ministry of Commerce, Kolkata

** National Horticulture Board, Ministry of Agriculture, Govt. of India, Gurgaon.

Emerging Issues and Conclusion

In order to sustain the potato revolution in the country, several issues on the production front and marketing front stand out in bold relief. First and foremost is the need for the timely and accurate availability of national crop estimates and improvement of potato estimates in Bihar, north-eastern region etc. It is expected that by 2020, the average yield becomes about 25 tonnes/ha. The per capita annual production would have increased to about 32 kg by the time (CPRI, 1997). How can we achieve the utilization and consumption of potato in diversified form, in view of recurrent gluts, predominance of cereals in food basket, lack of appropriate policy support for potato marketing and so on?

These complex issues can be resolved through concerted policy measures. In conclusion, besides continuing annual quick surveys on potato outlook, the CPRI has initiated crop forecasting research in collaboration with the Department of Space, for the country. The future strategies should focus on a strategic policy framework for the *laggard* potato producing states. As regards potato storage, cold storing potatoes at 8-10°C with CIPC treatment should be encouraged but its socio-economics needs to be investigated critically. With a view to ensure on farm storage of potatoes for the various advantages by the small potato producers, the indigenous potato storage systems require to be refined and improved. The CPRI, Shimla has intensified research endeavours in this regard. On the marketing front, the package of policy measures include effective market intervention scheme, boost to cooperative marketing, improvement of market intelligence, global market surveys, special fillip to export of seed potatoes to Asian countries and export of processed products to Gulf countries and other markets, initiating export oriented research, setting up Potato Development Section by National Horticulture Board and Potato Marketing Section by APEDA, priority to potato movement in the country by the railways and an educative campaign on food value of potato. All this would call for stepping up investment in potato research from the level of 0.16% of value of potato output to 0.5% of value of potato output for securing a sustained potato revolution in the interests of food and nutritional security for the burgeoning population in the country.

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DEVELOPMENT OF MUSHROOM INDUSTRY IN INDIA – AN INTEGRATED APPROACH

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Mushroom farming differs from traditional agricultural activities. It does not require arable land and can be cultivated on waste as well as unproductive land. In fact, mushrooms are cultivated indoors on artificial substrates and due to the use of vertical space their land requirement is also far less. About 15,000 kg of mushroom protein is produced from one hectare of wasteland, whereas only 5,000 kg of protein can be produced from one hectare arable land. In India, urbanization and industrialization are eating away the arable land at a very fast rate, since majority of population in India is vegetarian, mushroom cultivation is highly beneficial as a rich source of protein. Food and Agriculture Organization (FAO) has also recommended mushroom as a food contributing to protein nutriton of developing countries. Mushroom cultivation is essentially a recycling process in which agricultural/industrial wastes are utilized as the substrate. The developing countries, therefore, are in a position to use these wastes with available cheap labour. Then only they are able to produce this source of protein and fight the protein malnutrition. Moreover, mushroom cultivation is an eco-friendly activity and it can also increase the income of small and poor farmers. During the last few decades mushroom has attained the status of a commercial crop. In Europe and USA, it has attained the status of a high-tech industry. Today, its cultivation has been taken up in about 100 countries of the world and its production is increasing at an annual rate of 7%. Present world production of mushroom has been estimated to be 5 million tonnes only, which is expected to reach around 7 million tonnes in the next 10 years.

Current Status

In India, about 50,000 tonnes of mushrooms are produced annually. However, if the same rate of increase is maintained the country may achieve the target of 1 lakh tonne in the beginning of this century. It need not be emphasized that along with increase in production, the consumption will also have to increase simultaneously. Presently, per capita mushroom consumption in India is a dismal low (20-25 g); whereas in USA, Germany, Britain, France, Italy and Canada it is as high as 2-3kg. Besides low production and consumption, average productivity of mushroom is also low in our country. To a large extent this is due to that in our country both seasonal as well as climate controlled cultivation are prevalent. Cultivation in the seasonal farm is being done uner low input, low-cost conditions and therefore their productivity is also low. Most of these farms use unpasteurized compost, chemically-treated casing soil and old low-yielding strains of button mushrooms. On the other hand in climate-controlled high-tech farms pasteurized compost and casing soil, improved cultural practices and high-yielding strains/hybrids of button mushrooms are used to ensure higher productivity. Although their day-to-day expenditure and cost of production are higher, the quality of their mushroom is generally better than those produced in seasonal farms.

India produces a number of crops, producing a large quantity of residues. The food crops alone produce more than 200 million tonnes of agricultural residues annually and even if we utilize only 1%

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of this quantity, (2 million tonnes) for mushroom production, we can easily produce one million tonne of mushroom. Thus, these data indicate tremendous potential in India. In coming century, our population is likely to increase further, our requirement will increase and hopefully the consumption and demand will also increase. To meet these challenges we have to increase our production accordingly. We have already entered the new century and before we develop our strategy to meet the challenges of the next 25 years it would be appropriate to identify and enlist our weaknesses and strength in this field. Our major weaknesses/disadvantages are:

- Lower and inconsistent yield.
- Lack of high-yielding and quality strains.
- Lack of indigenously manufactured machineries for high-tech mushroom farms.
- Lack of diversity. 85% production confined to white button mushroom.
- Low quality product with presence of residual pesticidal toxicity.
- Lack of availability and demand in the domestic market.
- High production cost especially in high-tech farms with imported technology/strains.
- Lack of price support and marketing system.
- Lack of processing and packaging technology, and quality control.
- Shortage of trained manpower for mushroom industry.
- Belated start of mushroom R&D and slow progress.
- Lack of coordination between R&D organizations and mushroom industry.
- Lack of awareness about the nutritive values of mushroom and poor promotional activities.
- Weak financial status of farmers and entrepreneurs and limited government assistance.

It is obvious that our weaknesses encompass a vide variety of aspects like production technology, post-harvest technology, marketing, human resource development and financial support besides a general lack of awareness about mushrooms among consumers. It need not be emphasized therefore that to remove these weaknesses an all out effort by all concerned whether in Government or private sector will have to be made. On the other hand, some of the strength/advantages inherent to India are:

- Abundance of agricultural residues.
- Varied agroclimatic conditions
- Cheap and abundant labour.
- A large cadre of scientific and technical manpower.
- Large domestic market.
- Majority of population being vegetarian.
- A wide base of cooperative farming, marketing and banks.
- An extensive network of R&D organizations.

Future Strategy

It is generally agreed that in the new century research and development strategy will be decided mainly on the basis of population, increase in income and urbanization. India is likely to touch one billion mark of human population and if the rate of increase is not lowered we are very likely to outnumber China in the next 50 years. Obviously, we will have to more than double our food production and similar increase will have to be ensured. However, this would need concerted and integrated efforts on various aspects of research and development in mushroom production.

RESEARCH AND DEVELOPMENT

Genetic Resources

To achieve such a challenging task our primary emphasis would be on the conservation of natural resources, particularly genetic resources, their improvement and successful management and utilization so that higher and sustainable production of diverse mushroom species could be ensured. The problems of poverty-alleviation and malnutrition could be effectively dealt with. For increasing the production of high-yielding strains/hybrids will be developed for the existing species of mushrooms, whereas new species of edible mushrooms will be identified and their cultivation method developed to diversify mushroom portfolio of our country. Besides lower production and productivity, there is a lack of diversity of mushrooms in our country compared to other countries. Presently, 13 genera/ species of edible mushrooms are being cultivated in different countries. The global share of white button mushroom is gradually going down. However in Indian context, about 85% of our production is of button mushroom, whereas 15% comprises oyster and paddy straw mushrooms. Although cultivation methods of some specialty mushrooms like black ear (*Auricularia* sp.) and milky mushrooms (*Calocybe indica*) have been developed but they are yet to be effectively transferred to the farmers. Similarly, cultivation of shitake mushroom (*Lentinula edodes*) on synthetic saw dust logs is also ready for transfer after some refinement sooner than later. It is obvious that lack of diversity in mushroom in India is not only coming in the way of increasing our production but is also an impediment in increasing the consumption of mushroom. Since, a diversified product range will obviously help in improving the marketability/consumption of mushroom in our country. In India, with varied agroclimate, specialty mushrooms can be cultivated in different seasons/regions at much cheaper cost. It may be pointed out that cultivation methods of most of the speciality mushroom is that they can be cultivated directly on a variety of agricultural and forestry waste without going for their composting.

Crop Production

Low productivity, low quality of the produce and high cost of cultivation are major weaknesses in production systems prevalent in our country. To harness the potential of high-yielding hybrid strains, good crop management practices with productive substrates, supplements, etc. will have to be worked out and adopted on a large scale. For such a strategy only need-based indigenous and cheap machineries should be developed and employed to increase the efficiency of workers. This will also reduce the cost of production, making this activity more competitive. One of the major problems in mushroom production in our country has been lack of sustainability mainly due to a variety of pests and diseases. An integrated pest management system based on resistant variety/biocontrol agents, biopesticides etc. will have to be worked out so that mushroom farming becomes a sustainable activity for producers and the consumers are saved from consuming the residual harmful pesticides occurring on chemically protected products. The preventive and curative measures to be developed will take care of both seasonal as well as climate-controlled farms.

Post-harvest Management

Mushrooms have a very short shelf-life and are highly perishable commodity and hence pose special problems of packaging and marketing. Therefore, due attention will have to be given to develop state-of-the-art methods of packaging and transport to prevent any qualitative or quantitative damage during transit, so that their availability and marketability in far-off places may be improved. Equal emphasis will be laid on their preservation and processing so that cost of canning and freeze-drying may be reduced on the one hand and more and more diverse processed products like pickles, soup-powder, ready-to-make recipes etc. are made available to consumers to meet their taste and likings, on the other. This will not only encourage value-addition, but will also increase mushroom consumption.

Increased purchasing power and urbanization are factors affecting increased consumption of processed food including mushrooms. Both of which have shown upward trend in India during last 10-15 years. Recent surveys have shown that number of people below the poverty line have deceased over the years. Hence, more and more people are likely to adopt mushroom eating both in fresh and processed forms.

Infrastructure

Mushroom a non-traditional indoor crop of our country, has suffered a lot due to lack of infrastructural support. In the initial decades mushroom farming was being practised in dwelling houses or in improvised huts leading to low-productivity and inferior quality due to disease and pest infestation. Only in the 90s with the establishment of Export-Oriented Units (EOUs) organized mushroom farms with adequate infrastructural support came into being where climate controlled growing rooms, pasteurization chambers etc. were provided which could help in raising the production and productivity and improve the quality of the produce. However, this remained confined to big commercial growers only and the small farming community continued to suffer with poor infrastructure and many potential farmers could not adopt mushroom farming as a cash crop despite their willingness to do so. However during Eight Five Year Plan, the Govt. of India launched a Central Sector Scheme for development of mushroom by creating necessary infrastructure for production of quality compost and spawn as "Mother Units". It was envisaged that these mother units located in different states would provide ready-to-use pre-spawned compost to farmers, which will help boost the country's production at a very fast pace. The scheme had also component for training of the farmers in mushroom production technology. Under the scheme, more than 3 dozen spawn units and 2 dozen compost production units have been sanctioned and altogether 25,000 farmers were required to be trained by the end of the Ninth Plan. During Ninth Plan, canning facilities have also been added to these mother units so that the problem of disposing the produce may also be tackled. It is evident that the Central Govt. has spent crores of rupees under the scheme and as and when it becomes fully functional it is likely to spread the technology to almost all the states of India involving a large number of farmers which will ultimately boost up the total mushroom production in the country.

However, in view of the slow progress of the scheme and lack of motivation among farmers, it is suggested that during the Ninth Plan mushroom parks with a viable number of growing units with climate controlled growing facilities may be established in the vicinity of mother units. These growing units may be leased to potential and trained mushroom growers who may obtain the inputs from the mother units and raise mushroom crops in their units throughout the year with better profitability and sustainability. In these parks, crops of diverse mushroom species during different seasons may also be encouraged to increase the profitability and to cut the cost of cultivation. The growers may sell their produce partly as fresh mushroom and may sell the rest to the mother units for canning and processing, if they so desire so that the problem of marketing could also be addressed to some extent.

HRD

It need not be emphasized that all these facets of research and development need urgent and special attention, because India has already lagged behind other players at the international level, since we were late starter and also our rate of growth in this field was rather slow. To make urgent amend, it is obvious that a special drive will have to be made to strengthen the R&D organizations along with human resource development so that all concerned with mushrooms may be given best training and exposure to newly-emerging techniques and findings on mushrooms. Similarly, training programmes meant for the technicians and other cadres of the industry will also be strengthened so that the shortage of trained manpower for mushroom industry in the country is removed sooner than later. A more meaningful interaction and coordination will have to be established between scientific institutions and the industry for immediate solutions to their day-to-day problems. Similarly, farmers also need to be trained in large numbers, if this non-traditional crop has to be adopted far and wide. Hence, establishment of some training organizations, especially devoted to mushroom cultivation is urgently called for, where trainers and trainees could be trained and their skill upgraded as and when needed.

Financial Support

The entrepreneurs in our country do not have strong financial position and hence they mostly depend on borrowed financial resources. The Government of India on their part will have to bring forth more liberal financial and other support to both small growers and entrepreneurs which may include loans at lower interest rate, subsidy and a price support based on quality control to help them in marketing their produce. Besides all these, an untiring effort to apprise the general populace about the nutritional and other qualities of mushroom will have to be made so that more and more people take to mushroom eating atleast as a "health food".

SUMMARY

India has a large domestic market for mushroom. The purchasing power of its people has been increasing over the years and its will further improve in the next century. With more increasing education and scientific temper, people are becoming more conscious of nutritious and healthy foods. Knowledge about nutritional and medicinal values of mushroom is also spreading fast. With the help of modern channels of information and communication, it is expected to be further accelerated in the years to come. It is explicit that the demand for mushroom in the domestic market will considerably increase and their production will have to be increased accordingly. However, not only their cost of cultivation will have to be reduced, so that it remains within the purchasing power of majority of the people, but also the industry will have to spend on mass media to make more and more people habitual mushroom consumers. At the global level, production of mushroom is increasing @ 7% annually and its demand is also increasing appreciably. However, recently the prices of mushroom in the world market have shown some recession due to export from some competitive countries like China at a very low price. Therefore, Indian mushroom producers will have to work with a more competitive zeal to make their produce cheaper and qualitatively superior, so that they are able to stand the stiff competition.

To meet the challenges of the next century we will have to augment or sustain the advantages at our command and at the same time will have to remove the weaknesses inherent in our system. If, abundance of agricultural residues, availability of cheap labour, diverse agroclimate, a large domestic market and an ever-increasing global demand are some of the major advantages to India; delayed'

entry of India in mushroom R&D and slow rate of development of scientific/technical capabilities, high cost of land and electricity, lack of machineries and power, poor financial status of farmers and entrepreneurs, lack of diversity in mushroom portfolio, poor product promotion in the domestic market, and stiff competition in the global market are some of the weaknesses to which India is adversely exposed. If with a concerted effort of one and all, we are able to remove majority of these weaknesses and if we adopt an integrated approach to address most of the weaknesses and advantages together, then India's production of mushroom in the 21st century is poised for a phenomenal rise, which we hope and cherish to achieve as early as possible.

STRATEGIES FOR DEVELOPMENT OF FLORICULTURE IN INDIA

M L Choudhary*, Ravindra Kumar, Renu Pandey and Chacko Priya Marie

India has a long history in flower cultivation but the story of commercialization is hardly a decade old. This was due to the initial planning where thrust was given to food crops. During the Eighth Five-Year Plan, Planning Commission had identified floriculture as a vibrant sector and thereby several developmental programmes were started for its promotion. No doubt there is a pressure on land due to organizations, industrialization and increase in population, which causes a gradual depletion of arable land. This situation has led to a decrease in land holding and per capita land availability. The Indian agriculture is primarily a traditional based agriculture where wheat, rice, maize etc. were given due importance during earlier plans. Since India has already achieved self-sufficiency, the small holding lands now looks for diversification while profit earning should be very important compared to traditional agriculture. Though there were initial glitches in floriculture promotion as well as floriculture export such as unorganized farming, lack of improved technology, production impediments, high cost of finance, management, infrastructure shortcomings and incorrect product mix. But after burning the fingers of farmers and close liasioning of the government and institutes have recovered the setbacks. During the Ninth Five-Year Plan, the GOI has again focussed on floriculture promotion and several activities like Model Floriculture Centres (MFCs) and Centre sponsored tissue culture laboratories and on-farm demonstrations by state departments were organized with a basic motive to acquaint with the technology and the type of flower to be grown for higher profit.

THE INDIAN ADVANTAGES

Nature has gifted our country with bountiful of natural resources in terms of varied agroclimatic conditions, perennial water resources, diverse soils, enormous native germplasm besides second largest human resources. In India, abundant sunshine throughout the year especially in autumn and winter is perhaps the first blessing for year-round production without depending on artificial light and related cost escalation due to additional energy inputs. The average radiation received (434 and 462 cal/cm^2/day) at Quito-Equator and Nairobi (2,895 and 1,800m above sea-level respectively), two of the best tropical production centres located near to equator matches with many of the places in India, especially with Bangalore (450 cal/cm^2/day). Besides, Bangalore offers uniform radiation throughout the year with maximum radiation (540 cal/cm^2/day) and minimum radiation (387 cal/cm^2/day) which are at par with the maximum (550 cal/cm^2/day) and minimum (368 cal/cm^2/day) at Nairobi (Kenya). Whereas the radiation levels are more or less uniform at Quito of Equator with maximum of 475 cal/cm^2/day and minimum of 404 cal/cm^2/day. Hence the need for artificial illumination does not arise in the Indian context, which is otherwise practised in Holland during winter months.

Ideal temperatures for tropical production of flowers should be over around 28°C day and 18°C during night. Of the Indian production centers, Bangalore (29°C day, 18°C night) offers the best climatic range, followed by Pune, Hyderabad and Delhi (32°C day and 18°C night). However, Bangalore and Pune with salubrious climate throughout the year are the most favorable destinations for floriculture hubs. Other centers with high temperatures in summer (Delhi and Hyderabad) and extremely low

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temperatures (Delhi) in winter dictates the use of energy-intensive cooling (Delhi and Hyderabad) and heating (Delhi) systems.

Besides, India possesses some other significant advantages. They are:

- A wide variety of soils suitable for flower growing thereby reducing the need to depend on costly artificial media.
- Relatively nearer to the new emerging markets like Japan, Australia and Middle-East.
- Shorter production cycle (only 45 days) from day of pruning to harvesting compared to 55 - 60 days in Kenya and Equador. Hence precise programming of flowering is possible in Indian conditions to meet the peak market demands.
- During the peak demand worldwide from November to March (Christmas, New Year Day, Valentines Day, etc.), weather in India is very conducive for top quality flower production. Also, unlike other African countries, this period is free from adverse climatic disturbances like monsoon and rainstorms.

Floriculture being a new sector faced several constraints in development. It took time for people to appreciate the economic importance of the floriculture activity and its potential for yielding better returns with higher profit. Though India is endowed with a wide variety of agroclimatic conditions and, is at the centre of the flower trade, a few important issues have been encountered with production, storage and marketing. Major emerging issues related with the Indian Floriculture Industry have been discussed below:

EMERGING ISSUES

Promotion of Floriculture among Small/Marginal Farmers

Small farmers constitute 78% of the total farming population, commanding 33% of the total cropped area. Floriculture being a capital-intensive activity, small farmers have so far not ventured into this field. However, floriculture is one activity by which farmers can derive maximum benefit out of smallest pieces of land available with them. So promotion of flower cultivation with higher returns will prove to be a viable option for diversification.

Technology Transfer

Commercial floriculture needs strong technology support for domestic and export markets. Alien technology imported by the export unit is very costly and does not suit to our climatic conditions. Several research institutes and SAUs have programmes for technology generation in their department for floriculture/horticulture. There quite a number of technologies developed from various institutes which are at par with alien technology but unfortunately it could not replace the existing technology due to poor technology transfer. Two major aspects of technology support needed are availability of quality planting material and production technology for major flower crops.

Infrastructure

Since floriculture has transformed into a commercial venture, we need a strong infrastructural support both for the production and shipment of the produce within a short period of time. Presently, infrastructural support for marketing is not very strong. The sudden growth in the flower export and slow pace of infrastructural development led to situations of imbalance in this regard. Non-availability of cool chain facilities and organized market affects quality and fails to fetch a good price both from

the export and domestic markets. It is high time that a strong marketing channel should be developed for quick disposal of produce due to highly perishable nature of the product.

Marketing Cost

Due to non-availability of organized marketing system in the country, cut flowers failed to get their due share of the cost of flowers paid by the consumer. The middleman (wholesaler and retailers) corners a large share. The marketing cost for flowers for export is extremely high, nearly 30 - 40% of the gross price. The components contributing to high market cost include high freight cost, limited cargo space, imposition of duty on imports from India in EU agents and other commissions.

Product Range

Since India is blessed with a wide range of climatic conditions right from Kanyakumari to Kashmir where a wide range of flower crops can grow, unfortunately it is not fully exploited to a greater extent. Presently, the Indian cut flower exports have a major constraint in terms of poor product range. It has so far been largely a mono crop (rose) export. The orchid export has suffered to low volumes. Export of other products has not proved competitive.

Human Resource

Inspite of India having a large pool of scientific manpower, availability of trained personnel for floriculture projects; whether for export or domestic market has been limited. The skilled worker force employed in large numbers by export-oriented units have proved expensive in view of low knowledge base and poor efficiency.

Based on the above emerging issues, certain strategy needs to be formulated to minimize the limitations of the Floriculture Industry and to overcome the stress faced by the growers.

STRATEGIES FOR DEVELOPMENT OF FLORICULUTRE

Database Formation

Information is one of the major tools for development of floriculture. Collection, classification and interpretation of data about economics of production, productivity, prices, etc. should be done. This data will be used by various government agencies to plan for future, work out strategies to counter problems faced by growers apart from assessing the current growth rate.

Increased Budgetary Support

The investment in horticultural research by the ICAR in the Central sector has increased significantly in the last two plans. The plan allocation on horticulture sector, which started in Fourth Plan with a modest allocation of Rs 34.78 million, was enhanced to Rs 768 million in the Eighth Plan, an overall increase in Plan Investment over 4 Plans being in 25 years. The current allocation both for plan-to-plan schemes of horticulture comes to Rs 216 crores by the ICAR. The plan expenditure for central Sector Scheme of the Department of Agriculture & Cooperation has also been risen tremendously from Fourth to Eight Plan. It is expected that horticulture will continue to remain as a thrust area in the Tenth Plan.

Genetic Resources, Conservation and Characterization

Plant genetic resources are the backbone of the crop improvement programme of the country. Their conservation is fundamental for their long-term availability. In horticultural crops, urbanization, decline of old plant material and unchecked exploitation of wild resources is causing a grave threat to

survival of indigenous and rare species and varieties of a number of crops. Many horticultural crops and cultivated varieties are indigenous to India. Systematic efforts have been put forth for the conservation of crop species.

Exploration

According to Vavilov, India is a primary centre of origin of many plant species next to China. In India, especially the North-East is considered as a house of many exorbitant and rare species of orchids and wild ornamental plants. Deploring these new spices and introducing them into the market would help our country to project their own product in the International market, just like Australia.

Strengthening Infrastructure Facilities

Special attention needs to be paid in this area, particularly for the marketing related support system. The domestic market infrastructural needs more attention to provide the cushion to absorb the surplus produce from export units. Provision of refrigerated transportation facilities will help in the speedy transport of flowers to the auction centres and cities. This will also help in the area expansion not only around major cities but also in localities connected with rail.

Technology Support

Production technology for major flower crops with demand in domestic and export markets needs to be standardized. The research institutions should be provided with resource support that will take up specific problem-oriented programmes. Location-specific crop development programmes need to be supported, so specific production zones with available strengths for major crops can be identified to receive concerted developmental efforts.

India still adopts the traditional method of flower production unlike other countries, which ultimately leads to poor quality and low yields of the produce. Hence, it is the need of the hour to give emphasis on adoption of innovative technologies like plasticulture, IPM, INM, etc. This goal can be achieved by the active participation of KVKs, Model Floriculture Centers (MFCs), etc.

Quality Planting Material

In order to obtain superior quality blooms good quality planting materials such as seeds, budded stocks, bulbs, tubers and micropropagated plants should be made available to the growers. Planting material required for export of certain produce in demand in importing countries should be made available by hassle-free imports or by encouraging licensed production of propagules in Indian nurseries and micropropagation units.

Development of Standard/Location-Specific Varieties

Since Indian varieties are not able to cope up with the International standards in terms of quality, the development of a standard variety which can match with the International standards needs serious attention. It is also necessary to identify the specific zones for the production of a particular crop. This will improve the quality of the produce in its best environment. For example, south India has been identified as the ideal location for the cultivation of *Anthuriums* and orchids, whereas north India (Delhi) for roses and chrysanthemums.

Ensuring Higher Productivity

Efforts should be made to achieve potential yields otherwise low yields lead to inconsistent supply, lower profits, non-uniform and poor quality produce.

Product Development

Research and developmental efforts should be directed for new product identification, which could have novelty value in the export markets. The wealth of beautiful flowers in the Himalayan regions needs exploitation through commercialization for 'niche' markets.

Post-Harvest Management

Flowers are most perishable commodities and require proper handling, storage and transportation. These things if not properly enforced, lead to considerable loss in quality as well as the economic value. There is a need to develop a strong post-harvest management right from harvesting to its placement to the final consumer. Standards have been developed for grading, ideal packaging materials and storage requirements of several flower crops in demand. Besides, priority should be given for maintenance of cool chain and pre-shipment treatments required by various importing countries.

Product Diversification

It is proposed that dry flowers and plants should receive special attention in the product diversification efforts. These constitute nearly 70% of the exports of the floricultural products from India. The demand in the domestic market is also growing. So far no scientific and systematic efforts have been made to provide the research and developmental support to this important product range. In view of the growing environmental concerns the demand for eco-friendly products in the global floriculture trade is increasing. It is suggested that programmes in research and development for organic farming of flowers be initiated in a few selected Institutions.

Developing Wholesale and Auction Markets

Indian wholesale markets have been dominated by middlemen or *dalals*, who keep the producers in the dark about the final selling price. Hence developing regulated flower markets where auction and wholesale of their produce at best prices can be done, is very much required. This could be done by coordination between various agencies like APEDA, State Agricultural Marketing Board, NHB, etc.

Area Expansion and Diversification

There is no much scope for horizontal expansion of area under floriculture as it faces a stiff competition from food crops and cash crops. The best possible alternatives could be by increasing the areas under greenhouse as the production per unit area is more than that in the open field conditions. Promotion of intercropping with loose flowers and rotation of food crop with flower crops would be a profitable venture. In addition, other possible alternatives are promoting terrace and backyard cultivation for high value ornamentals, promotion of flower cultivation for perfume and essential oil extraction, promotion of flower and foliage cultivation suited for dry flower production and promotion of certain flowers for pigment extraction.

Linkage with State Department

A strong linkage between growers/industry and institutes with the government is the most urgent requirement for smooth functioning of floriculture developmental programmes. The government can play a key role as the coordinating agency to cater to the demands of both industry/growers and institutes with its strong networks and resources around the state.

Enhancing Role of Women in Floriculture

Floriculture offers a wide range of opportunities to women in terms of employment, income generation, empowerment and above all self-fulfillment. Since a large number of women in rural areas

where floriculture is practised are already engaged in growing flowers, they have an opportunity to increase their income by taking to modernization in floriculture.

Encouraging Flower Production by Cooperative/Self-Help Group

To improve the profitability of farmers, formation of Growers' Cooperatives Associations or self-help groups should be promoted, which through cooperative/joint efforts in production and marketing may benefit through economics of sale, etc.

Human Resource Development

India can take full advantage in floriculture development if its manpower is adequately equipped with technical know-how. The existing mandate of the research institutes/SAUs etc. needs modification to develop the commercial edge. Suitable training and demonstration programmes are developed for upgrading the skills of farmers, research staff and extension personnel. Technology dissemination has particularly suffered due to poor extension support and hence, this aspect needs special attention. Since Hi-tech horticulture is a highly specialized and a high investment business, there is a need to provide vocational training facilities for middle level workers. Organizations like DOAC and NHB need to come forward in this area so that our potential is not affected merely by lack of trained manpower.

CONCLUSION

India possesses agroclimatic and locational advantages, thus enjoying an enviable position in horticulture, especially floricultural map of the world. In India, floriculture is estimated to cover an area of 73,536 ha with production of 3,65,685 tonnes of loose and 61,21,523 lakhs cut flowers. Inspite of these advantages, we have not been able to make a major breakthrough in the international front. Focussed attention of Government, enthusiasm of entrepreneurship, growing demand in domestic and overseas markets will result in an unprecedented growth. However, floriculture has to grow dynamically, addressing all the issues emerging fully backed by policy environment and research to advance sustainability. Evidently, floriculture is expected to grow well but have many challenges and advantages of the growth which can only be harnessed with the above mentioned strategies.

APPROACHES FOR CULTIVATION AND MARKETING OF MEDICINAL AND AROMATIC PLANTS

A.A.Farooqi* and K.N.Srinivasappa

Medicinal and aromatic plants have been used for a long time for their medicinal properties. About 2,000 native plant species have curative properties and 1,300 species are known for their aroma and flavour. The Indian systems of medicines, popularly known as Ayurveda, Unani and Siddha drugs are of great demand in the country. There is already a spurt in demand of plant-based drugs and lately many such native species of medicinal values are being brought under systematic cultivation.

In medicinal plants, China and India are major production centres having more than 40% of global biodiversity. International market of medicinal plants is over US $ 60 billion/year, which is growing at the rate of 7%. China besides meeting its domestic requirement is earning US $ 5 billion/ year from herbal trade. India at present exports herbal material and medicines of Rs. 446.3 crores, and according to recent estimates it can be raised to B 3000 crores by 2005 (Source: Planning Commision, March, 2000).

Conservative estimates of 'medicinal plant related trade' in India are reported to be about Rs 5.5 billion/year. The market demand for medicinal plants is growing exponentially, especially on the international scene, compared to domestic market. Of the total turnover of Rs 23 billion of Ayurvedic and herbal products, 'over-the-counter' products contribute to about Rs 12 billion. Ayurvedic ethical formulations constitute around Rs 6.5 billion and Ayurvedic classical formulations to around Rs 4.5 billion. The ever-increasing global market of herbal products is largely dominated by China, providing superior quality products at competitive prices. In order to become strong players in the international trade, India has to upgrade the quality of its 'goods' and tone its marketing skills. The marketing of medicinal plants can be roughly divided into 2 categories, viz. marketing of value-added items and non-value added items. While the former holds good for value-added products the scenario with non-value added products is rather dull.

With regards to aromatic crops, recent years have witnessed a rapid growth in the world demand for essential oils and natural aroma chemicals used in drug synthesis, food flavouring, fragrances, perfumes, cosmetics and related products. The world essential oil production at raw material level is estimated at around Rs 4,500 crores annually. Of this, 55-60% goes to food flavours, 15-20% as fragrances and rest serves as raw materials for aroma chemicals.

SCOPE

India is blessed with a wide variety of soils and agroclimatic conditions that supports a large variety of plants. Of these, about 65 plants have large and consistent demand in world trade. India, however, produces only limited quantities of these materials. In terms of market share in production value, India holds sixth place with a mere 7% share. On the contrary, we are still importing about 10 types of essential oils to the tune of 8,000 tonnes/annum.

At present, about 90% collection of medicinal plants is from the wild plants. Since 70% of the plant collections involve destructive harvesting, many useful plant species are endangered or threatened.

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Similarly, marketing of medicinal and aromatic plants being unorganized and unregulated often quality is not maintained. Since medicinal and aromatic plants sector has a number of stake holders having divergent interest, without proper coordination, sustained growth in medicinal and aromatic plants cannot be ensured. The emergence of new intellectual property regime in the light of India's joining WTO is likely to pose important challenges in future. Medicinal and aromatic plants should therefore be viewed as a possible link between conservation of biodiversity, sustainable economic development and affordable health care.

As modern medicine has not been able to provide cure to some of the diseases like cancer, AIDS and arthirits, the future mankind is partially dependent for their health care needs on the flora of the tropical rain forests of the tropical countries of the world, like India. Screening of traditional medicinal plants and others is expected to provide drugs for antibiotic resistant infectious diseases, new epidemics, various cancers and AIDS, and ageing related ailments. Efforts are also underway to genetically engineer the plants to acquire life-saving medicinal properties.

India is one of the richest countries in the world as regards genetic resources of medicinal and aromatic plants. It accounts for 11% of total known world flora, though its total land mass occupies only 2.0% of the globe. India stands tenth among the PGR-rich countries and is one of the world's top 12 mega-diversity nations. Two out of the 18 'hot spots' in the world are in India. Moreover, India is bestowed upon with remarkably diverse agro-ecological conditions facilitating immence possibility for introducing and domesticating new exotic plant species. Even though, over 105 plants provide the basis raw materials used in modern medicine world over, the number of plants thus exploited in India is as small as 40.

Many medicinal and aromatic plants are hardy, need minimal care and are not attacked easily by pests and herbivorous animals. Often the whole plant is used. Thus the cultivation of medicinal and aromatic plants is more economically lucrative to farmers compared to conventional cash crops. Thus the need of the hour is to generate and publish data on the agronomics of growing the medicinal plants in large scale followed by demonstration of the economic viability to interested farmers under a buyback guarantee from the user herbal and essential oil industries.

CONSTRAINTS

In the changing scenario, India has to enhance its research and developmental preparedness in the field of medicinal and aromatic plants to meet not only our current needs but it has also to emerge as a front runner at international level. Our research efforts have to be relevant, need-based, demand-and market-oriented, effective, efficient and visible. To achieve these targets, some priority areas warrant immediate attention. They are:

Identification

There is a need to identify the correct species before taking up the cultivation of these crops. Many a time, the supplies of herbal materials, either collected or cultivated fail to test for active principle present in particular herb. A common example is problem associated with *Phyllanthus niruri/amarus*. Availability of different species result in compounding the problem on the absence of required ingredient in the sample. This can also happen with other medicinal plants such as *Withania somnifera*. A small shrub resembling Ashwagandh was collected by a supplier from the wild around Mysore area in Karanataka. On testing for the active ingredient it was found that the collected herb was a different

plant material altogether, i.e. its genus was also different.

Starting Material

The starting material like seeds, cuttings, saplings etc. for these plants are not available anywhere for most of the plants required to be cultivated. In such a situation one of the alternatives is to collect the seed material from the commercial supply of such plants where the entire plant is used. For other plants, collection of starting material from the wild followed by captive regeneration using nursery techniques seems to be the only solution.

Lack of Availability of Propagation Material

There are many medicinal plants for which adequate propagation material be it vegetative or seed material is not available for commercial cultivation. It could also be due to shortages in the availability of commercial grade quality material. It is well-known that there is limited availability of material with medicinal and aromatic plants all over the country including the organization like Division of Horticulture; University of Agricultural Sciences, Bangalore; and Indian Institute of Horticultural Research, Bangalore; Central Institute of Medicinal and Aromatic Plants, Lucknow Regional Research Laboratory, Jammu etc. Even with some private breeders, there are limitations in the availability of adequate seed or planting material.

Impact of Agroclimatic Conditions

Sometimes, cultivated herbal item which looks perfect morphologically, fails to accumulate or synthesize the active material if grown outside its natural habitat. In one example, this was the case with *Bacopa monnieri* cultivated in Andhra Pradesh by a well-known supplier. The active ingredient is present in very low amounts. It could be due to the differences in germplasm as well. Therefore, it is recommended that germplasm of *Bacopa monnieri* from northern and north-eastern states could be sourced for cultivation in southern states.

Limited Biomass

Due to inherent limitations, biomass of herbal items like Bacopa, and *Centella asiatica* is quite small, which means the cultivated crop is of higher price than collected item. Also, these crops tend to occupy a large percentage of farm area which could more efficiently utilized by cultivating other medicinal or cash crops.

Economic Viability

Information on economics of cultivation is almost entirely absent. As everybody knows, regardless of how much ever useful the crop may be, no farmer would come forward to cultivate it, if cultivation of that plant is economically unviable. Most of the farmers insist on knowing the returns per acre of land even before starting any discussion. Many farmers who regularly cultivate cash crops are reluctant to try cultivation of medicinal plants simply because they are not sure whether new crops can be economically lucrative. Initially, one may fear that cultivation is not economically viable, since the collectors of herbs from the wild do not need to spend money and time for land preparation, sowing, irrigation, weeding etc., while a cultivator has to do all the above and then wait till the plant part(s) to be used comes of right age, before it can be harvested.

Production Costs

As against the natural collection, the availability or product costs of some cultivated medicinal plants, are expected to be higher. However, for some materials the product costs may go down with the introduction of cultivation as a result of enhanced supplies.

Production Technology

Although some package of practices are available at the experimental level, but these are to be tested at the commercial field level. Moreover, problem of pesticides has to dealt with, as pesticides may have to be used at particular stage of cultivation. This is because pesticides residues have been observed in cultivated spices, turmeric and ginger. These can create problems during product development, either for domestic market or for export. According to the expert opinion, crop diseases cannot be eliminated easily. The research on use of biofertilizers and biopesticides in herbal cultivation has to be intensified to shortlist the usage of particular biofertilizer or biopesticide. This is more important as some pesticides may have to be used during storage.

Lack of Market Support

Market promotion is an important issue for development of this sector. When marketing turns global, it is the developmental agencies, which guide the producers on market promotion and pushes the commodity into world market. In the absence of any such promotional efforts by the Government or industry-aided agency, any venture in developing new variant of essential oil source of aroma and flavour rarely survives. The importance of Commodity Boards are well understood and realized in many South-East. Asiaan countries which are making huge investments in promoting their commodities.

Value-addition (Crude Drugs)

Trading of crude herbs as such has limited market scope. Very few herbs like senna, isabgol and *Gloriosa superba* are directly exported from India. For all other crude drugs, Indian herbal industries are the only available markets. These industries include the manufacturers of typical Ayurvedic formulations, herbal health food and beverages (very few in India), pharmaceutical companies (selected few items only) and other manufacturers of herbal human and veterinary products (major segment). Though there are more than 7,000 herbal products manufacturing companies in India, only 10 of them have a turnover of more than 50 crores, 25 of them between 5 and 50 crores and the rest 6,965 have a turnover of less than 5 crores. Thus, proportionately the consumptions of herbs by these 6,965 companies is accordingly small. Most of these companies are themselves struggling to survive in the market due to various reasons. These days the trend is that the developing countries have switched over to higher levels of value-addition. The vendors are being encouraged to do the basic value-addition in their respective countries. Thus, exports of crude drugs 'as such' is gradually declining and the export of semi-finished products in increasing significantly.

Proper Packing

Most of these crude drugs are sold in jute gunny bags . Many of the crude drug traders recycle these gunny bags many a times. It is often the complaint of consumers that because of gunny bags being contaminated with the material of prior transaction, the herbs are contaminated. Very often gunny bag would be so deteriorated that it can hardly hold the material which often spills in the transport vehicles or becomes prone to mix up as holes are formed due to prolonged usage and rough handling by the transporters. Some companies offer better prices simply because the herbs have been packed well.

Organically-grown Herbs

As stated earlier, pesticide, herbicide and weedicide residues are important concern to industries which are exporting their products to developed countries. As with vegetables, these days organically-grown medicinal and aromatic plants are also becoming very popular. Many regulatory bodies of different countries insist on a variety of certificates from the exporters of natural products like phytosanitory certificate, Koscher certificate, certificate of chemical analysis, HACCP certificate, cultivation certificate etc. Those herbs, which have a international market in the developed countries, can fetch 3- 4 times their prices if grown organically.

Market of Value-added Items

Apart from crude drugs, India is exporting many other products, which can be roughly classified into 4 broad categories they are:

Herbal extracts

This is one of the fastest growing export markets today. These extracts are used by a variety of manufacturers abroad, viz. herbal pharma industries, herbal cosmetics and health food industries. The major challenge here is standardization of the extracts up to international standards. This industry is generally a 'high volume and low to medium margin' type of industry since there is stiff competition from China. China exports more than worth Rs 16,000 crores of traditional herbs annually, whereas India exports only hardly Rs 285 crores (2 years ago, APEDA).

The USA alone exports herbs worth more than 60 crores US $ annually. The global herbal market is around US $ 62 billion. Of which, the European Union (EU) holds highest share (45%). The Germany occupies major share (25%), followed by Asia (19%), Japan (16%), North America (11%) and remaining countries (9%).

Essential Oils and Oleoresins

This segment is also growing steadily since many essential oils feed the perfumery and aroma therapy industry while oleoresins serve as a raw material to health food industries. The Spice Board of India is constantly encouraging export of value-added spices by offering grants under various schemes. The latest details on export of different spices, essential oils and oleoresins can be obtained from *Journal of Medicinal & Aromatic Plants* **22** (1A): 1-10, 2000.

Formulations

This is most potential segment. Unlike monoherbal extracts which have a short life-cycle as a product , the formulations has a longer life. Internationally the marketing of formulations is however equally difficult. Recently, USA has created a new regulatory body called Dietary Supplement Health and Education Act (DSHEA),1994. A survey shows that 50% of Americans regularly consume dietary supplements and place increasing reliance on non-traditional healthcare products. In another report an estimated 600 dietary supplement manufacturers produce approximately 4,000 products with annual sales of around $5 billion in USA alone. This industry is a high volume and high margin industry. The major challenges here are drug registrations and initially very high research and documentation costs. But for India it is the most potential segment since India has a rich knowledge and experience base of herbal products (Ayurveda, Siddha and Unani). Recently, Government of India has allotted a budget of Rs 1,000 crores for setting up of a 'Medicinal Plant Board' under the Ministry of Health and Family Welfare, Department of Indian System of Medicine.

Phytochemicals

Some phytochemicals are also gaining market as bulk drugs, natural food colours and natural perfumery chemicals. This is a dynamically changing market as the natural product chemist keeps discovering new bio-active molecules from plants while synthetic medicinal chemists keep find ways to synthesize these molecules in laboratories. These chemicals fall outside the preview of the herbal medicines or herbal drug supplements and are treated as strictly as chemical drugs. Thus, market of such chemicals is limited and requires very high levels of technological expertise.

Marketing problems

Post-harvest Technology

Many medicinal plants require proper post-harvest technology for cleaning, cutting and drying the harvest of economic parts/portions of medicinal crops. Common examples to illustrate this point include roots of coleus, and drying of marigold flowers. Some mechanical chopping and drying facilities are essential to impart efficiency while handling large harvest and to undertake drying when weather conditions are unfavourable. As farmers have little access to such facilities, quality of produce varies from season to season.

Storage

Non-availability of proper storage, leaves the herbal material open to the physical and economic damage.

Prices

Except for contract cultivation where prices are based on mutual agreement between buyers and farmers or farmers' leader who organizes the production on behalf of buyers, prices of other herbal materials/medicinal plants are generally based on demand and supply in the market. There is difficulty on part of buyers to frequently raise the procurement prices in the event of export prices going up owing to upswing in demand for extracts, or due to fall in local currency against US dollar or other currencies from the western markets. Similarly, farmers would not like buyers to revise the prices downward in case of export prices in rupee terms come down. However, either the regular domestic demand or export to the hard currency market should ensure that farmers must get their fair prices.

Market Infrastructure

There is general lack of modern market infrastructure to facilitate marketing on modern concepts.

Quality

Quality problems have been found to be more in medicinal plants than aromatic plants due to herbal nature of many medicinal plants, and on account of the sensitivity of various active principles present in crops of herbal origin.

Approaches for Improvement

To overcome these constraints, a coordinated and mission-mode approach is required among planners, administrators, scientists, developmental agencies, user industries and growers. If this path is followed, a great contribution to this important sector of medicinal and aromatic plants can be made which is directly related to our health and life-style. These plants are part of our national heritage and

let us join together to save, use and conserve it safely not only for ourselves but also for the coming generations. Some suggestions to overcome the constraints and thereby make a rapid stride in economic growth based on medicinal and aromatic flora are:

Exploitation of selected crops: Medicinal and aromatic plants are numerous. These should be exploited/ manipulated simultaneously. Select few where the country can hold the sway in international market. Gear up and concentrate all R & D efforts on these selected few crops. However, conservation of all other plant genetic resources must be done for future use.

Multiple choice of varieties/crops: More than one improved variety should be developed and released in each selected crop so as to offer genetic heterogeneity over space vis-à-vis disease epidemics. For the same reason, not one but all the available varieties in a crop should be spread in diverse areas of cultivation. Crop-diversification should also be likewise emphasized tactically.

Adjustable crop husbandry : In order to establish and expand the cultivation of aromatic plants in arable lands, development of suitable crop-husbandary, involving rotation and/or intercropping with conventional food crops must be a pragmatic proposition. Wasteland or dryland areas should be brought under cultivation using highly remunerative but stress-hartly aromatic grasses, etc. so as to alleviate the rural proverty and abridge the economic disparity.

Scientist-industry interaction/linkage : User industry should be invited frequently to the R & D institutions to discuss their problems and device a mechanism to provide scientific solutions to them through suitable sponsored projects. Industries can take advantage of the vast facility of research and development available at these institutions rather than developing their own R & D units.

Quality control : Maintenance of quality satisfying the international standards for aroma products and essential oils is really imperative to compete in the international market. This can be achieved chiefly by cultivating only genetically superior varieties of aromatic plants; wild bulk gives not only poor heterogeneous quality but also poor yield of the end products. Control of quality during distillation in aromatic plants is the next requirement. Both these facts need to be given utmost care and emphasis while cultivating the medicinal and aromatic plants for commercial exploitation.

Medicinal Plants Board: With a view to contain marked fluctuations in the price-structure of medicinal plants as also to offer financial support as a cottage industry. This board linking 5 other components, viz. user industries, growers, growers' cooperatives, extension units, and R & D institutions offering price-umbrella to growers, ensure prompt lifting of produce from grower's fields monitor the export and import affairs and impart necessary guidelines to the associated components and also to banking institutions for fiscal assistance to growers etc.

Efficient transfer of technology : Development of appropriately trained extension workers, adequate extension infrastructures and timely action hold the key to successful transfer of technology. Besides, there is no substitute to missionary zeal as international demand for herbal products is growing with remarkable pace. Faster release of improved varieties and other technologies and still faster transmission of information far beyond the precinct of R & D institutions may make the users take the advantage of timely demand of compete the international race for natural aroma products.

Chemical and pharmacological studies: There should be a drive to locate prospective molecules possessing anti-arthritic, anti-diabetic, anti-cancer and anti-viral properties in our diverse flora. Extensive work has to be taken up to develop drugs, elucidate its chemical and pharmacological action, prove its effectiveness and safety and also to patent them in favour of our country's economy.

Alternative uses: In a bid to find out alternative uses for medicinal and aromatic plants, an efforts should be made to evaluate our medicinal plant wealth for the pesticidal properties.

Post-harvest studies: Post-harvest processing of medicinal plants with emphasis on quality enhancement and value-addition should ascribe paramount importance. Chemists should develop fast, less cumbersome and inexpensive analytical procedures to determine the quality of medicinal plants, crude drugs and medicinal formulations.

Development of manpower: In order to meet the requirement of trained manpower in this specialized field, an intensive programme should be chalked out to train our human resource in leading international institutes and reputed laboratories both at home and abroad, to make them familiar with the latest technological advancements. These suggestions augur well with the prevailing international scenario relating to medicinal plants, essential oils and other natural aromatic compounds. India, the oriental giant, is truly in the take of stage and can once again capture the world market soon for many herbal products and essential oils by 2005 as envisaged.

CONCLUSION

Thus, it can be concluded that the medicinal and aromatic plant industry is in for a very bright future and can become a powerful leader globally. However individuals wanting to start fresh in this field should be careful with regards to the areas they select. A thorough assessment of techno-economic feasibility of any project should be undertaken prior to making any investments. The success of this industry will largely depend upon whether or not, we are able to cultivate medicinal and aromatic plants, not only for our national requirements but for the global requirements, without having to jeopardize our biological diversity.

CURRENT TRENDS AND STRATEGIES FOR DEVELOPMENT OF CASHEW

EVV BHASKARA RAO*

There is a perceptible change in crop status of cashew during the last decade. A crop which was considered as most appropriate for soil conservation, aforestation and wasteland development has now become an important horticultural crop with tremendous potential for export earnings. The export earnings touched an all-time high of Rs 2,569 crores during 1999 – 2000, exporting 96,805 tonnes of cashew kernels. Cashew is produced in 27 countries on commercial scale, most of which are in Asian and African zones, besides Brazil and South America. Together, these countries produce around one million tonnes of raw nuts of which almost 50% (499,299 tonnes) was produced during 2000 – 2001 in India. With a strong processing potential in the country India's import is to the tune of 2 - 2:5 lakh tonnes of raw nuts mostly from African countries, which is also processed. In effect in the total world production, India processes almost 75% of the nuts produced in the world. During last year, it was estimated that in the world trade, cashew kernel was to the tune of 1.29 lakh tonnes of which India exported 81,616 tonnes of kernels accounting approximately 60% of the world trade.

In India, cashew is cultivated in 7.12 lakh ha, Maharashtra having the share of 18.36% of the total area. Kerala with a share of 23.57% ranks first in production, producing 117,748 tonnes (2000 – 2001). Tamil Nadu with a share of 12.06% in area has very low contribution of 7.86% in production, and in West Coast Karnataka also with around 30.01% share of area contributes only 7.92% of the total production. Specifically Karnataka, Goa and Tamil Nadu should be considered for replanting of old and unthrifty/unproductive forest plantations which are developed in late 1950s and early 1960s. Majority of the area was maintained under neglected conditions with a large number of gaps due to the mortality as a result of stem-and root-borer infestation as well as natural calamities. Consolidation of the area under cashew in Karnataka, Goa and Tamil Nadu will be the first priority to be addressed. The estimated area and production of cashew in India is given in Table 1.

Table 1. Area and production of cashew in India (2000 – 2001)

State	Estimated			
	Area (ha)	Yield (tonnes)	Area	Production
Kerala	122,400	117,748	17.17	23.57
Karnataka	92,722	39,534	13.01	7.91
Andhra Pradesh	108,500	91,700	15.23	18.35
Goa	54,976	20,032	7.71	4.01
Maharashtra	130,824	115,376	18.36	23.1
Tamil Nadu	85,963	39,285	12.06	7.86
Orissa	89,401	65,099	12.54	13.04
West Bengal	9,220	6,827	1.29	1.36
Others	18,600	9,240	2.61	1.84
Total	**712,606**	**499,299**		

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Development of cashew industry has been much more faster than the development of production potential. As indicated earlier we process 75% of the world production but in reality India has the capability of processing almost the total production in the world of one million tonnes of raw nuts. With the emerging competition from Brazil, Vietnam and other African countries in the international market, proper strengthening of the processing capabilities, and concerted efforts are needed in terms of research support for increasing the production, upgrading the processing capability to improve the quality of processing and development support for scientific cultivation to boost the production and productivity. This calls for careful planning and execution of programmes on research and developmental fronts.

Cashew plantation

Cashew development programmes have been receiving high priority with increased allocation from Seventh Plan period onwards. The effect is apparent in terms of increased production during the past decade. From the production of 2.85 lakh tonnes during 1989 – 90, the yield has reached 5.20 lakh tonnes by 1999 – 2000. However, due to the adverse weather conditions and outbreak of pest incidence, crop suffered during 2000 – 2001, coming down in production to 4.99 lakh tonnes. But the trend analysis during the last 10 years is quite encouraging especially in view of cashew being recognized as an important horticultural crop. During the past one decade, the availability of grafts has considerably increased and we have almost achieved self-sufficiency in planting material generation. Annually 60 - 70 lakh grafts are available to the farmers for taking up fresh planting/replanting. The plantations which are raised in early 1990s are likely to reach their potential yielding stage during the Tenth Plan period. It is estimated that by the end of Tenth Plan, with 59.8% of area increase and 145.5% of production increase over 1990-91 level, we may have an area of 8.50 lakh ha under cashew cultivation with the productive area of over 7.55 lakh ha established in the yielding stage. The estimated production with the current growth of 6.32% annually will reach 7.24 lakh tonnes even if the productivity remains

at 941 kg/ha (Tables 2 and 3). Considering the world scenario it appears that there is a potential to market over 1.5 lakh tonnes of processed kernels in the international market. India should not get complacent and attempt to break into the non-traditional markets in South East and Far East as well as West Asian zones by aggressively marketing higher quantity of processed kernels. Projected yield will

Table 2. Area, production and productivity of cashew in India (1990-2007)

Year	Area (ha)	Productive area (ha)	Annual increase in area (per cent)	Productivity	Production (tonnes)
1990-91	5,32,000	4,64,000		634	2,95,000
1991-92	5,34,000	4,82,000	2,000	635	3,05,000
1992-93	5,60,000	5,08,000	26,000	709	3,49,000
1993-94	5,65,000	5,17,000	5,000	694	3,48,000
1994-95	5,77,000	5,10,000	12,000	631	3,22,000
1995-96	6,35,000	4,85,000	58,000	720	4,18,000
1996-97	6,59,000	5,15,000	24,000	835	4,30,000
1997-98	6,75,000	5,12,000	16,000	740	3,60,000
1998-99	7,06,000	5,73,000	31,000	800	4,60,000
1999-00	6,86,000	6,01,000	-20,000	900	5,20,000
2000-01	7,12,000	6,17,000	26,000	796	4,99,000
2001-02	7,33,410	7,06,000	21,410	819	5,78,214
2002-03	7,55,465	6,86,000	22,054	842	5,77,612
2003-04	7,78,182	7,12,000	22,717	866	6,16,592
2004-05	8,01,583	7,12,000	23,401	890	6,37,280
2005-06	8,25,687	7,33,410	24,104	916	6,79,904
2006-07	8,50,516	7,55,465	24,829	941	7,24,392

Crop loss, 23% in Andhra Pradesh (1997-98) 1997-98; 36% in Orissa (1999-00) due to natural disaster.

be mainly due to new orchards established with vegetatively propagated material of proven yield potential. Higher growth rates in productivity can be achieved with appropriate scientific interventions.

INTERVENTIONS

For increasing the productivity, the first priority to be considered should be increasing the production growth rate. As mentioned earlier even if productivity remains at 941 kg/ha, from present level of 796 kg/ha we can achieve a production of 7.24 lakh tonnes. In farmers' fields, many of the technologies are yet to be adopted. Only planting of grafts is being followed by over 95% of farming community with over 78% adopting recommendation of varieties. All the studies/surveys indicate adoption rates ranging between 35 and 48 for other recommendations. Promoting scientific cultivation through effective transfer of technology will certainly help in realizing the benefits of research efforts made during the past 3 decades. A number of technologies are available which can be profitably exploited.

Table 3. Growth rates during 1990-91 – 2000-1

	Cumulative growth rate				Annual growth rate		
Year	Area	Productive area	Productivity	Production	Production	Area	Productivity
1990-91					3.39	0.38	0.16
1991-92	0.38	3.88	0.16	3.39	14.43	4.87	11.65
1992-93	5.26	9.48	11.83	18.31	-0.29	0.89	-2.12
1993-94	6.20	11.42	9.46	17.97	-7.47	2.12	-9.08
1994-95	8.46	9.91	-0.47	9.15	29.81	10.05	14.10
1995-96	19.36	4.53	13.56	41.69	2.87	3.78	15.97
1996-97	23.87	10.99	31.70	45.76	-16.28	2.43	-11.38
1997-98	26.88	10.34	16.72	22.03	27.78	4.59	8.11
1998-99	32.71	23.49	26.18	55.93	13.04	-2.83	12.50
1999-00	28.95	29.53	41.96	76.27	-4.04	3.79	-11.56
2000-01	**33.83**	**32.97**	**25.55**	**69.15**	**6.32**	**3.01**	**2.84**

Varieties

Cashew is grown in India in 11 agro-ecological conditions which have got different bioclimatic parameters. In these, available soil water content, length of growing period and humidity vary considerably. In the country, there are over 40 varieties which are released for different agroclimatic regions. Varieties which are best-suited have been identified for each of the cashew-growing districts in different States (Table 4).

Cashew, Vridhachalam-3 (VRI-3)

Table 4. Varieties recommended for different agro-ecological sub-regions and bioclimatic conditions

Region No.	Agro-ecological factors/ bioclimatic conditions	States/districts	Varieties recommended
		Andhra Pradesh	
07.3	Eastern Ghat (south), hot, moist, semi-arid/dry, sub-humid ESR with medium to deep loamy to clayey mixed red and black soils, medium AWC and LGP 150 – 180 days [H6Dm (CD)5]	West Godavari, Krishna, Guntur, Prakasam and parts of Nellore districts	BPP-6, BPP-8, BPP-4, Ullal-1, Chintamani-1 and VRI-2
		Tamil Nadu	
08.1	Tamil Nadu uplands and Leeward flanks of South Sahyadris, hot, dry, semi-arid eco-subregion with moderately deep to deep, loamy to clayey, mixed red and black soils, medium AWC and LGP 90 – 120 days [H6Dd3]	Tirunelveli	VRI-2 and VRI-3
08.3	Tamil Nadu uplands and plains, hot, moist, semi-arid ESR with deep red loamy soils, low AWC and LGP 120 – 150 days [H1Dm4]	Dharmapuri, North Arcot, Chengalpattu, Villupuram, South Arcot, Tiruchirapalli, Thanjavur, Puduk-kotta	VRI-2 and VRI-3
		Orissa	
12.1	Garjat hills, Dandakaranya and Eastern Ghats, hot moist sub-humid ESR with deep loamy red and lateritic soils, low to medium AWC and LGP 180 – 210 days [J2Cm6]	Kalahandi, Phulabani, Balangir, Sabalpur, Sundargarh, Koraput	BPP-8, Bhubaneswar-1 and Dhana
		Andhra Pradesh Major areas of East Godavari	BPP-6, BPP-8, Ullal-1
		Orissa	
12.2	Eastern Ghats, hot, moist, sub-humid ESR with medium to deep loamy red and lateritic soils, medium AWC and LGP 180 – 210 days [H2Cm6]	Puri, Ganjam, Cuttack, Baleshwar [parts of 12.2 districts also fall into 18.4]	BPP-8, Bhubaneswar-1 and Dhana
		Andhra Pradesh Interior parts of Srikakulam,	BPP-6, BPP-8, Selection-2,

		Vijzianagaram, Vishakapatnam, East Godavari, West Godavari	Ullal-1
12..3	Chhotanagpur Plateau and Garjat hills, hot, dry, sub-humid ESR with moderately deep to deep loamy clayey red and lateritic soils, medium AWC and LGP of 150 – 180 days [J2Cd5]	**West Bengal** Parts of Midnapore and Bankura are covered under this – part of Midnapore comes under 15.1	BLA-39-4, Jhargram-1, BPP-8
15.1	Bengal basin and north Bihar plain, hot moist sub humid ESR with deep loamy to clayey alluvium – derived soils, medium to high AWC and LGP 210 – 240 days [08Cm7]	Parts of Midnapore	BLA-39-4, Jhargram-1, BPP-8
18.4	Utkal plain and east Godavari delta, hot, dry, sub humid ESR with deep, loamy to clayey coastal and deltaic alluvium-derived soils, medium AWC and LGP 180 – 210 days [S7Cd6]	**Andhra Pradesh** Part of Srikakulam, part of Vijzianagaram, part of Vishakapatnam, part of east Godavari, part of West Godavari [coastal areas fall into this category, while interior parts fall into 12.2] - East Godavari – major area falls under 12.1] **Orissa** Part of Puri, Ganjam, Cuttack, Baleshwar	BPP-6, BPP-8, BPP-4, Ullal-1, Chintamani and VRI-2 V-4, BPP-8, Dhana
19.1	North Sahyadris and Konkan coast, hot humid ESR with medium to deep loamy to clayey mixed red and black soils, medium to high AWC and LGP 210 – 240 days [E6B8]	**Maharashtra** Thane, Raigarh, Ratnagiri, Sindhudurg [coastal areas fall in to 19.3]	V-4, V-6, V-7, Dhana, Kanaka, Goa-1, NDR-2-1, Ullal-1, Ullal-3, Ullal-4, VRI-3, V-1, VRI-2 and BPP-8
19.2	Central and south Sahyadris, hot, moist, sub-humid to humid transitional ESR with deep loamy to clayey red and lateritic soils, low to medium AWC and LGP 210 -270 days [E2Cm (B)7(8)]	**Kerala** Part of Kannur, Wayanad, part of Kozhikode, part of Malappuram, part of Palakkad, part of Thrissur, part of Ernakulam, Idukki, Kottayam, Pathanamthitta and Kollam **Karnataka** Part of Uttara Kannada,	VRI-3, Kanaka, Dhana, VRI-2, NDR-2-1, Selection-2, Ullal-3, Priyanka, Amritha, Ullal-1 and Ullal-4

		Shimoga, part of Chikmagalur, part of Dakshina Kannada, and Kodagu **Goa**	
19.3	Konkan, Karnataka and Kerala Coastal plain, hot humid to per humid transitional ESR with deep, clayey to loamy, acidic, coastal alluvium – derived soils, low AWC and LGP 240 – 270 days [R7A(B)8(7)]	**Kerala** Part of Kannur, Wayanad, part of Kozhikode, part of Malappuram, part of Palakkad, part of Thrissur, parts of Ernakulam, Idukki, Kottayam, Pathanamthitta and Kollam part of Kasaragod, and part of Trivandrum **Goa** Coastal areas of Goa **Maharashtra** Coastal areas of Thane, Raigarh, Ratnagiri and Sindhudurg	V-4, V-6, V-7, Dhana, Kanaka, Goa-1, Selection-2, NDR-2-1, Ullal-1, Ullal-3, Ullal-4, VRI-3, V-1, VRI-2 and BPP-8

While establishing new orchards, it is also suggested that multiclone orchards may be raised to preserve and exploit the natural cross-pollinated nature of the crop. Planting more than one clone in a garden also gives the insurance against the total crop loss in a single variety when it succumbs to adverse weather conditions prevailing during the flowering period or sudden outbreak of pest. Clones should be chosen in such a way that they differ in flushing and flowering period so that the full orchard does not succumb to any kind of biotic or abiotic stresses in a given year. The main pest which is causing severe loss of cashew crop is the tea mosquito bug (TMB). The peak activity of TMB in different states has been studied under All-India Coordinated Research Project on Cashew. It has been found that it differs in the west coast and east coast and also during different years based on variations in meteorological factors. In order to perpetuate ecofriendly cultivation practices it is recommended that varieties may be chosen in such a way that flowering does not coincide with the peak activity of TMB in a given location. The activity of TMB is also depending upon the weather factors in different years (Table 5). Fortunately the same weather factors also influence either preponement of flowering

Table 5. Peak period of activity of TMB in different locations

	1998-99	1999-2000	2000-2001
West Coast			
Chintamani	Jan-Feb	Jan-Feb	December
Madakkathara	Dec-Feb	Jan-Feb	Jan-Feb
Vengurla	Nov-Dec	Jan-Mar	Jan-Mar
East Coast			
Jhargram	Jan-Feb	Dec-Jan	January
Jagadalpur	Jan-Feb	Dec-Jan	January
Vridhachalam	—	Mar-Apr	Mar-Apr

or delaying the flowering response. These factors are to be taken into consideration while making the varietal recommendation for different locations. It is necessary that this is clearly brought to the farmers' knowledge so that they choose the variety which is specifically recommended for the area instead of cultivating variety of their choice based on the performance noticed at some other locations.

Nutrition

Another intervention which can greatly benefit is the fertilizer application. Even minikit trials conducted way back in 1970s have clearly indicated the response of cashew to nitrogenous fertilizers but seldom farmers apply fertilizer in the recommended quantity to cashew plants. With the additional investment of 14% higher cost, the yields can almost be doubled to get 101% profit (Table 6). The benefit with fertilizer application is much higher when mixtures of organics and inorganic are applied (Table 7). Yield from the trees giving very low yield of 300 kg/ha could be boosted up to 1 tonnes/ha through application of recommended doses of NPK and mixing with organics (10 kg poultry manure/tree/year). These are the simple technologies which can potentially increase the yield from the existing gardens especially the benefits are likely to be much higher when implemented in the orchards which have been raised during the past one decade with the grafts of recommended varieties. In west coast where the cultivation is mostly in undulating hilly terrain individual tree base terracing and crescent bunding as a soil conservation measure also can boost the yields significantly. This will also ensure adequate moisture in soil for effective utilization of fertilizers which are applied (Table 8).

Table 6. Effect of fertilizer application on cashew (1982 – 1994)

Treatment	Cumulative cost of cultivation	Increase over control (%)	Income (Rs/ha)	Net profit	Increase over control (%)
250g N:125g P_2O_5: 125g K_2O/tree/ year (control)	36989	-	52,450	15,461	-
500g N:125g P_2O_5: 125g K_2O/tree/year	39571	7	59,026	19,505	26
750g N:125g P_2O_5: 125g K_2O/tree/ year	42219	14	73,372	31,153	101

Table7. Effect of organic manures on the yield of cashew per year (14 years old cashew tree)

Treatment	Yield (kg/tree	Increase over control (%)
No manure application (control)	1.53	-
Only application of organic manure @ 20 kg poultry manure/tree/year	1.7	11
Recommended fertilizer doses (500g N:125g each of P_2O_5 and K_2O)	2.76	80
Full dose of NPK and 10 kg poultry manure/tree/year	5.14	236

Table 8. Effect of soil conservation on cashew (10 years old tree)

Treatment	Increase in yield (%)
Control plot	-
Individual tree base terracing with crescent bunding (4 m terrace)	127

Irrigation

Compared to the west coast, east coast region has relatively lesser precipitation and high summer temperatures. Cashew is cultivated only as a rainfed crop but the benefits of protected irrigation cannot be ignored. This is much more beneficial in areas with very low length of growing period. Even in soils with low water-holding capacity the protected irrigation at 200 litres/tree at fortnightly interval gives very attractive profit of 121 per cent increase over the unirrigated plants (Table 9).

Table 9. Effect of protective irrigation on cashew – 1987 – 88 (13 years-old trees)

Treatment	Total cost of cultivation Rs	Increase over control (%)	Total Income (Rs/ha)	Profit (Rs/ha)	Increase over control (%)
Irrigation @ 200 litres/tree once in 15 days during Nov-March	3480	74	15988	12508	121
Irrigation @ 200 litres/ tree once in 15 days during Jan-March	2740	37	10696	7956	41
Control	2000	—	7644	5644	—

There are some farmers especially in Maharashtra who are quite conversant with high production technologies in fruit crops. In cashew also, drip irrigation along with fertilizer application is highly beneficial in boosting up the yield upto 142 per cent (Table 10). This benefit is obtained especially in

Table 10. Effect of drip irrigation and fertilizer application on cashew

Treatment 1989-1998 (10 years)	Total cost of cultivation (Rs)	Increase over control (%)	Returns (Rs)	Profit (Rs/ha)	Increase over control (%)
Irrigation alone @ 80 litres/tree once in 4 days	39560	126	103134	63574	48
Fertilizer application alone-750g N, 187g each of P and K	21524	23	88186	66662	55
Irrigation and fertilizer application 80 litres/ tree once in 4 days and 750g N, 187 g each of P and K/ tree/ year	54060	209	157,793	103737	142
(Control)	17475	-	60356	42881	-

young orchards which are raised in the recent years. This technology helps in rapid development of the canopy and ground coverage in the shortest period. As cashew yield is dependent upon the canopy surface area which is exposed to sunlight, faster development of the canopy is one of the main reasons attributed to the higher yields in cashew especially in the young orchards. Therefore, it is recommanded that this technology is more relevant to new gardens which are being developed so that the benefit in terms of production from the area expansion/replanting can be realized much faster with a very short gestation period.

Intercropping

Popularization of the intercropping and cover cropping is also essential for cutting down the gestation period for returns in the early stages of orchard life. Cashew and pineapple cultivation especially in the hilly terrains is highly beneficial with the returns received from pineapple and also the benefit accrued in terms of soil conservation and water conservation by cultivation of pineapple in trenches across the slope (Table 11). In the plain lands of east coast even simple cultivation of cover crop helps in addition of organics and also acts as mulch during the high temperatures in summer resulting in higher yields.

Table 11. Intercropping and cover cropping in cashew plantation during the early period (first 8 years)

Treatment	Cumulative cost of cultivation (Rs)	Increase over control (%)	Total income from the system (Rs/ha)	Total profit (Rs/ha)	Increase over control (%)
Cashew + pineapple	56065	141	114,030	57965	316
Cashew + cover crop (*Mucuna bracheata*)	23243	-	41565	18322	31
Cashew alone – Control	23243	-	37168	13925	-

High-density planting

One of the new innovations in the cultivation of cashew is high-density planting which need to be intensively demonstrated in most of the states where replanting programmes are contemplated. The high-density planting with appropriate pruning from the beginning proved to be highly beneficial from the research trials conducted in Karnataka, West Bengal and Maharashtra. Plant density of 384 plants at a spacing of 6.5 m x 4 m in hedge row system gives best returns with 145% increase over the normal spacing (Table 12). In addition to the increased returns obtained from high-density plantings right from the initial years, soil health improvement in terms of leaf litter addition is certainly a good sustainable agricultural practice. This ensures recycling of nutrients which otherwise normally would have been lost due to the growth of weeds and clearing the weeds for collection of nuts which are the normally picked up from the ground. Thus, emphasis may be given for taking up high-density plantings

at least in 50% of the annually planted/replanted area contemplated for developmental support in the Tenth Plan period. If we are able to bring at least 50% replanted area under high-density plantings, the yield estimate at the end of Tenth Five Year Plan could be around 8.0 lakh tonnes. Therefore for popularization of high-density plantings, establishment of demonstrations in farmers' as well as Corporation plantations should be given high priority during Tenth Plan period.

Table 12. High-density planting of cashew

Treatment	Density No/ha	Total cost of cultivation		Returns (Rs)		Total profit (Rs)		Increase over control %	
		With pruning	with pruning	with pruning	without pruning	with pruning	without pruning	with pruning	without pruning
5m X 5m	400	38735	37571	97536	92182	58801	54611	94	73
6.5m X 4.0m	384	37102	36627	110837	104766	73735	68139	143	116
5m X 4m	500	50249	49069	114622	105000	64373	55931	112	77
8m X 8m	156	22329	21599	52480	53148	30151	31549	—	—

These scientific innovations/interventions in cultivation will certainly help in boosting up of production to much higher levels than projected earlier. Necessary support in transfer of technology should form a part of developmental component during the Tenth Plan period.

FUTURE OUTLOOK

The future looks quite bright for cashew. However, there are certain apprehensions which need to be addressed. The first and foremost is the price stability of raw nuts in the country. In the recent times great crash in the prices in most of the plantation crops has caused a lot of concern for the plantation crop farmers. Even in cashew due to fall in the international kernel prices the raw nut prices have considerably reduced, but unlike the other plantation crops produces, still raw nut price is at remunerative levels. Present rate of cost of cultivation with various scientific practices enumerated, the raw nut prices of Rs 30/kg appears to be a reasonable return. However, with the increased production anticipated during the Tenth Plan period from the orchards which are raised during the past one decade period reaching potential production stage, marketing concerns need to be addressed properly. One of the programmes at present contemplated in Tenth Plan approach document is to develop infrastructure for marketing and processing. At present processing is concentrated in Mangalore (Karnataka), Quilon (Kerala) and to a minor extent in Panruthi (Tamil Nadu) and Palasa (Andhra Pradesh). Maharashtra which is producing substantial quantity of about one-fourth of the production has very little processing capabilities established. Processing in the production centers itself will be advantageous to the farmers as the cost for transportation is not discounted by the processing industry from raw nut prices for transportation of the nuts to far-off places. Similarly establishment of marketing societies in different states will also free the farmers from the exploitation by the middleman who procure the raw nuts and sell it to the processors without involving themselves either in supporting the cultivation or processing. With the increased production there is a scope for increasing domestic market activity. Therefore, the processing units at farm level should also be encouraged for the small farmers to process raw nuts produced by them for selling the processed nuts in the domestic market. This will supplement larger units to concentrate on the export market while the small processors need not compete with the sophisticated processing units for marketing the kernels in the domestic market. Support for these activities through establishment of Marketing Societies and Growers' Cooperatives for small-scale processing and also popularizing the use of apples for additional returns to the farmer are the areas which should receive adequate attention in the strategy for the development of cashew in the country.

INTEGRATED DEVELOPMENT OF COCOA

P.P.Balasubramanian*

Cocoa (*Theobroma cacao*. L), a native of Amazon base of South America, got its entry into India in the early half of the 20th century. It is considered as a plantation crop like coffee, tea, rubber but it seldom receives the plantation status under the Indian Agrarian Administrative Sector. It is one of the major supporters of agro-based industry in India. Cocoa beans is the primary raw material for confectioneries, preparing beverages, chocolates and other edible products. The commercial sector in India hardly takes place in a major way in the international export trade. Majority of the processed cocoa products are consumed within India.

Cocoa is hardly grown as a mono crop. It is generally grown in the interspaces of coconut and arecanut gardens. In any groves of tall-growing palms where 40-50% sunlight penetration is possible, cocoa stands first to absorb such surroundings remaining symbiotic to main crop, providing as good an income as possible besides helping in the amelioration of soil conditions making it beneficial not only for its own growth but also for the benefit of the main crop under which it takes its shelter. Therefore, integrated development of cocoa means, in other words, integrated development of coconut and arecanut along with cocoa.

INDIAN COCOA SCENARIO

The area under cocoa prior to 1980 was 22,600 ha with an estimated production of 3,200 tonnes of dry beans. Kerala was the major state holding 18,000 ha with 1,500 tonnes of production, whereas Karnataka was the only other state where cocoa cultivation was existing with an area of 4,300 ha and production of 1,700 tonnes. Not much change took place in increasing the area but on the contrary a declining trend has been observed in both the states. In 1996-97, the area in Kerala and Karnataka was 10,240 and 1,160 ha, with 5,750 and 650 tonnes of production respectively. Since 1997-98, the non-traditional tracts of Karnataka. Andhra Pradesh and Tamil Nadu started production of developing cocoa. As on day, with the implementation of Eighth Plan programmes through distribution of high-yielding varieties in the form of clones and hybrid seedlings, the area under Karnataka has increased to 4,400 ha. Andhra Pradesh and Tamil Nadu, which are new entrants from later part of 80s have an area of 2,744 and 92 ha respectively. Kerala further dwindled down in its area to the level of 8,949 ha. The productivity of cocoa on an average stagnates at half a tonnes of dry beans per ha. The details of area production and productivity of cocoa as on 2000-01 is given in Table 1.

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Table 1. Cocoa-producing states in India

State	Area(ha)	Production (tonnes)
Kerala	8949	4400
Karnataka	4400	1700
Andhra Pradesh	2744	850
Tamil Nadu	92	45
Total	**16185**	**6995**

WORLD COCOA SCENARIO

Production

Commercial cultivation of cocoa commenced in Ghana. From Ghana it spread to Ivory Coast, Nigeria and Cameroon. In these countries there was an immediate expansion in area and they eventually turned out to be the major producers of cocoa in the world. Now Cote d 'Ivory is the largest producer of cocoa in the world, followed by Indonesia and Ghana, accounting for a total production of 12 lakh tonnes. Total world production is estimated as 28.01 lakh tonnes as shown below. Comparing to this, the Indian production of 6,000 tonnes being obtained from 14,000 ha is no where nearer to the global situation (Table 2).

Table 2. Cocoa-producing countries of the world during 2000-01

Country	Production ('000 tonnes)
Cote d' Ivory	1,200
Ghana	395
Indonesia	390
Nigeria	190
Brazil	147
Cameroon	115
Ecuador	80
Others	284
Total	**2,801**

Consumption

Netherlands and USA are major consumers of cocoa and cocoa products. Other consuming countries are Cote d' Ivory, Germany, Brazil, UK and France. (Table 3).

Table 3. Cocoa-consumning countries

Country	Production ('000 tonnes)
Netherlands	437
USA	439
Cote d' Ivoire	230
Germany	215
Brazil	202
UK	167
France	142
Malaysia	117
FSU	80
Others	772
Total	**2,801**

COMMERCE OF COCOA

Various cocoa products are confectionery in nature and highly palatable. It is a good balanced health drink and a consumable article. Owing to rich source of fat, it has gained importance in circles of navigation and army expeditions. India earned a foreign exchange of nearly Rs 9.65 crores in 1997-98 by exporting cocoa products (Table 4).

Table 4. Export potential of cocoa products

Item	1994-95		1995-96		1996-97		1997-98	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Cocoa beans	-	-	-	-	-	-	-	-
Cocoa butter	379	391	300	342	498	382	96	118
Cocoa powder	83	62	57	52	86	55	171	126
Chocolate/chocolate Confectionery	301	232	595	492	653	543	762	690
Other cocoa products	50	30	-	-	-	-	44	31
Total		**715**		**886**		**980**		**965**

Quantity tonnes;
values in Rs, lakhs

Kerala was the leading state in promoting cocoa cultivation. Massive area coverage was possible through distribution of cocoa seedlings. There was an attractive price for cocoa pods and beans prevalent

till 1980's. This favourable condition coupled with planting material distribution could bring about an enviable coverage under cocoa cultivation recording 29,000 ha of area under cocoa in 1980-81. Being a crop subjected to monopolistic exploitation of the available industrial units, however paved ways for fall in price in 1981-82 and 1982-83. Inadequate marketing network and fall in price since 1982-83 developed a sense of insecurity among farmers, which detrimentally affected its expansion, besides attributing to neglectful approach by the plantation community. Throughout 1980's wet beans price of cocoa remained below Rs 10/kg. Only from the beginning of 1990's the price gradually increased, varying from Rs 12 to Rs 17/kg which could help in restarting the cocoa cultivation. Average price of cocoa fetched by an Indian farmers is around Rs 17/kg of wet beans at present (Table 5).

Table 5. Domestic and international price of cocoa beans (dry)

(price, Rs/kg)

Year	Domestic	International
1996	48.95	48.40
1997	56.30	49.20
1998	60.00	55.70
1999	74.00	65.60
2000	64.00	38.80
2001	54.00	44.63

EFFORTS OF COCOA DEVELOPMENT IN THE PAST

A Central Sector Scheme providing training to farmers and laying out of field demonstrations on scientific methods of cultivation and on-farm processing of cocoa beans was implemented in the Fifth Plan and the same was continued in the subsequent Plan periods (Sixth and Seventh).

Cocoa Variety G IV 18.5

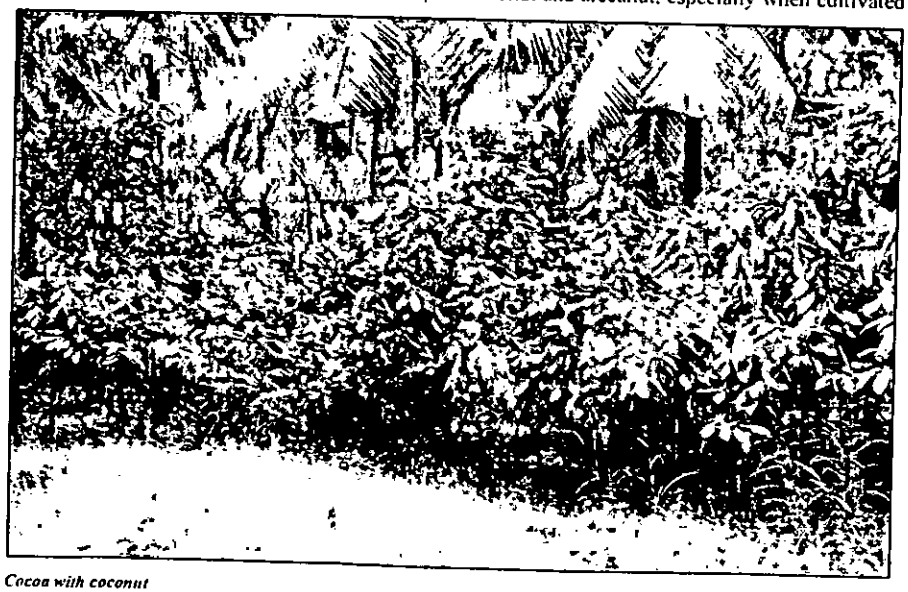
During the Eighth Five-Year Plan steps were taken to generate good quality planting materials, rejuvenate unproductive trees and support irrigation and marketing network besides measures for transfer of technology through demonstration and farmers' training programmes. The first National Seminar on Development of Cocoa Industry decided that all future plantings should be done only with vegetatively propagated planting materials. Until such time as enough vegetatively propagated planting materials are made available, F_1 Hybrid seedlings produced by different institutes could be utilized.

Even though a good beginning in this regard was made during Eighth Plan period, establishment of clonal seed gardens, demonstration plots and production and distribution of hybrid seedlings and grafts production, oriented programmes with a project approach and integrated measures were highly lacking. The infrastructural development also was very much limited particularly towards the generation of high-yielding clones and hybrid seedlings. Even though research institutes were assisted towards development of clonal seed gardens, there was no proper linkage with area coverage.

Suport for creating Infrastructure for generation of planting materials which has been provided only to research institutes which has been quite inadequate as compared requirement of planting material. Strengthening this area with the establishment of regional nurseries has become a thrust area in this regard.

NINTH PLAN STRATEGY

Experience over the years had shown that cocoa comes up very well in traditional areas in the country (Kerala and Karnataka) as an intercrop of coconut and arecanut, especially when cultivated



Cocoa with coconut

under irrigation. If properly managed with fertilizers and irrigation, the yield of main crop (coconut and arecanut) also increases. The experience in the farmers' fields also had been similar in the early years. It was considered that this crop combination is either compatible or symbiotic. The large return of organic residues by cocoa and the substantial build-up of organic-matter content of the soil were the reasons for the benefit to coconut and arecanut. To increase production, the unthrifty nature of existing cocoa gardens does pose serious problems. Rejuvenation by top-working method standardized by the research has been found beneficial. However, adoption of such practices is possible only in Kerala and Karnataka. Due to its high location-specific nature, adoption of such practices in large scale is rather difficult. Therefore, emphasis should be given again on new area development.

The productivity of existing gardens is not highly encouraging, as such productivity level is only just 30% of the potential exploitable by using high-yielding clones. The genetic inferiority of the existing plantations is one of the factors for low productivity. Contribution of the research has resulted in the availability of hybrids. Clonal multiplication of these varieties have a potential productivity of 3kg of cocoa/tree. Basic infrastructural build-up by regional nurseries is therefore the foremost approach in the Ninth Five-Year Plan. Technological development in cocoa by way proper nutrition, clonal multiplication, and pest and disease management are of recent origin. The transfer of these technologies among farmers is an essential part of propagating economic level of cocoa plantation management. Besides, adequate publicity of these aspects as one of the measures of transfer of technology, development of model cocoa clonal gardens is also envisaged in the Ninth Five Year Plan. To strengthen the present marketing systems in cocoa adequate infrastructure for the formation of marketing systems is also envisaged in Ninth Plan. Integration of production technologies is the salient approach of Ninth Five-Year Plan.

Infrastructure Available

Promotional activity on agriculture, particularly perennial agriculture, seldom stands aloof from the angles of research, development, input support, infrastructural facilities, organized marketing, processing and export activity. Indian agriculture has made a tremendous growth in the post-independent era and the growth of horticulture sector in particular has made commendable performance in the recent past as far as cocoa promotion is considered. Owing to its industrial and commercial value, the research sector have played a prominent role.

Cocoa Varieties

The research efforts have resulted in selection and hybridization whereby 11 high-yielding varieties have been recommended for large-scale planting. These varieties have the capacity to produce up to 4 kg dry beans/plant against 1 kg/plant being obtained from the existing plantations (Annexure I).

The research institutes and agencies assisted in Eighth Plan for planting material generation will provide the nucleus planting material (clone of high-yielding varieties) to identified agencies for

Annexure 1 Varietal wealth of cocoa

CPCRI, Kasaragod

Tree	Genotype	Bean weight	Yield dry bean (kg/plant)	Compati-bility
I-56	PaxNA32	1.20	6.99	SI
I-14	Jorgan Red Axil	1.17	7.51	SI
III-105	Amel x PA 7	1.06	3.98	SI
NC42/94	T86/2	1.08	3.03	SI

SI-Self-incompatible.

KAU, Trichur

Name	Mean number of pods	Mean pod weight (g)	No. of beans/pods	Mean yield wet bean (kg/plant)	Mean dry bean (kg/plant)
M 16.9 (CCRP1)	56.2	384.7	46.2	6.2	2.5
M 13.12 (CCRP2)	53.9	311.3	45.5	5.2	2.4
GI5.9 (CCRP3)	68.5	240.6	42.3	6.5	2.9
GII 19.5 (CCRP4)	66.2	402.1	45.4	8.3	3.9
GIV 18.5 (CCRP5)	37.9	425.0	45.2	4.3	1.7
GVI55 (CCRP6)	50.1	895.0	48.0	11.3	3.1
GVI56 (CCRP7)	78.1	526.7	46.9	9.7	4.0

establishment of regional nurseries in Ninth Plan. The regional nurseries established in the first 2 years will generate F_1 hybrid seedlings from the nucleus seed material obtainable from the research/ developmental agencies identified for such support in the Eighth Plan. From third year onwards the regional nursery will supply clones of high-yielding variety developed from their clonal mother plants stocked under each of such regional nursery.

Propagation

In view of high variability showed by seedling progenies, vegetative propagation is preferred

for a large-scale planting. Though vegetative propagation of cocoa by budding, rooting of cuttings and grafting are feasible, widely accepted method in India is budding.Standardization of grafting techniques is one of the novel contributions of research in the propagation front of cocoa.

Several state and central institutes are producing such grafts. The F_1 hybrid seedlings of compatible and potential parantage are also being advocated for a large-scale planting.

Management

Nutrient and irrigation are major inputs for achieving high productivity. Such agro-management practices have been standardized. The fertilizer recommendation for cocoa under average management is 100:40:140g of N, P_2O_5 and K_2O/plant for an year and cocoa-producing over 60 pods/year double this dose is recommended. Considering the potential of this crop to expand in other areas, locations-specific recommendations are necessary. Cocoa is susceptible to various diseases like black pod, cherelle rot, foliar infection caused by collectotrichum, stem canker, charcoal pod rot and zinc deficiency. While control measures have been evolved for many of the diseases, efforts are needed for controlling phytophthora infections and vascular streak dieback (VSD).

Demand and Supply of Cocoa

The demand for cocoa-based products in the country has been growing at a rapid rate of about 15-20% from 1994 onwards. As assessed based on nominal rate of growth the demand of cocoa beans is nearly 30,000 tonnes by 2005. Cocoa has a vast potential for exports as well which has not been tapped well so that India emerges as the net exporter of cocoa and cocoa products. As the current domestic production of cocoa beans is not sufficient to meet the demand, the industry had to import the shortfall. The demand and supply gap of 1996-2005 are given in Table 6

Table 6. The demand and supply gap of cocoa during 1996-2025

Year	Demand	Supply	Gap (tonnes)
1998	13,000	6,000	7,000
2000	1,72,000	6,000	11,200
2005	3,0000	10,000	20,000

FUTURE STRATEGY

Cocoa even though comes under the definition of plantation crops, pure plantation of cocoa as such is practically absent in India. Cocoa is generally taken up as an intercrop or more precisely a companion crop in irrigated coconut and arecanut gardens. To some extent it is grown under rainfed conditions in some parts of Kerala. The production of cocoa beans hardly meets 30% of the demand projected by the processing industry in India. As assessed, the demand of cocoa beans is 30,000 tonnes by 2005 AD. To step up the production to the projections of the industry, at least 23,000 tonnes is to be produced within a span of 10 years. In other words, if only a 20% annual growth rate is achieved, attaining 30,000 tonnes by 2005 is possible. In order to achieve this production level, 20,000 ha at least will have to be brought under cocoa during Ninth Five-Year Plan. In order to attain self-sufficiency, increasing the area by intercropping cocoa in available irrigated coconut/arecanut gardens both in traditional and non-traditional areas is the only way. Therefore, intercropping cocoa in 15,000 ha of irrigated coconut and arecanut garden with F_1 hybrid seedlings/grafts has been suggested in the Tenth Plan. To increase the production, the unthrifty nature of existing gardens is to be replanted/rejuvenated

by top-working method. Infrastructural support by establishiment of regional nurseries and transfer of technology through demonstrtion, farmers training and plant- protection campaigns are also insisted in Tenth Five-Year Plan.

By the execution of aforesaid developmental programmes the production of cocoa beans is believed to reach the level of 30,000 tonnes by 2009 AD (Table 7).

Table 7. Yield level projection of cocoa by 2009 AD

Base year	Production (tonnes)
1999-2000	6,000
2000-01	7,200
2001-02	8,640
2002-03	10,400
2003-04	12,430
2004-05	14,920
2005-06	17,900
2006-07	21,500
2007-08	25,800
2008-09	30,000

Since cocoa development falls under State Work Plan system, where ever potential areas are available, the states have to make an integrated approach for development of cocoa.

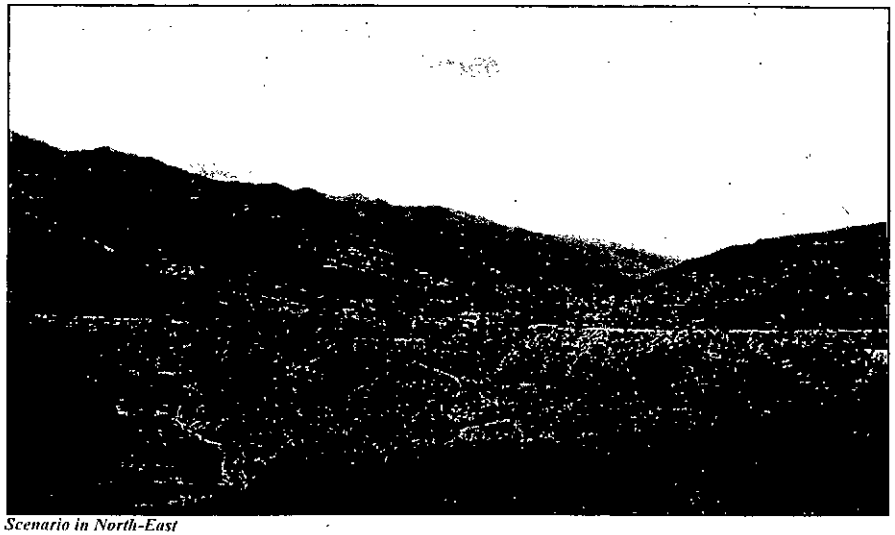
IMPLEMENTATION OF THE TECHNOLOGY MISSION FOR INTEGRATED DEVELOLPMENT OF HORTICULTURE IN NORTH-EASTERN STATES INCLUDING SIKKIM

J.S. Mann* and S.K. Kaul**

North-Eastern Region comprises Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. The region accounts for nearly 8% of the country's geographical area and about 4% of population. The topography of the region ranges from hills and mountains to riverine plains and plateaus. The climatic conditions in the region is diverse varying from temperate to subtropical and tropical. The average annual rainfall in the region ranges from 1,637 to 6,317 mm.

Background of the Scheme

A high level commission under the chairmanship of Shri S.P. Shukla, Member, Planning Commission, recommended in March, 1997, that the North-Eastern region needs to be given new thrust to horticultural development. An Expert Committee constituted by the Ministry of Agriculture, Govt. of India, under Chairmanship of Dr M.S. Swaminathan, recommended development of horticulture in North-Eastern states for rural prosperity in the region. A working group of Zonal Planning Team of Assam Agriculture University recommended in July, 1997, that North-Eastern region holds promise for quantum leap in horticultural development both in market expansion and production growth. The Ninth Five Year Plan of the Govt. of India also fully recognized the horticultural potential of the region and emphasized the Mission Mode approach for sustained development of horticulture in the region.



Scenario in North-East

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Based on these recommendations, a Centrally Sponsored Scheme on Technology Mission for Integrated Development of Horticulture in North-Eastern States including Sikkim was approved by Cabinet Committee on Economic Affairs on 27 February 2001 and the Mission was launched with an outlay Rs. 229.38 crores.

Goals of the Mission

- To establish convergence and synergy among numerous ongoing governmental programmes.
- To achieve horizontal and vertical integration of these programmes.
- To ensure adequate, approapriate, timely and concurrent attention to all the links in the production, post-harvest management, processing, marketing and consumption chain.
- To maximize economic, ecological and social benefits from the existing investments and infrastructure created for horticultural development in the region.
- To promote ecologically sustainable intensification, economically desirable diversification and skilled employment.
- To generate value-addition, promote the development and dissemination of eco-technologies.

Mini-Missions

The Technology Mission consists of 4 Mini Missions which individually address specific goals.

Mini Mission I	Research being coordinated and implemented by ICAR.
Mini Mission II	Production and productivity being coordinated by DAC and implemented by Horticulture Departments of the States.
Mini Mission III	Post-harvest management, marketing and export being coordinated by DAC and implemented by NHB, DMI, NCDC, NAFED and APEDA.
Mini Mission IV	Processsing being coordinated and implemented by Ministry of Food Processing Industries.

Components : Mini Mission I

i) Supply of nucleus/basic seed and planting material of horticultural crops.

ii) Standardization of production and protection technologies.

iii) Technology refinement and imparting training through on-farm trials on farmers' fields and imparting training to extension functionaries.

Implementation of Mini Mission II

- The Department of Agriculture and Cooperation has released funds to Indian Council of Agriculture Research for implementation of this Mission.
- ICAR is required to have close coordination with Directors of Horticulture of the States concerned and address the issues as per their needs under Mini Mission I.
- Directors of Horticulture are also required to have close liasion with the local ICAR station/SAU.

- The technologies and varieties of horticultural crops required by the states should be made available to them by ICAR.
- The states should regularly depute district level staff to ICAR stations to keep abreast of the latest technologies.

Components : Mini Mission II

- Area expansion—Planting material, replacement of old and senile orchards/plants.
- Creation of water sources—Community tanks or bunds, tube-wells and bore-wells.
- On-farm water management—Drip irrigation, microirrigation and green-houses.
- Production of planting material.
- Transfer of technology through frontline demonstrations, publicity, training of the trainers and training of the farmers, field level workers and officers of Department of Horticulture.
- Popularization of organic farming and use of biofertilizers.
- Promotion and popularization of improved tools and implements.
- Promotion of Integrated Pest Management—Biocontrol laboratories and disease fore-warning units.
- Establishment of Plant Health Clinic, Tissue/Leaf Analysis Laboratories.
- Entrepreneurial development of women farmers.
- Development of information base through remote sensing.
- Tackling of emergent requirements.
- Infrastructural support for horticulture.

Implementation of Mini Mission II

In order to ensure smooth flow of funds for implementation of the Mission activities, the funds are routed through Central Small Farmers Agri-Business Consortium (SFAC) to the State SFAC. The release of funds to the implementing agencies/beneficiaries in the state is required to be by the state SFAC.

- Cluster approach : Cluster/compact area approach would ensure integration of linkages between activities of all 4 missions and help eradicate jhum cultivation which is prevalent in North-Eastern Region.
- Area expansion should be linked with other components like plant protection, plasticulture, post-harvest management, processing and marketing.
- Selection of beneficiaries : beneficiaries

Passion fruit - a prospective fruit of NE

should be selected in a contiguous area, whole of the villages should be selected to ensure cluster approach.

- Only elite planting material/HYV should be used for expansion of crops in new area and for replacement of senile orchards/plants.
- Only grafted material should be used.

Production of Planting Material

- Assistance under this component is provided for establishment of multi-crop nurseries which include Progeny and Herbal Gardens, Tissue Culture Units by State Government, private, cooperatives and NGOs. Private sector should be encouraged to take up establishment of integrated nurseries, small nurseries and tissue culture units.
- The assistance excludes cost of land, building and barbered wire fencing which will have to be provided by the beneficiaries.
- Planting material of horticultural crops/varieties recommended by ICAR for North-Eastern states should mainly be multiplied at these nurseries.
- Mother plants should be obtained from ICAR institutes or obtained from outside from credible institutes/organizations.
- Nurseries should be established in such a manner that planting material of all horticulture crops can be multiplied and supplied in bulk.
- Nurseries should be located in the areas where area expansion has to take place.
- Nurseries should be self-sustaining after the initial grant.
- While selecting the beneficiaries in private sector preference should be given to agricultural graduates and in Government sector the nurseries should be manned by trained experts.
- In the absence of legislation/nursery act the State Governments should ensure quality control of the planting material produced by these nurseries.

Establishment of Model Floricultural Centres (MFCs)

- Total approved cost for establishment of one MFC is Rs 70.00 lakhs.
- Model Floriculture Centre (MFC) should serve as the focal unit for the development of floriculture in the state.
- State Government should prepare detailed project report having the details of location, infrastructure, equipment available and proposed to be Purchased.
- Crops should be identified for multiplication at the Centre and germplasm should be obtained from ICAR research station/obtained from outside from credible institutes/ organizations.
- Person responsible for managing the MFC should be trained and he should necessarily visit one of the MFCs already established in the country. The State Governments should ensure that the same person continues at least for 3 years at the Centre.

Integrated Mushroom Units

- Integrated mushroom unit primarily consists of composting, spawn production, training and a processing unit. The approved cost of establishment of an Integrated Mushroom Unit is Rs 50.0 lakhs.
- The person responsible for managing the mushroom unit should be a qualified Plant Pathologist.
- The mushroom unit should be established in the area where its consumption is assured or marketing is easier.
- While establishing the mushroom unit, be as per approved components provided in the guidelines and the layout of the mushroom unit could be as per design of National Research Centre for Mushroom, Solan, Himachal Pradesh.
- The staff responsible for running of the unit should be trained at NRC Solan.
- The compost and spawn should be made available to the growers at their doorstep through the truck provided to the mother unit.
- Mushrooms produced by farmers in the area covered by the Integrated Mushroom unit should be collected from the farmers, brought to the mother plant, processed and marketed. This would encourage farmers to take up this activity in wide areas.

TRANSFER OF TECHNOLOGY

Training of Farmers

- Beneficiaries should be selected from among the farmers already engaged in horticultural activities under various components. For a 7-day training programme a provision of Rs

Jack fruit in NE

1,500/farmer within the state and Rs 2,500 outside the State has been made in the scheme. The assistance involves transportation charges, honorarium to experts and per day allowance to farmers, and at the end of training, farmers should be provided with minikits of seed, planting material and spawn.

- Training schedule for a whole year should be drawn up in advance with the training institutes/research station.
- Development of women farmers needs to be given priority. Base line survey, training and formation of women cooperatives should be taken up as per existing programmes of Extension Division. These programmes should be included in action plans of the state.

Training of Trainers

- District/Block level horticultural staff needs to be trained in latest technologies preferably outside the state. For this a provision of Rs 50,000 is available per trainee. Staff should be trained at ICAR stations both within and outside state.
- Trained staff is required to be employed for providing further training to horticultural staff and farmers in the state.
- Provision has also been made in the scheme for establishing Supervisory and Gardener level Training centres. The states need to establish these centres, in consultation with ICAR, for in-depth penetration of the programmes in the state.

Organic Farming

- Since North-Eastern states are already very low chemical fertilizer-consuming states, the organic farming holds great promise and potential for ushering in organic horticulture which has immense preference from consumers within and outside the country.
- Production of organic compost, therefore, needs to be taken up in large scale at farmers' level.
- The scheme provides for establishment of vermi-culture units (earthworm) at a cost of Rs 30,000/unit. These units can be established by group of farmers, cooperatives, etc.
- For providing further impetus to organic horticulture, under the scheme, farmers could be given an assistance of Rs 10,000/ha for adopting organic farming.
- For making organic produce acceptable in the local and international market, a provision for assistance of Rs 5 lakhs or 90% of cost for obtaining certificate has been made. Certification can be availed by group of farmers.

Horticultural Equipments

- Latest horticultural equipments need to be popularized through training of farmers.
- Assistance @ Rs 1500/farmer is available for manually operated equipments, Rs 5,000 for power operated, Rs 45,000 for power tillers and Rs 9,000 for diesel engine.
- State Govt. should procure these equipments as per the laid down procedures.
- Beneficiaries should be selected from farmers already engaged in area expansion.

Pest Management

- Integrated Pest Management (IPM) is required to be adopted in horticultural crops/ orchards/plants for which assistance of Rs 1,000 per ha is available
- IPM includes use of biological, pheromones, biopesticides, etc. and mechanical control methods.

- Assistance is vailable for establishing Leaf Analysis Labs in private and Government sectors.
- Assistance is also available for establishing plant health clinics.

Mini mission III

NHB Programmes

The Department of Agriculture and Cooperation has released funds under the Technology Mission to the National Horticulture Board (NHB) for making these available to implementing agencies/ beneficiaries as per their approved programmes. They are:

- Development of commercial horticulture through production and post-harvest management back ended capital subsidy @ 20% of the total project cost up to a maximum of Rs 30 lakhs.
- Capital Investment Subsidy Scheme for construction/modernization/expansion of cold storage -back ended subsidy@33.3% up to a maximum of Rs 60 lakhs.

High density planting of pineapple

- Technology Development-100%.
- Strengthening of nutritional status in rural areas-@Rs 250 minikit per family, Rs 2,500 for zero energy cool chambers and Rs 5,000/school for demonstration.

Projects relating to above NHB programmes are required to be submitted to NHB directly in the prescribed proforma available with them.

Programmes of Directorate of Agricultural Marketing

Under the Technology Mission the funds for development of markets are routed through Central Small Farmers' Agri-Business Consortium. The proposals of the states in this regard are required to be sumbitted to Directorate of Marketing, Faridabad or to SFAC. The funds would be made available to the states for market developmental activities on the proposals recommended to Horticulture Division (T.M.Cell), DAC, by the Directorate of Marketing.

Components

- Development of wholesale markets @ 50% of the project cost up to a maximum of Rs 50 lakhs.
- Development of rural primary markets @ 50 % of project cost up to a maximum of Rs 7.5 lakhs.
- Development of Apni Mandis @ 50% up to a maximum of Rs 7.5 lakhs.
- Quality control through strengthening of laboratories –100% of the project cost up to a maximum of Rs 2.5 lakhs.
- Promotion of Agmark in domestic trade by strengthening the State Grading laboratories and agricultural marketing information network.
- Alternate marketing system-25% of the project cost up to a maximum of Rs 60 lakhs.
- IT networking of major markets.

Mini Mission IV-Nodal Agency-Ministry of Food Processing and Industries (MFPI).

Under the Technology Mission, funds relating to projects for establishment of processing industries in the states would be routed through Central SFAC. However, SFAC would make available funds to the states on the recommendations of the MFPI. Therefore, the states are required to send their proposals either directly to MFPI or to SFAC in order that these could be attended to without delay. The financial assitance is available on the pattern of the approved schemes of the Department of Food Processing Industries.

Components

Promotion of new units.

Revival of existing units

Promotional activities.

Physical targets-MM-II *(ha/no)*

Component	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura
Area expanhsion (ha)	1310	1210	1750	1760	1100	1570	1600	1050
Model Floriculture Centres	1	1	--	1	1	--	--	1
Integrated Mushroom Units	1	1	--	1	1	--	1	1
Community Tanks	1	5	2	3	2	3	2	1
Tube-wells	2	10	10	17	14	30	--	10
Nursery (large) (Pvt.)	2	1	2	--	--	--	--	--
Nursery (large) (Pub.)	2	2	3	3	1	1	2	1
Nursery (samall) Pvt.	4	2	5	--	--	--	--	--
Nursery (small) (Pub.)	12	--	7	4	5	4	4	3
Tissue culture lab	--	1	--	1	--	--	--	1
Training of farmers	1700	100	300	530	300	900	3000	700
Training outside state	200	290	140	300	200	100	300	100
Training trainer	10	7	15	16	10	10	10	--
Training centers	1	1	--	2	1	--	1	--
O.F. (Earth-worm Unit)	5	4	7	4	6	5	5	5
Incentive for organic farming	100	50	220	200	150	50	60	150
Equipment (manual)	400	600	100	220	200	600	800	200
Power operated	100	--	200	--	100	70	200	50
Power tiller	10	123	20	20	15	60	3	20
Diesel engine Adoption of	30	100	22	20	50	--	--	--
IPM(ha)	300	1000	400	2000	300	--	200	200
Disease forecasting lab.	1	2	1	1	1	--	1	1
Leaf analysis lab	--	1	1	1	1	--	1	1
Plant health clinic	1	2	1	1	1	--	1	1

Mission-wise financial targets of the Technology Mission on Integrated Development of Horticulture in North-Eastern States including Sikkim for 2001-2002

(Rs in lakhs)

Component	MM-I	MM-II	MM-III NHB	MM-III Dt. of MKT	MM-IV	Total
State	Financial targets	Financial targets	Financial targets	Financial targets	Financial targets	
Arunachal Pradesh	8.75	502.45	197.00	76.00	10.00	794.20
Assam	159.95	610.12	167.00	76.00	20.00	1033.00
Manipur	--	485.53	82.00	76.00	5.00	693.53
Meghalay	30.81	625.71	82.00	76.00	50.00	864.52
Mizoram	--	457.05	77.00	75.50	100.00	709.55
Nagaland	--	429.60	117.00	75.50	20.00	642.10
Sikkim	34.61	564.85	132.00	75.50	50.00	856.96
Tripura	15.98	452.90	222.00	75.50	20.00	786.38
Service charges to SFAC	--	41.28	--	6.00	3.465	50.75
Infrstructure and remote sencing	--	75.00	--	--	26.535 (Promotional activities)	101.53
Emergent requirement	--	50.47	--	--	--	50.47
Total	**250.01**	**4294.96**	**1076.00** (NHB share 607.14)	**612.0**	**350.0**	**6583.06** (-) 607.14= 5975.8

Mission-wise release of funds during 2001-02 (up to 7 November 2001)

(Rs in lakhs)

Mission	Allocations	Releases	Release (%)
Mini Mission-I	250.00	143.10	54.24
Mini Mission-II	4295.00	2025.92	47.17
Mini Mission-III	1080.86	1080.86	100.00
Mini Mission-IV	350.00	200.32	57.32
Total	**5975.86**	**3450.20**	**57.73**

Mission-wise release of funds during 2001-02 (up to 7 November 2001)

State	Release of funds	Activity
Sikkim	Rs 85.0 lakhs	○ 1 Wholesale market ○ 14 Rural Primary markets ○ 2 Grading laboratories
Arunachal Pradesh	Rs. 199.0 lakhs	○ 6 wholesale markets ○ 24 Rural Primary Markets ○ 2 Grading laboratores
Total	Rs 284.0 lakhs	

Release of funds (up to 7 November 2001) under MM-II

(Rs in lakhs)

	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Total
Allocations	502.45	610.12	485.53	625.71	457.05	429.60	564.85	452.90	4128.21
Ist release	173.35	83.03	183.53	134.30	126.85	118.95	150.45	116.75	1087.21
IInd release	150.00	150.00	--	100.00	134.81	75.00	200.00	75.00	884.81
Service charges to SFAC									41.28
Infrastructure									50.00
Remote sencing									25.00
Emergent requirement									50.47
Total									4294.96

Release of funds (up to 7 November 2001) for Awareness Campaign-cum-Workshops on Technology Mission

State	Place	Date of workshop held on	Funds released (Rs in lakhs)
Arunachal Pradesh	Itanagar	06-10-01	1.50
Assam	Guwahati	08-10-01	1.00
Mizoram	Aizwal	23-9-01	1.50

Monitoring of the Scheme by Steering Committees

Committee	Date of meeting	Chairman
Central Steering Committee Meeting	20-08-01	Secretary (A&C)
Steering Committee for MM-I	10-10-01	Vice-Chancellor-Assam Agriculture University
Steering Committee for MM-II	09-08-01	Special Secretary (A&C)
Steering Committee for MM-III	09-08-01	Special Secretary (A&C)
Steering Committee for MM-IV	09-07-01	Secretary-DFPI
State level Steering Committee, Arunachal Pradesh	14-08-01	Chief Secretary
State level Steering Committee, Nagaland	18-08-01	Chief Secretary
State level Steering Committee, Sikkim	03-11-01	Chief Secretary
State-level Steering Committee, Tripura	22-09-2001	Chief Secretary

CONSTRAINTS IN THE IMPLEMENTATION OF THE SCHEME

- The North-Eastern States were being advised for the last two years to mobilize their human and other resources for implementation of the scheme which was in process of being formulated. However, some of the states have yet not fully geared up their resources for implementation of the scheme. This is evident from the fact that proposals on post-harvest management, processing and marketing are not being sent.
- Though the first instalment of the funds was released to the states in the month of July, 2001, no progress report so far has been received from the states. This shows that a proper mechanism by them is still to be devised for effective implementation. Further release of funds would depend on receipt of these reports.
- Assam, Arunachal Pradesh and Mizoram have constituted state-level SFAC. However, these states have not made their SFACs operational for release of Technology Mission funds by the Central SFAC. Nagaland has so far not constituted the state-level SFAC.
- Manipur and Nagaland are not adequately responding to the implementation of the scheme.
- States need to nominate 'Nodal Officer' for Technology Mission, who can be contacted

for the reports and other information. The Nodal Officer should be well-versed with implementation of the mission.

- Indian Council of Agricultural Research is not responding adequately on meeting the requirements of the states with regard to planting material/technologies. The Council has not furnished progress report to DAC on implementation of Mini Mission-I.
- Assam, Mizoram, Manipur and Meghalaya have so far not held meeting of their state-level steering committee.

Difference in Implementation of Technology Mission vis-a-vis other Schemes :

- The Technology Mission is being implemented by more than one Department/Ministry keeping in view the specialized requirements of the Mission programmes. This is a coordinated efforts Mission.
- This central scheme covers all the aspects such as research, production, post-harvest management, storages, marketing and export of the produce.
- The Technology Mission implementation is being monitored by various steering committees such as Central Steering Committee, Mission-wise Steering Committees and State-level Steering Committees.
- The physical verification of the ongoing programmes of the Mission is undertaken by State-level SFAC.
- Funds of the Technology Mission are being routed through Central SFAC to State SFAC to implementing agencies beneficiaries, therefore, avoiding any delay in availability of funds to implementing agencies which otherwise would have been if funds were routed through the State Govts.
- Implementation of the Mission is being monitored by the Prime Minister's Office.
- Awareness campaigns and workshops held in Northern-Eastern States have generated desired awareness about the Mission in various sections of society engaged in horticulture related activities.

OUTLOOK

Implementation of Technology Mission would help in beneficial use of the potential of the region and reduce rural poverty/regional disparity. The Mission would also provide significant employment in the region.

EXPERIENCE OF HORTICULTURE DEVELOPMENT THROUGH MACRO MANAGEMENT APPROACH

Jose C. Samuel* and H.P. Singh

Macro Management mode of implementing developmental programmes in the agriculture sector was conceptualized sometime in 1998-99 with a view to facilitate the State Governments to draw regionally differentiated programmes to address the felt needs through Work Plans. In the Macro Management Scheme, 27 Central/ Centrally Sponsored Schemes of the Department of Agriculture & Cooperation (DAC), including nine schemes in the Horticulture sector were subsumed into one scheme under the title Centrally Sponsored Scheme on Macro Management in Agriculture-Supplementation/ Complementation of State efforts through Work Plans. The total outlay of the scheme is 1851.50 crores to be implemented in years 2000-01 (Rs 760.50 crores) and 2001-02 (Rs 1091.00 crores).

Initial Exercise of Programme Identification

The following schemes relating to horticulture sector were subsumed under the Macro Management Scheme (Table 1).

Table 1. Scheme subsumed under Macro Management

(Rs, crore)

Scheme	Outlay for IX Plan	Expenditure till Sept. 2000-01
Integrated Development of Fruits	125.00	14.9
Integrated Development of Vegetables	43.84	5.2
Development of Commercial Floriculture	19.90	2.4
Development of Mushroom	19.50	2.3
Development of Spices	142.84	17.02
Development of Horticulture through Plasticulture Intervention	375.00	44.7
Integrated Development of Cashew and cocoa	76.00	9.06
Development of Beekeeping for Improving Crop Productivity	22.50	2.7
Development of Medicinal and Aromatic Plants	14.50	1.7
Total	**839.08**	**99.98**

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The above schemes involved a number of activities like nursery development, area expansion, rejuvenation, technology dissemination, infrastructural development etc. In order to facilitate the State Governments to select the programmes as per their felt needs the Horticulture Division provided a framework activities which formed a part of the approved components during Ninth Plan. The summary detail of the components along with the pattern of assistance for different activities is given in Annexure I.

Annexure I. Programme for 2001-02 under Macro Management

(Rs.lakhs)

Sl. No.	Crop / component	Physical	Financial
A.	**Development of Cashew and Cocoa**		
I.	***Cashew***		
1.	Regional Nursery (No.)	3	9.00
2.	Farmers Training (000 Nos.)	10	15.00
3.	Plant Protection Campaign (No.)	200	16.62
4.	Demonstration (No.)	255	20.00
5.	Contingency	-	23.36
	Total		**83.98**
II	***Cocoa***		
1.	Farmers Training (No.)	2700	4.05
2.	Demonstration	165	11.97
	Total		**16.02**
B.	**Development of Spices**		**150.00**
C.	**Development of Medicinal and Aromatic Plants**		
I.	***Medicinal Plants***		
1.	Establishment/Maintenance of Herbal Gardens	9	9.0
2.	Establishment/Maintenance of Nursery Centres	9	11.25
3.	Transfer of Technology	25	23.45
4.	Temporary Staff, Evaluation, Technical Service		38.00
II.	***Aromatic Plants***		
1.	Production and Distribution of quality planting material (ha)	152	60.8
2.	Setting of Modern Distillation Units (No.)	10	7.5
	Total		**150.00**
D.	**Development of Vegetables**		
I.	Production of Planting Material		
	Onion		
1.	Breeders Seed (q)	2.5	2.50
2.	Foundation Seed (q)	17.5	4.375

3.	Certified Seed (q)	400	25.00
	Potato		
1.	Breeder Seed (q)	41.50	2.50
2.	Foundation Seed (q)	500	7.50
3.	Certified Seed (q)	1200	12.00
	True Potato Seed (part of expenditure)	4	1500
II.	***Seed Village Concept***	8	40.00
III.	***Improvement of Production and Productivity***		
1.	Development of Irrigation Source (ha)	200	53.50
2.	Disease Forecasting System (part of Expenditure) against Rs 7.5 lakh/uint	4	15.00
3.	Assistance for adoption of IPM	5500	82.50
4.	Mechanisation in Vegetable cultivation	400	80
IV.	***Technology Transfer***		
1.	Farmers Participatory Demonstration	500	50
2.	Training and Visit	133	100
3.	Publicity and Media Support	-	33.545
4.	Workshop / Seminar	2	10
5.	Technology Development and Application	3	30
V.	***On-Farm Post-Harvest Handling Rs 50000/per unit (maximum 30% of cost)***	100	50
VI.	***Development of Information System***	-	80.00
VII.	***Monitoring and Evaluation***		
1.	Assistance to Nodal Agency	-	45.25
2.	External Evaluation / Technical Services	-	10.58
	Total		**748.000**
E.	**Development of Beekeeping**		
1.	Promotion of Research and Development		10.00
2.	Production of Bee Colonies ('000)	25	78.75
3.	Distribution of Hives ('000)	25	87.50
4.	Migration (Nos.)	150	3.75
5.	Training		15.00
6.	Promotion		15.00
7.	Consortium for SDA		15.00
8.	Monitoring of Scheme		15.00

9.	Headquarters for Technical Service and Studies		10.00
	Total		**250**
F.	**Plastieulture**		
1.	PDC (No.)	18	270.00
2.	Training through PDC		20.00
3.	Seminar and Workshop		6.00
4.	Pilot Scale Testing. Studies		5.00
5.	NCPA Sett.		45.00
	Total		**350.00**

Preparation of State Work Plans

The State Governments were required to prepare detailed Work Plans duly highlighting the SWOT analysis along with the physical and financial programme for 2000-01 and 2001-02. The Work Plans were discussed in the Department of Agriculture & Cooperation (DAC) on different occasions. Under the Macro Management Scheme. State Governments can include all the approved components of Ninth Plan as per the approved pattern of assistance. Besides, they have the freedom to include new components of priority nature. The guidelines for Macro Management Scheme are:

- The states will prepare their Work Plans in consultation with the Subject Matter Divisions in the Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India.
- Where necessary, new interventions proposed by the states are also considered for inclusion in the Work Plan provided.
  - It is not covered under any other approved scheme of Central Government or is not a part of any ongoing state scheme.
  - The expenditure on the new initiative would not be more than 10% of the total allocation to the state under Macro Management Scheme.
- Subsidy payable under the Work Plan should not exceed the present subsidy level approved under the Centrally Sponsored Schemes subsumed into Macro Management Mode.
- To facilitate coordination among various implementing agencies Standing Finance Committee should be set up under the Chairmanship of APC/Chief Secretary.
- Attempts would be made by the DAC to release the first installment of funds amounting to 50% of the annual allocation by April each year. The State Government should ensure immediate release of funds to the implementing agencies concerned.
- The second installment would be released on a graded basis depending upon 60% utilization of available funds and furnishing of Utilization Certificate.
- The states should ensure that the central assistance released under the scheme is utilized in accordance with the approved Work Plan for the year.
- The responsibility of monitoring the progress of the activities under the Work Plan rests with the Subject Matter Divisions concerned in DAC.
- In view of the priority accorded by the Government of India to Natural Resources Management and to Horticulture Development, the Work Plans must reflect th critical

significance of these sectors. Accordingly, it need to be ensured that the proportionate allocations in the Work Plan for NRM and Horticulture are not less than the funds released under 27 erstwhile Centrally Sponsored Schemes during the Ninth Plan period as a whole (including the allocations made under Macro Management mode in 2000-01 and 2001-02).

During finalization of the Work Plans, some deficiencies were observed. They are:

- Horticulture did not form a part of the Work Plan in many states.
- Some of the important horticultural crops were not included for development.
- The relevant components required for the holistic development of the crop were not included.
- The unit costs were in variance with the approved cost norms.
- New programmes were included in much large scale.

Since the nodal department for implementing the Macro Management Scheme in the state is the Agriculture Department, the general tendency is to neglect the horticulture sector.

HORTICULTURE SCENARIO UNDER MACRO MANAGEMENT

The final picture that emerged in terms of outlay for horticulture sector under the Work Plans for 2000-01 and 2001-02 is given in Table 2.

Table 2. Horticultural development programmes under Macro Management Scheme

(Rs lakhs)

Crop/item	2000-01 (from Oct. 2000)	2001-02	Total	Share (%)
Fruits	1411.5	2851.8	4263.4	17.2
Vegetables	419.60	730.33	1149.91	4.6
Mushroom	166.41	193.5	359.91	1.5
Floriculture	517.56	864.4	1381.96	5.6
Spices	1190.12	1644.39	2834.51	11.5
Medicinal and Aromatic Plants	84.95	139.2	224.15	0.9
Cashew	670.58	819.0	1489.58	6.0
Cocoa	46.92	59.76	106.68	0.4
Plasticulture	5795.51	6514.9	12310.41	49.8
Beekeeping	50.86	30.9	81.76	0.3
Technology transfer	19.3	73.2	92.5	0.4
New technologies	8.33	108.33	116.66	0.5
Information Technolgy	30.72	137.3	168.02	0.7
Others	40.83	110.7	151.53	0.6
Total	**10453.17**	**14277.71**	**24730.89**	**100**

Almost 50% of the outlay for horticulture under the Work Plan is on plasticulture followed by fruits (17%), spices (11%), cashew (6%) and vegetables (5%). This trend is more or less in conformity with the per cent outlay earmarked for these sectors during the Ninth Plan.

The state-wise details of programme under different sectors of horticulture is given in Annexure II. From the same it is seen that the maximum share of the total outlay of Rs 247.32 crores

Annexure II. Outlay under Macro Management 2000-02

Rs lakh

State	Fruits	Vegetables	Mush-room	Flowers	Spice	M&AP	Cashew	Cocoa	Plastic	Beekeeping	Tech. Transfer	Newtech	IT	Others	Total	% of Total
Andhra Pradesh	123.5	73.9		35.6	44.4				822.2			16.6	44.4		1160.6	4.6
Bihar	112.8	47.2	88.0	51.5	16.5	19.4			167.0				79.0		581.4	2.4
Goa																
Gujarat	188.9	18.5		18.5	140.5	5.3			617.0						988.7	3.9
Haryana	100.5	76.7		66.7					66.7	5			8.5	13.3	332.4	1.3
Himachal Pradesh	321.4		17.4	45.5		9.5			55.0	5.2	38.0		25.0	3.0	520.0	2.1
Jammu and Kashmir	179.0					11.0			157.0	39.0		100.0	8.0		494.0	1.9
Jharkhand	121.6	33.9	104.0	72.1	5.0	5.6			112.8		27.3			15.2	497.5	2.0
Karnataka	1276.7	59.7	33.1	334.7	739.3	24.4	429.1	98.4	3955.6		15.2				6966.2	28.2
Kerala	135.0	400.0			883.1		722.0		800.0						2940.1	11.9
Madhya Pradesh																
Maharastra	650.0		56.0	200.0	100.8	101.0			2463.9					40.0	3611.7	14.7
Manipur																
Meghalya																
Mizoram																
Nagaland																
Orissa	134.4	11.3		40.2	75.0								3.1	8.0	272.0	1.1
Punjab														2.0	2.0	0.008
Rajasthan	341.4	40.7	21.7	34.4	307.4	30.6			402.6	23.1	12.1				1214.0	5.0
Sikkim									11.3					11.3	0.04	
Tamil Nadu	291.3	198.3	24.4	372.8	484.8	14.5	338.5	8.4	2479.9						4212.9	17.0
Tripura																
Uttar Pradesh	100.0	97.7	15.0	25.0	35.0	3.0			100.0						375.7	1.5
Uttaranchal	25.9	6.9	0.3						39.0					70.0	142.1	0.6
West Bengal	100.0	85.1	0.3	40.0					54.0						279.4	1.2
Dadra and Nagar Haveli																
Daman & Diu																
Delhi	61.0			45.0	3.0				18.0	3.0					130.0	0.6
Lakshdweep																
Chandigarh																
Andmans and Nicobar																
Pondicherry																
Total	4263.4	1149.9	360.2	1382.0	2834.8	224.3	1489.6	106.8	12310.7	81.6	92.6	116.6	168.0	151.5	24732.0	100.0
	17.2	4.65	1.46	5.59	11.3	1	6.02	0.43	49.8	0.34	0.38	0.47	0.77	0.61		

is for Karnataka (28%) followed by Tamil Nadu (17%) and Maharashtra (15%). Incidentally, these states have earmarked substantial outlay for plasticulture, particularly drip irrigation. The financial details of the components included in the Work Plan for Karnataka is given in Annexure III. The list of activities indicate the range which have been availed by the State Governments.

Annexure III. Karnataka State Horticulture Programme

Financial(Rs. lakhs)

S.N.		Scheme	2000-01		2001-02		Total	
			Out	Exp.	Out.	Exp.	Out.	Exp.
1		**Fruits**						
	(i)	Supply of quality planting material						
		(a) Nursery Development						
		Large nursery(Nos.)						
		Small nursery(Nos.)						
		Maintance of nurseries estblished (98-99)	3		3		6	
		Maintance of nurseries estblished (99-2000)	10		10		20	
		Assistance for 36 small nurseries in pvt. Sector	80		110		190	
		Strengthening of pvt. nurseries						
		(b) Tissue culture(Nos.)						
	(ii)	Area expansion(ha)	105		127.5		232.5	
	(iii)	Training of farmers						
	(iv)	Publicity/media support	10.5		10.5		21	
	(v)	Improving porductivity & rejuvenation(ha)	11.25		20.35		31.6	
	(vi)	Tissue Analysis Labs-public/ private sector (Nos.)	31		31		62	
		Supply of Tissue Culture Plants						
	(vii)	Plant Health Clinics(Nos.)						
	(viii)	Disease Forecasting Units(Nos.)						
		Integrated management of pests and diseases						
	(ix)	Hort. Mechanization(Nos.)						
	(x)	On-farm handling of fruits(Grp.)	10		10		20	
	(xi)	Promotion of IT in fruits(Comp)						
	(xii)	Training . Publicity. Frontline Demonstration						
	(xiii)	Upgradation of technical know-how						
	(xiv)	Development of cashew						
	(xv)	Contingency						
	(xvi)	Administrative cost	5.05		5.05		10.1	
	(xvii)	Technical development and application	5		5		10	
	(xviii)	Incentives to growers (tonnes)	270.8		332.4		603.2	

	(xix)	Second year maintenancy (ha)						
	(xx)	Development of progeny orchards						
		(a) Planting material(Nos.)						
		(b) Manure and fertilizers(Qt.)						
		(c) Irrigation facilities(Nos.)						
		(d) Rejuvenation of *mali* shed (Nos.)						
		(e) Equipment and machinery						
		(f) Strengthening block nursery(Nos.)						
		(g) Contigency						
	(xxi)	Scheme of strengthening of Govt. nursery						
		(a) Fencing						
		(b) Improved implements including tractor						
		(c) Irrigation facilities						
		(d) Shade nets						
		(e) Mother planting material						
		(f) Labour charge						
	(xxii)	Olive cultivation						
		(a) Area expansion(ha)						
		(b) Greenhouses(m^2)						
		(c) Nursery production(Nos.)						
	(xxiii)	Establishment of plant clinic under						
		Crop Doctor Scheme						
		(a) Purchase of slides, photos, charts, etc.						
		(b) Soil testing kits, etc.						
	(xxiv)	Strawberry cultivation						
		(a) Area expansion(ha)						
		(b) Nurseries(Nos.)						
		(c) Subsidy on packing material (packs)						
		Total	**270.80**		**332.40**		**603.20**	
2.		**Vegetables**						
	(i)	Supply of vegetable seeds (farmers)						
	(ii)	Subsidy on-farm ventilated storage for onion(Nos.)						
	(iii)	Off-seasons vegetable production(Nos.)						
	(iv)	IPM in vegetables(ha)						
	(v)	Assistance						
		(a) Quality fruit plants						

		(b) Hybrid vegetable seeds						
		(c) Foundation seeds (q)	6		7		13	
		(d) Certified Seeds(q)						
	(vi)	Production of foundation and certified seeds(ha)	5.7		5.7		11.4	
	(vii)	Demonstration Plot						
	(viii)	Distribution of seed mini-kits						
	(ix)	Contingency						
	(x)	Strengthening of seed testing labs.	11		13		24	
	(xi)	Publicity/Research.	5		6.3		11.3	
	(xii)	Hybrid seed demonstration						
	(xiii)	Promotion for vegetable seed production programme in farmers' field (ha)						
	(xiv)	Promotion for vegetable cultivation infrastructure						
	(xv)	Improving productivity						
	(xvi)	Distribution of biofertilizers and botanic pesticides(ha)						
	(xvii)	Distribution of hybrid/high-yielding vegetables seeds (Nos/ha)						
	(xviii)	Singhara cultivation						
		(a) Development of ponds(ha)						
		(b) Planting materials(ha)						
		(c) Pest and disease management						
	(xix)	Makhana cultivation						
		(a) Referination of ponds(ha.)						
		(b) Settlement of ponds						
		(c) Plantation of Makhana seeds(ha)						
		(d) Demonstration plot(Nos.)						
		(e) Processing Unit						
		(f) Miscellaneous						
	(xx)	Potato seed production programme						
		(a) Expenses on procurement of breeders seed						
		(b) Expenses on fertilizer						
	(xxi)	Root and tuber crops						
		(a) Establishment of sub-biocentre (Nos.)						
		(b) Establishment of Demons. Farm(Nos.)						
		(c) Distribution minikits(Nos.)						
		(d) Contingency						

		(e) TPS demonstration(Nos.)						
		(f) Tapioca rehabilitation programme (ha)						
		Total	**27.70**		**32.00**		**59.70**	
3		**Mushroom**						
	(i)	Establishment of spawn production laboratory through Cooperative Society						
	(ii)	Establishment of pasteurized compost unit	1.5		1.85		3.35	
	(iii)	Training of farmers(Nos.)						
	(iv)	Contingency						
	(v)	Spawn production (spawn bottles)	1.5		2		3.5	
	(vi)	Purchase of equipment and machinery	1		1.25		2.25	
	(vii)	Strengthing of existing laboratory	5		5.45	10.45		
	(viii)	Training Publicity Research & Development	5		6.3		11.3	
	(ix)	Adminstrative cost	1		1.25		2.25	
	(x)	Contingency						
	(xi)	Establishment of mushroom producers' co-operative society(Nos.)						
	(xii)	Incentives for development of processed mushroom(Nos.)						
	(xiii)	Interest subsidy(Nos.)						
	(xiv)	Assistance for mushroom production to small and marginal farmers (Nos)						
		Total	**15.00**		**18.10**		**33.10**	
4		**Floriculture**						
	(i)	Hi-Tech greenhouses/polyhouses						
	(ii)	Shade houses with agro shade nets	11		28		39	
	(iii)	Area expansion	17.1		66		83.1	
	(iv)	Model floriculture centre	66		100.6		166.6	
	(v)	Tissue culture units (Nos.)						
	(vi)	Mist chamber (Nos.)						
	(vii)	Protected cultivation						
	(viii)	Transfer of technology						
	(ix)	Monitoring and evaluation						
	(x)	Strengthening of Model Flori. Centre at Gharawela						
	(xi)	Contingency						
	(xii)	Model floriculture centre in private sector /NGO/KUK	21		25		46	
	(xiii)	Processing units						

	(xiv)	Training programme(Nos.)						
	(xv)	Setting up of demonstration units						
	(xvi)	Incentives for handling units						
	(xvii)	Setting up of flower nurseries						
	(xviii)	Publicity/media and floriculture promotion. seminar etc.						
	(xix)	Cut flower production (Nos.)						
	(xx)	Supply of planting materials (Nos.)						
	(xxi)	Supply of fertilizers/chemicals(ha)						
	(xxii)	Assistance to flower grower						
	(xxiii)	Other infrastructure						
	(xxiv)	Financial assistance to flower grower for production of quality flower						
		Total	**115.10**		**219.60**		**334.70**	
5		**Spices**						
	(i)	Supply of pepper cuttings/vanilla cuttings						
	(ii)	Supply of rhizomes (ginger/turmeric)						
	(iii)	IPM promotion in spices						
	(iv)	Production of clean spices						
	(v)	Assistance for polishing drums (turmeric)						
	(vi)	Sprayer (chilli)						
	(vii)	General						
	(viii)	Laying out demonstration						
	(ix)	Training. publicity and workshop	38		47		85	
	(x)	Distribution of minikits						
	(xi)	Contingency						
	(xii)	Plant protection measures on quick wilt(ha)	56.25		62.5		118.75	
	(xiii)	Maintance of pepper demonstration	2.1		3.5		5.6	
	(xiv)	Management of support plants	25		30		55	
	(xv)	Establishment of demonstration-cum-seed multiplication						
		(a) Ginger	90		95		185	
		(b) Chilli	32		34.5		66.5	
		(c) Turmeric	24.75		24.75		49.5	
		(d) vanilla	17.5		25		42.5	
		(e) Black peeper						
		General						

	(xvi)	Demonstration of plant protection measures on chilli (ha)						
	(xvii)	Distribution of plant protection equipments (Nos.)	20		20		40	
	(xviii)	Administrative cost	15.8		20.6		36.4	
	(xix)	Production and distribution of hybrid/ improved varieties of pepper (Nos.)	25		30		55	
	(xx)	Pepper rehabilitation(ha)						
	(xxi)	Procurement of nuclear plating material						
		(a) Ginger (tonnes)						
		(b) Turmeric(tonnes)						
	(xxii)	Demonstration and production of nucleus seed programmes						
		(a) Ginger						
		(b) Turmeric						
		(c) Chilli						
		(d) Garlic						
		(e) Tree spices						
		(f) Seed spices						
		(g) General programme						
	(xxiii)	Area expension(ha)						
		(a) Pepper						
		(b) Ginger						
		(c) Chilli						
	(xxiv)	Supply of organic manure to increase productivity of ginger						
	(xxv)	Block demonstration of spices						
		Total	**346.40**		**392.85**		**739.25**	
6		**Development of medicinal and aromatic plants**						
	(i)	Area expansion(ha)						
	(ii)	Establishment of herbal garden						
	(iii)	Establishment of nursery attached to herbal garden (Nos.)						
	(iv)	Assistance to distillation unit						
	(v)	Demonstration of medicinal and aromatic plants (Nos)	6		7.5		13.5	
	(vi)	Contingency						

	(vii)	Providing assistance for medicinal garden	2		2		4	
	(viii)	Training	1.1		1.5		2.6	
	(ix)	Publicity, research and development. monitoring and evaluation (Nos.)	1		1.3		2.3	
	(x)	Admins. Cost	1		1		2	
	(xi)	Setting up of analytical labs.						
	(xii)	Transfer of technology(Nos.)						
	(xiii)	Demonstration Cum Seed production (ha)						
	(xiv)	Assistance to distillation units						
	(xv)	Rejuvenation						
	(xvi)	Pest and disease management						
		Total	**11.10**		**13.30**		**24.40**	
7		**Cashew**						
	(i)	Maintenance of gardens estb. during previous years (98-2000)	29.11		43.88		72.99	
	(ii)	Area expansion(ha)	133.2		158.55		291.75	
	(iii)	Plant protection compaign (Nos.)	9.35		6.23		15.58	
	(iv)	Administrative cost and publicity	17.59		14		31.59	
	(v)	Training to farmers	11.25		5.94		17.19	
	(vi)	Cahew rehabilitation @ 4,000/ha						
	(vii)	Development of new plantation with clones(ha)						
	(viii)	Replanting/rejuvenation of old uncommercial gardens(ha)						
	(ix)	Adoptation of intensive pest control measures(ha						
	(x)	Executional infrastructure(ha)						
	(xi)	Progress monitered by Directorate of Cashew Development, Cochin (Nos.)						
		Total	**200.50**		**228.60**		**429.10**	
8		**Cocoa**						
	(i)	Area expansion(ha)	26.4		32.65		59.05	
	(ii)	Training to farmers	3.15		4.5		7.65	
	(iii)	Administrative cost and publicity	14.4		17.25		31.65	
	(iv)	Plant protection campaign						
	(v)	Establishment of Demonstration Plots (Nos.)						
	(vi)	Distribution of high-yielding cocoa clonel seedlings(Nos.)						
		Total	**43.95**		**54.40**		**98.35**	

9		**Plasticulture**						
	(i)	Drip irrigation/installation(ha)	1678.3		2045.6		723.9	
	(ii)	Agro-shed net (50%)	7		12.25		19.25	
	(iii)	Mulching(50%)						
	(iv)	Sprinkler irrigation (set)						
	(v)	Greenhouses(Nos.)	34		36		70	
	(vi)	Low tunnel-50% assistance						
	(vii)	Subsidy for establishment of poly greenhouses(ha						
	(viii)	Subsidy on drip irrigation in private sector(ha)						
	(ix)	Drip demonstration in departmental farms	17		45.5		62.5	
	(x)	Contingency						
	(xi)	Administrative cost	12.5		15		27.5	
	(xii)	Training to farmers and staff	12		14		26	
	(xiii)	Publication, research and development monitoring, and evaluation	11.4		15		26.4	
	(xiv)	Drying of spices(sq.m.)						
	(xv)	Polygreen/polyshade net house (m²)						
		(a) Low cost						
		(b) Medium cost						
		Total	**1772.20**		**2183.35**		**3955.55**	
10		**Beekeeping**						
	(i)	Assistance to farmers for honey bee colony (Nos.)						
	(ii)	Creating awareness for promotion of honey production (Nos.)						
	(iii)	Bee queen and colony production (Nos.)						
	(iv)	Bee colonies to be distributed (Nos.)						
	(v)	Training(Nos.)						
	(vi)	Contingency						
11		**Technology Transfer**						
	(i)	Organisation of workshop						
	(ii)	Training of farmers	6.9		8.25		15.15	
	(iii)	Publication of bulletins						
	(iv)	Purchase of vehicles						
	(v)	Furniture and infrastructure						
	(vi)	Information technology						
	(vii)	Miscellaneous						

		Total	**6.90**		**8.25**		**15.15**	
12		**New technologies**						
	(i)	Leaf analysis						
	(ii)	Endemic pest eradication						
	(iii)	Construction of water storage tanks(Nos.)						
	(iv)	Deep tube-wells storage tanks(Nos.)						
	(v)	Creation of irrigation facilities in nurseries						
		Information technology						
	(i)	Building of information network						
	(ii)	Conduct of show/exhibitions						
	(iii)	Service centres						
	(iv)	Conduct of seminars/workshops						
	(v)	Hiring of Vehicles						
	(vi)	Information technology Units						
14		**Others**						
		Infrastructure Development						
	(i)	Vegetable fruit shop (Nos.)						
	(ii)	Sundry shop (Nos.)						
	(iii)	Collection and grading centre (Nos.)						
	(iv)	Refrigerated van						
	(iv)	Contingency						
		Popularization of improved Tools						
	(I)	Providing 500 kits to farmers on 50% assistance						
		Development of plantation crops						
	(i)	Plantation of tea (ha)						
	(ii)	Plantation of of coffee(ha)						
		Subsidy towards construction						
	(i)	Greenhouses						
	(ii)	Poly Greenhouses						
		Production of quality seed at SHRF and building infrastructure						
	(i)	Quality seeds/planting material production						
	(ii)	Multiplication of breeder seeds						
	(iii)	Purchase of machines and equipments						
	(iv)	Building storage facilities						
		G. Total	**2809.65**		**3482.85**		**6292.50**	

Constraints Faced in Monitoring the Scheme

The following constraints are being faced in monitoring the scheme.

- The Work Plans for Goa and Madhya Pradesh have not been received by the Horticulture Division. Hence it has not been possible to have a national perspective of horticultural programmes in the country.
- Although targets have been indicated in the Work Plan for different activities, their progress has not been reported.
- The funds have been released in lumpsum for the entire scheme. The component-wise expenditure has not been reported, hence it has not been possible to monitor the expenditure for the horticulture sector.
- The states have not been responding, particularly to the Directorates of Cashew and Cocoa, and of Spices for reporting the progress.
- Since the funds are released to Agricultural Department, Horticultural Department in the states do not receive funds on time for taking of the programmes.

Work Plan for SAUs/ PSUs

With the amalgamation of the Centrally sponsored/ Central Sector Schemes under the Macro Management many activities which were being implemented through SAUs and Public Sector Undertakings (PSUs) were left out from the Work Plan. Separate Work Plan were, therefore prepared for such activities by the organizations concerned as indicated in Table 3.

Table 3. Details of Work Plan for programmes executed by other organisations

Organization	Programme	Outlay for 2001-02 (Rs. lakh)
Directorate of Cashew & Cocoa	Dev. of cashew & cocoa	100.00
Directorate of Spices	Dev. of spices	150.00
	Dev. of M & A plants	150.00
NHRDF	Dev. of vegetables	750.00
NHB	Beekeeping	250.00
NCPAH	Plasticulture	350.00
Total		**1750.00**

The first release amounting to 50% of the outlay has been released to the organisation concerned.

The summary details of the activities proposed to be taken up during 2001-02 through the Work Plan is given below:

ACTIVITIES ON HORTICULUTAL DEVELOPMENT TO BE INCLUDED IN WORKPLANS

Production of Desease-free Quality Planting Material and Seeds

- Establishment of big/small nurseries (Pvt.): @ Rs 8.00 lakh for big and 2.00 lakh for small linked with institutional finance.

- Incentive for establishment of Tissue Culture Units : @ Rs. 21 lakh for public. 10 lakh for private sector
- Seed and True Potato Seeds : Rs. 2.00 lakhs per project
- For spices: Rs 3.00 per pepper cutting. Rs 1,000 for low input crop and Rs 10,000/ ha for high input crops
- Hybrid seed production. both Public and Private : @ Rs 5,000/ for low input crop and Rs 10,000/ha for high input crops

Area Expansion. (a) Fruits ranging from Rs 7,000/ to 70,000/ha.

(b) Flowers ranging from Rs 8000to Rs 20,000/unit of .2 ha

(c) Spices ranging from Rs 1,250/h (chilli) to Rs 5,625/ha (ginger).

Improving Productivity : Rs 7,000/ to 70,000/ha.

a) Use of micro nutrients: Rs.7,000/ha.

b) Use of bio-control/bio-pesticides: Rs.5,000/ha

c) Plant protection: Rs 5,000 ha

Transfer of Technology

a) Farmers participatory demonstration of technology: @ Rs 5,000 each

b) Training and visit: @ Rs 1,500 per beneficiary for a group of 50.

c) Special training programmes

d) Incentive for dissemination of information through print/electronic media.

Plant Health Clinics : Rs.3.00 lakhs to private and 5.00 lakhs to public sector.

Drip Irrigation : 50% of cost for SC/ST/S/M/Women. 35% for others subject to Rs 28,500/ha. for reserved category and Rs 21,500/ha for others as per the following details:

(Rs. per ha)

Farmer Category	Category A States (Andhra Pradeseh Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu)	Category B (all other states except states in Himalayan belt). (15% of Category A)	Category C (Himalayan States including Uttaranchal and West Bengal Hills) (25% of A)
SC/ST/S/ M/W(50%)	Rs 22,500/	Rs 26,000/	Rs 28,500/
Others (35%)	Rs 16,000/	Rs 18,200/	Rs 20,000/

Protected Cultivation/ Greenhouse and Net house: 40% of cost subject to maximum 40,000 for 500m²

Integrated Disease Management: 50% of cost subject to Rs 3500/ha for 4 ha/beneficiary.

Disease Forecasting Units: @ Rs.1.00 lakh to private and Rs.2.50 lakhs to public sector.

Horticulture Mechanization: Rs 6,000 for animal driven equipments to Rs 20,000 for power-driven equipments per beneficiary

Tissue/Leaf Analysis Lab: 5.00 lakhs to private and 20.00 lakhs to public sector.

Facilities for On-farm Handling and Storage of Perishables: 5.00 lakhs per beneficiary group.

Technology Refinement and Adoptation: Rs 5.00 to 10.00 lakhs

Distribution of Minikits: @Rs 240/beneficiary

Integrated Mushroom Development Centres:@ Rs 22 lakhs for each unit

Model Floriculture Centre: Those established in Eighth Plan to be maintained.

Establishment of Demonstration-cum-seed Production Plots for Medicinal and Aromatic Plants:@ Rs 1500/plot of 0.05 ha and Rs 12,500/ha for area expansion for a maximum of 4.00 ha/ beneficiary.

IT Support for Horticultural Development

a) Asistance for procurement of computer and networking

b) Development of Horticulture Database

CONCLUSION

The Macro Management mode of implementing programmes for the development of agriculture became effective from October 2000 under which 27 ongoing Schemes of the Department of Agriculture & Cooperation were subsumed. This included nine schemes pertaining to the horticulture sector amounting to Rs.839 crores for the IX Plan. The Work Plans provide flexibility to the State Governments to take up programmes as per their felt needs and priority. The total outlay for horticulture development through the Work Plans by various States amounts to Rs.247.30 crores for two years (2000-01 and 2001-02). Besides an amount of Rs.17.50 crores have been earmarked for activities to be taken up through SAUs/PSUs as direct funded component through Work Plans during 2001-02. The outlay for horticulture development programmes through Work Plans are almost at par with the outlay earmarked during the IX Plan before the Schemes were subsumed. However, there is delay in flow of funds to the Horticulture Department from the Agriculture Department in many States, which has hampered the progress in development. Besides, reporting of progress has not been systematic. To address the issues on horticulture it would be appropriate to have separate Work Plans for the Horticulture Sector.

INTEGRATED PROGRAMME FOR DEVELOPMENT OF HORTICULTURE IN TRIBAL/HILLY AREAS

Paramjit Singh*

The spectacular increase in production of foodgrains has made India a self-sufficient and food-secured nation. The new challenge facing the country is to meet the nutritional needs of the growing population to build a healthier nation. Horticulture not only produces nutritional food but also has potential to improve accessibility to food through better employment and high economic return. It has been proved beyond doubt that horticulture is the best alternative for improving productivity of land, generating employment opportunities, improving economic conditions of the farmers, providing raw material for industry, enhancement of exports, etc. Horticulture which includes fruits, vegetables, floriculture, root and tuber crops, flowers, medicinal and aromatic plants, spices and plantation crops like cashew, coconut and arecanut, provides the best opportunities for diversification of agriculture in India. One or the other horticultural crop can be successfully cultivated under all geo-climatic situations – tropical, subtropical, temperate and arid regions.

TRIBAL AND HILLY AREAS

The tribal/hilly areas in Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Gujarat, Uttaranchal, Maharashtra, Orissa, Bihar, Rajasthan, north-eastern states and north-western hill region offer vast potential for growing horticultural crops. In view of the fragile ecological balance, the strategy for development in these areas, has to be sustainable with development and environment becoming mutually supportive and reinforcing. Horticulture provides abundant scope for development and preservation of ecological balance. Therefore, intervention of horticulture is sought for development of tribal/hilly areas. It will help soil conservation, increase income of tribal/hilly population through production of low-volume high-value produce, create more employment opportunities, improve nutritional status of the poor in tribal/hilly areas, and protect the environment. Tribal areas are "Scheduled Areas" defined in the Indian Constitution. The criteria followed for declaring an area as Scheduled Area are preponderance of tribal population; compactness and reasonable size of the area; under-developed nature of the area; and marked disparity in economic standard of the people. There are 73 districts in India covered under Scheduled Areas commonly known as tribal areas. According to 1991 census, Scheduled Tribes account for 67.76 million representing 8.08 % of country's total population. They are spread across the country mainly in forest and hilly regions. 87% of the main workers among tribals are engaged in agricultural and allied activities.

APPROACHES FOR DEVELOPMENT IN TRIBAL/ HILLY AREAS

The Working Group on Horticulture for Ninth Plan recommended development of horticulture in tribal and hilly areas with an integrated approach and emphasis on horticulture-based land-use/ cropping systems and support for activities related to these as a package. The crop-oriented horticultural development schemes have failed to reach the poor farmers in hilly and tribal areas since these schemes

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were only intended to increase production and productivity of specific crops in potential areas having maximum infrastructural facilities and adequate economic resources with farmers to exploit the opportunities thrown open by new technologies.

For development of tribal/hilly areas, integrated compact area development approach needs to be followed and need-based support should be provided for crop production with forward and backward linkages, such as availability of genetically-improved planting materials and seeds of high-yielding varieties; supply of inputs; post-harvest infrastructural facilities, like, collection centres, storage, transport and marketing, etc. This will help to tap huge unexploited potential of these areas for expanding the production base and create market surplus. Consequently, income of poor farmers will increase, employment opportunities shall be created and nutritional status of the tribal and poor people of these areas will improve.

SCHEME ON INTEGRATED DEVELOPMENT OF HORTICULTURE IN TRIBAL/HILLY AREAS

In order to fully exploit country's limited land resources and favourable agroclimatic situations and also promote balanced regional growth by providing growth opportunities in tribal and hilly areas, Government of India has launched a Central Sector Scheme on "Integrated Development of Horticulture in Tribal/Hilly Areas" during Ninth Plan. The infrastructure developed under the scheme will create growth potential in these areas for overall economic growth, reducing regional imbalances. The scheme does not cover north-eastern states as for such areas a separate Technology Mission for development of horticulture has been set up.

The farmers in tribal/hilly areas have been practising horticulture in traditional manner and the technological developments in horticulture have not reached them. Nevertheless, in these areas, through adoption of improved technology, improved cultivars, plant-protection measures, nutrients and water management etc., it is possible to increase production of horticultural crops by 2-3 times. For development of horticulture in these areas, therefore, an integrated area development approach is adopted in which crop production, transfer of technology, post-harvest management and marketing are proposed to be dovetailed together. The objectives of the scheme are:

- Production of quality planting material of improved cultivars
- New planting with seed/planting material of improved/high-yielding varieties
- Improving productivity through adoption of improved cultivation technology, plant-protection chemicals, nutrient and water management
- Transfer of technology through farmers participatory demonstrations, trainings/visits of farmers, publicity through media support, extension literatures, etc.
- Creation of on-farm and post-harvest infrastructure such as, collection centre, packaging, transport, storage and marketing.

In view of the limited funds available, the scheme has been taken up on pilot basis only in 6 selected tribal/hilly districts, viz., Bastar (Chhatisgarh), Adilabad (Andhra Pradesh), Keonjhar(Orissa), Ranchi(Jharkhand), Panchmahal/Dahod (Gujarat) and Almora (Uttaranchal) for integrated development of horticulture. The district-level projects for 5 districts prepared by implementing agencies sponsored/ designated by State Department of Horticulture/Agriculture of the state concerned have been sanctioned

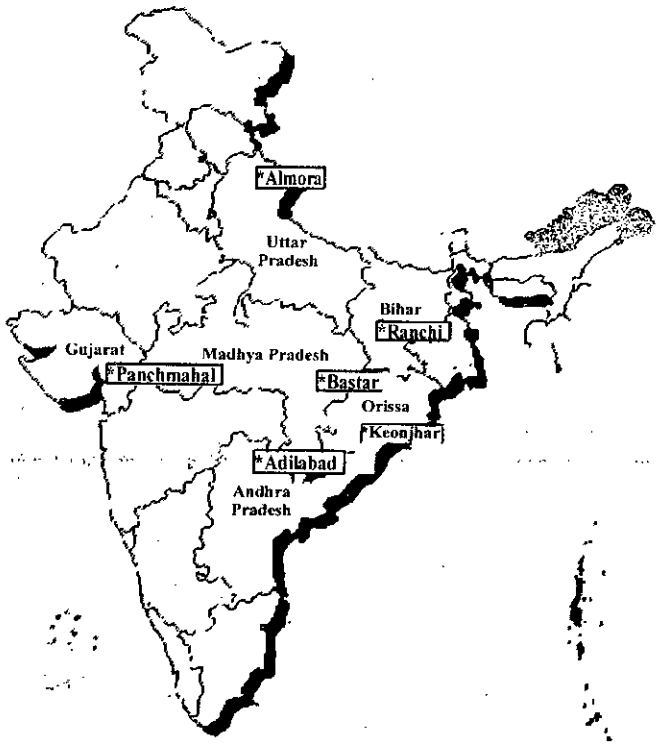

Fig. Districts covered under the Scheme on Integrated Development of Horticulture in Tribal/hilly Areas

during 2001-2002. These projects indicate resource inventory of the selected district, infrastructural facilities available, agroclimatic conditions prevailing in the district, horticultural crops already being grown and the potential horticultural crops of the areas, constraints, need-based support required, benefits expected through implementation of the project, etc. Before formulation of the projects, techno-economic feasibility, technology adoption, input support, infrastructure, marketing, etc. have been conducted with benchmark surveys to identify gaps in technology adoption, input support, infrastructure, marketing etc.

RATE OF ASSISTANCE PROVIDED

Government of India provides need-based support for integrated development of horticulture in selected districts. The components and rate of assistance available under the scheme are given in Table 1.

Table 1. Components and rate of subsidy given to farmers

Component	Rate of subsidy
Techno-economic feasibility study and project preparation	Maximum of Rs 2.50 lakhs for techno-economic feasibility study in districts and Rs 25,000 for project formulation.
Crop production	
○ Establishment of nurseries	Rs 10.00 lakhs for large nursery of 4 ha and Rs 1.50 lakh for small nursery of one ha as grant
○ Area expansion	Maximum of Rs 10,000/ ha towards cost of all inputs
○ Seasonal/annual crops(vegetable, root and tuber crops)	50% of the cost of inputs and labour cost etc. with a maximum of Rs 20,000/ha to be paid, in 3 annual installments of Rs 10,000
○ Fruits and other perennials	Rs 5,000 and Rs 5,000 for planting and maintenance in subsequent 2 years.
○ Floriculture	○ Rs 20,000/unit of 0.2 ha, for bulbous plants like gladiolus ○ Rs 15,000/unit of 0.2 ha for plants raised from cuttings and grafts like roses ○ Rs 4,000/unit of 0.2 ha for seed flowers like marigold ○ 50% of the cost or maximum of Rs 1.50 lakhs/500 m² for greenhouse. ○ Rs 0.50 lakh/unit for shade nets
○ Mushroom	○ Rs 12.35 lakhs for a spawn unit ○ Rs 22 lakhs for a pasteurized unit
○ Medicinal and aromatic plants	Rs 12,500/ha, (25% of estimated cost of Rs 50,000/ha.)
Transfer of technology	
(i.) Demonstration plots	
(a) Seasonal/annual crops (vegetable tuber etc.)	Rs 3,750/plot of 0.25 ha
(b) Fruits, and other perennials	Rs 15,000/plot of 0.5 ha
(c) Floriculture	Rs 30,000/plot of 0.2 ha
(d) Demonstration-cum-seed multiplication plot of medicinal plants	Rs 1,500/plot of 0.5 ha

Table 1 Continues

(ii.) Training/visits of farmers	Rs 1,000/farmer
(iii.) Printing of extension literature	Rs 15,000 for each district
Irrigation	
(i) Irrigation sources like wells, tanks, water pickups, tubewells, etc.	50% of the actual cost with a maximum of Rs 30,000/unit
(ii) Pumpsets	50% of the cost of pumpset with a maximum of Rs 8,000/unit
(iii) Drip irrigation/sprinkler system	50% of the cost of drip/ sprinkler irrigation system or maximum of Rs 28,500/ha
Horticulture Machinery and Equipment	○ 50% of the cost of power driven implements or maximum of Rs 20,000 to farmers cooperatives associations, NGOs etc. ○ Subsidy @ 50% the cost of small hand/ animal-driven implements for individual farmers
Evaluation, Technology Hiring, Seminar, Publicity, etc.	Maximum of Rs 30 lakhs
On-farm Handling Facilities	80% grant to meet the cost with a maximum of Rs 18 lakhs for each district
Implementing Cost	Not exceeding 10% of the project cost to SDA.
Alternative Marketing System	25% of the cost of the project with a maximum of Rs 60.00 lakhs per district as one-time grant

GUIDELINES OF THE SCHEME

The scheme will be implemented through SDA's to be identified by the Horticulture/Agriculture Departments of the concerned State Governments. For conducting techno-economic feasibility study with benchmark survey an assistance of Rs 2.50 lakh and for preparation of a project for integrated development of horticulture in the selected district, Rs 0.25 lakh is provided to concerned SDA/ consultant.

For increasing production and productivity of horticultural crops integrated crop management approach is suggested to take care of the seed/planting material requirement and to create production base by improving productivity through adoption of improved production technologies including Integrated Pest Management, Integrated Nutrient Management and area expansion. Besides the approved assistance, the beneficiary organizations/individuals will raise the balance requirement from their own resources or from institutional sources. The beneficiaries shall be identified by the SDA. The SDA shall register the beneficiaries under area expansion and establishment of nurseries programme and release funds. For transfer of technology, the demonstrations and trainings shall be coordinated and organized by the SDA in consultation with scientists of SAUs/Krishi Vigyan Kendras, etc.

For Irrigation facilities, SDA will identify beneficiaries and help them to raise loans from banks. The SDA shall register the beneficiaries under the component machinery and equipment and recommend sanction of funds. The SDA shall also ensure that the power-driven implements purchased with subsidy under this component are properly maintained with revenue earned from hiring out the implements to other needy farmers.

For evaluation, technology hiring, seminar, publicity etc., a total provision of Rs 30 lakhs has been made for technology hiring, seminars, publicity, evaluation etc. This component shall be directly implemented by the Horticulture Division in Department of Agriculture and Cooperation, Government of India. This Division will hire the services of necessary technical personnel to provide technical support to farmers, etc. and shall commission evaluation study on completion of the project. For implementing cost, SDAs shall be supported to meet office expenses and other administrative and contingent expenses etc. An assistance not exceeding 10% of the project cost depending on the needs of the SDA is proposed to meet these expenses during the Plan period.

For an efficient on-farm handling of produce, need-based post-harvest facilities, such as, collection, grading, packing, storage, on-farm processing etc. shall be created as common facility in the selected districts under the control of the SDA. For this, 80% grant shall be provided to meet cost of these facilities under the proposed Integrated Programme for Development of Horticulture in Tribal/ Hilly Areas. The remaining amount, if any, would be raised as loan through banks by the SDA. For creation of alternative marketing system, although marketing of the produce is linked with TRIFED and Directorate of Marketing and Inspection, yet it is essential to establish alternative marketing structure which sustain incentive for quality and enhanced productivity, improving farmers incomes and supporting the structure with improved technology and markets. In this system, producers and retailers will be integrated. This integration will take place through financial investment and patronage linked allocation of returns as well as by improving the bargaining position of retailers and farmers. The SDA shall oversee and monitor the progress of such sanctioned project. The need-based projects will cover all the gamut of horticultural development as the focus may vary from location to location. There might be items which are not visualized before the benchmark survey/techno-feasibility study is done.

SELECTED STATE DESIGNATED AGENCIES (SDA)

As is envisaged under the approved scheme, the State Designated Agencies (SDAs) identified by concerned State Governments for implementing the scheme in selected districts are:

Adilabad (Andhra Pradesh)	District Rural Development Agency (DRDA), Adilabad (Andhra Pradesh)
Almora Nainital(Uttaranchal)	Centre for Development Studies, Academy of Administration (Uttaranchal)
Bastar (Chhattisgarh)	Bastar Horticulture Development Society, Bastar(Chhattisgarh)
Dahod/Panchmahal (Gujarat)	N.M. Sadguru Water and Development Foundation, Dahod (Gujarat)
Ranchi (Jharkhand)	Birsa Agriculture University, Ranchi (Jharkhand)

Keonjhar (Orissa)	Agriculture Promotion and Investment Corporation of Orissa Ltd.(APICOL), Bhubaneswar (Orissa)

DISTICT-WISE PROJECT SANCTIONED

Except for the district of Keonjhar, based on the Techno-economic Feasibility Studies, the projects with need-based programmes have been sanctioned for implementation through identified SDAs. The district-wise project outlays sanctioned are:

(Rupees in lakhs)

District	Outlay sanctioned	Funds released
Adilabad	235.00	117.50
Almora	235.00	120.00
Bastar	226.82	113.41
Dahod/Panchmahal	147.29	73.64
Ranchi	225.75	115.37
Total	**1069.86**	**539.92**

The component-wise detailed outlay and physical targets under each sanctioned project are given in Annexures I,II,III,IV and V.

CURRENT STATUS OF DISTRICT PROJECTS

The Central Sector Integrated Programme for Development of Horticulture in Tribal/Hilly Areas

Annexure I

Project on Integrated Horticulture Development in Adilabad District, 2000-2001 – Physical targets and financial implications

	Project cost (Rs, lakh)
Techno-economic Feasibility Study and Project	2.50
i. Technology-economic Feasibility Study	0.25
ii. Project Formulation	
Total (I)	2.75
Establishment and maintenance of nurseries	
(a) Development of 12 nursery units at 3 farms, viz. Mudgal, Gudipet, Adilabad	2.70
(b) Infrastructure for strengthening of nurseries(irrigation source, preparation of pandals with shadenets, power tillers, creation of vegetable pandal, implements/sprayer, etc.)	12.30
Total(II)	**15.00**

Area expansion		
a. Fruit crops (mango – 400 ha/cashew– 400 ha.; banana – 400 ha/citrus – 100 ha and sapota – 50 ha) - 1350 ha	97.00	
b. vegetable crops – 180 ha	9.00	
c. Spices(chillies – 75 ha and turmeric – 10 ha) – 85 ha	5.00	
d. Floriculture –40 ha	14.00	
Total (III)	**125.00**	
Transfer of technology		
i. Demonstration (0.2 acre each)		
• Vegetable cultivation – 20 unit	2.00	
• Mixed floriculture - 20 unit	3.00	
• Cultivation of aromatic plants – 12 acres	3.00	
• Installation of a distillation plant	2.00	
sub-total (.i.)	**10.00**	
ii. Human resources development (farmers training; (orientation of staff and video shows)	4.00	
Total (IV)	**10.00**	
Irrigation		
(i) Open wells/infiltration wells/bore wells – 30 units	6.00	
(ii) Pump sets/oil engines – 30 units	2.40	
(iii) Drip and sprinklers – 95 units	26.60	
Total (V)	**35.00**	
Horticulture machinery and sprayers	Need-based	5.00
On-farm handing facilities		
i. Plastic crates - 800 nos.	1.20	
ii. Turmeric polishing machines – 2 units	0.80	
iii. Turmeric graders – 2 units	1.00	
iv. Chilli driers – 4 units	2.00	
v. Plastic sheets and shade nets	5.00	
Total (VII)	**10.00**	
Implementation cost	Need-based	20.00
Alternative marketing system	Need-based	3.25
Evaluation, technology hiring, seminar, publicity including media support etc. (to be operated by DAC, Govt. of India)	Need-based	5.00
Grand total		**235.00**

Annexure II

Component-wise detail of the financial proposal for Integrated Development of Horticulture in Almora district, 2001-02

Component	Project cost (Rs. lakhs)
Techno-economic study and project	
i. Technology-economic feasibility study	2.50
ii Project formulation	0.25
Total (I)	**2.75**
Establishment and Maintenance of Nurseries of Horticulture Department and Private Nurseries (2 ha)	
i. Tarikhet Compact Area	3.00
ii. Lamgara Compact Area	3.00
iii. Kapcot Compact Area	3.00
Total(II)	**9.00**
Area expansion (in Tarikhet, Lamgara, Kapcot Compact Area)	
a. Fruit crops (125 ha)	25.0
b. Vegetable crops (250 ha)	25.0
c. Floriculture and polyhouse (5 ha and 1000 m^2 polyhouse)	8.00
Aromatic and medicinal plants (16 ha)	2.00
Total (III)	**60.0**
Transfer of technology	
Establishment of Producers' Groups Facilitation Centre (PGFC) @ Rs 10 lakhs for each compact area for carrying out the activities as under:	
O Greenhouse demonstration(500 m^2)	1.50
O Seasonal /annual crops (1.3 ha)	0.20
O Fruits and other perennials (1.0 ha)	0.30
O Floriculture (1 ha)	1.50
O Demonstration site for irrigation methods/techniques (1 ha)	0.60

O Publication and distribution of extension literature	(need-based)	0.50
O Others (need-based)		0.40
O Training in appropriate techniques (30 farmers @ Rs 1,000/farmer)		3.00
O Exposure visits (400 farmers @ Rs 500/- farmer)		2.00
Total(IV)		**30.00**
Irrigation Facilities to FIGs/farmers for adoption of *in situ* moisture conservation methods/techniques in all the three compact areas for creation of rain water harvesting and drip irrigation system @ Rs.10 lakhs for each compact area		30.00
On-farm Handling Practices For Producers Groups in all the three compact areas @ Rs 5.5 lakhs for each block		16.50
i. Plastic crates	Need-based	
ii. Creation of common pre-cooling facilities and storage		
Alternative marketing system (25% of the cost of the system for a minimum cost of Rs 204 lakhs)		
i. Transportation facilities including good roapways, storage facilities and communication linkages @ Rs 12 lakh for each selected block		36.00
ii. Input/ utility service center for collection, grading and Storing @ Rs 50 lakh each selected compact area		15.00
Total(VII)		**51.00**
Horticultural machinery and equipment		
i. Tarikhet Compact Area		1.25
ii. Lamgara Compact Area		1.25
iii. Kapcot Compact Area		1.00
Total (VIII)		**3.50**
Evaluation technology, hiring seminar, publicity- need-based by DOAC		5.00
Need-Based programme		
i. Formulation and strengthening of FIGs/PGs		
ii. Commodity enlinking meets/workshops Rs 2 lakh in all		
iii. Networking workshops		
iv. Progress monitoring workshops etc. the Compact Areas		
Implementation cost (10% of the total project cost)		21.25
Grand total		**235.00**

Annexure III

Integrated Programme for Development of Horticulture in Bastar District of Chhattisgarh, 2000-2001.

Component	Amount (Rs, lakhs)
Upgradation of nurseries	
(3 Govt. nurseries at Badanji, Bademarenga, Kondagaon)	9.50
Expansion of area under horticultural crops	
a) Area expansion under fruit crops (mango 80 ha, cashew 80 ha and banana 24 ha) @ 50% of actual cost	1164
(b) Expansion of area under vegetable crops (tomato 60 ha, cauliflower 40 ha, cabbage 40 ha, brinjal 30 ha and chilli 40 ha) @ Rs.1000/ha	21.00
(c) Expansion of area under root and tuber crops (potato 40 ha, onion 50 ha, colocacia 24 ha and sweet potato 24 ha)	15.80
(d) Expansion of area under *Baadies* (1,000 beneficiaries @ Rs 400/ beneficiary for materials to be distributed, fruit plants vegetable seeds, planting material of root and tuber crops, fertilizers etc.)	4.00
Sub-total (II)	**52.44**
Transfer of technology	
a. Demonstrations	
(i.) Fruit demonstration plots (0.5 ha) - mango 12, cashew 12 and banana 6	1.95
(ii.) Vegetable demonstrations (0.25 ha.) - tomato 30, cauliflower 30, cabbage 30 brinjal 30 and chilli 30	5.63
(iii.) Root and tuber crops demonstrations (0.25 ha) - potato 30, onion 30, sweet potato 8 and colocacia 8	3.23
b. Training-and-visit of farmers 800 farmers @ Rs1000/ farmer)	
c. Printing of literature and media publicity	
Sub-total (III)	**18.96**

	(Rs in lakhs)
Irrigation facilities	
(a) Dugwells/tubewells/water pickups (for 60 farmers at 50% of actual cost but not more than Rs 3000/unit)	18.00
(b) Pump sets (200 pumpsets for lifting water from *nallahs*, river etc at 50% of the cost but not more than Rs 8,000/set)	16.00
(c) Drip irrigation (10 demonstrations of 0.5 ha at 50% of the cost but not more than Rs 28,500/ha	1.42
Sub-total (IV)	**35.42**
Horticultural machinery and equipment (250 sprayers/dusters @ Rs 1000/unit)	2.50
On-farm handling facilities (for four collection points at Bastar, Lohandiguda, Tarapur area in Jagdalpur Tehsil and Kondagaon)	
(i.) 4 Sheds (500 feet area) @ 80% of the cost (Rs 2,00,000/shed)	7.50
(ii.) 2 LCV's for collection of produce @ 80% of the cost (Rs 7.00 lakhs/vehicle)	14.00
(iii.) 250 plastic crates @ Rs 200/crate	0.50
Sub-total (VI)	**22.50**
Alternative marketing system (25% of the cost of the system for a minimum cost of Rs 2.40 crores)	60.00
Evaluation, technology hiring, seminars, media, etc.	**5.00**
Project implementing cost	20.00
Grand total (I to IX)	**226.82**

Annexure IV

Project Proposal of Integrated Horticulture Development for Ranchi District, 2001-2002–Physical targets and financial implications

		Project cost (Rs. lakh)
Project formation		
i.	Technology-economic feasibility study	2.50
ii.	Project formulation	0.25
	Total (I)	**2.75**
Crop production		
(i.)	Establishment of nursery	
(a)	Establishment of one large nursery of 4 ha	8.00
(b)	Establishment of one small nursery for individual beneficiary	1.50
	Sub-total (i)	**9.50**
Area expansion		
(a)	Fruit crops (mango, aonla, lithei, guava and Tamarind) – 10 ha	2.00
(b)	Vegetables (ginger and capcisum – 75 nos.: table pea – 75 nos.)	7.50
(c)	Floriculture(shade nets with fabrication work having extra layer of UV stabilized polysheet for gerbera cultivation and plant propagation) –20 nos.	10.00
(d)	Mushroom (establishment of one spawn unit)	12.35
	Sub-total (ii)	**31.85**
	Total (II)	**41.35**
Transfer of technology		
i.	Demonstration	
	○ Fruits– 10 ha	3.00
	○ Vegetables	

	○ Cultivation of vegetables– 100 nos.		3.75
	○ Permanent nursery for vegetable seedling– 50 units		6.00
	○ Floriculture - 20 nos(0.2 ha.)		6.00
	○ Model Floriculture Centre - 1 no.		51.40*
	○ Demonstration on medicinal/aromatic plants – 16 nos.		2.40
	○ Demonstrative distillation unit of IMT including furnace, pumpset and shade		2.50
	○ Mushroom production unit – 10 nos.		1.50
	○ Training and visit of farmers – 500 nos.		5.00
	○ Production of literature		0.15
	Total III		**81.70**
Irrigation			
i.	Irrigation well – 30 nos		12.00
ii.	Pump sets with delivery pipes – 200 nos.		16.00
iii.	Drip and sprinkler irrigation system – 25 units		7.12
	Total (IV)		**35.12**
Horticultural machinery and sprayers		Need-based	2.00
On-farm handling facilities			
i.	Construction of centre for grading, processing, packing and storage - 5 nos.		10.00
ii.	Construction of unconventional cool room in production centre – 5 nos.		7.50
	Total (VI)		**17.50**
Implementation cost			22.00
Alternative marketing system (25% of the cost of the market system)			17.50
Evaluation, technology hiring, seminar, publicity including media support, etc. (to be operated by DAC, Govt. of India)		Need- based	5.83
	Grand total		**225.75**

Annexure V

Activity wise break-up of outlays for Integrated Horticulture Development in Tribal/Hilly areas-Dahod/Panchmahal district for the year 2001-02.

Component	Physical targets	Rate of assistance	Total outlay (Rs, lakhs)
Crop production			
(i) Establishment of small nurseries in Dahod of one hectare each	4 ha in 4 villages	Rs 1.5 lakh/nursery	6.00
Area expansion			
(i) Seasonal / annual crops (vegetables/roots/ tubers)	120 ha	Rs 10.000/ha	12.00
(ii) Fruits and perennials	200 ha	Rs 20.000/ha	40.00
(iii) Floriculture roses. marigold	5 + 20 ha	Rs 15000/ 4000/ha	7.50
(iv) Greenhouse of 500 sq.mt	One	Rs 1.5 lakhs/unit.	1.50
Transfer of technology			
(i) Seasonal/annual: crops (vegetables. tubers)	15 ha	Rs 3750/ 0.25 ha	2.25
(ii) Fruits. and other perennials	20 ha	Rs 15.000/ 0.5 ha	6.00
(iii) Floriculture	3 ha	Rs 30.000/0.2 ha	4.50
(iv) Training and visits of farmers	300 farmers	Rs 1500/farmer	4.50
Irrigation			
(i) Wells	40 units	Rs 30.000/unit	12.00
(ii) Pump sets	100 units	Rs 8.000/unit	8.00
(iii) Drip Irrigation	30 ha	Rs 28,500/ha	8.50
On-farm handling, collection, storage and transportation	3 Centers	Rs 6 lakh/unit	18.00
Project preparation cost		RS 0.25 lakh	0.25
Techno-economic feasibility study		Rs 2.5 lakh	2.50
Total cost of the Project			136.40
Implementation cost 8%			10.89
Grand total			**147.29**

was sanctioned by Standing Finance Committee of Department of Agriculture and Cooperation, Government of India for implementation during Ninth Plan with an outlay of Rs 14.50 crores in 6 selected districts.

Salient features and present status of district projects sanctioned with the approval of Project Approval Committee are:

Adilabad (Andhra Pradesh)

Adilabad is the northern most district of Andhra Pradesh. The district has a total area of 16,126 km^2 covering 1,748 rural settlements and 11 urban settlements spread over 52 mandals. The earth surface is rugged, uneven and much undulating. The climate is characterized by hot summer and generally dry except during south-east monsoon. The average annual rainfall in the district is 1,044 mm which is more than the state average. The district is traversed by a number of major rivers like Godavari, Penuganga, Wardha and Pranahita besides minor rivers, Kadam and Pedavagu. The utilization of surface water in the district is the least due to lack of irrigation sources. The soils in the district are predominantly black cotton followed by chalka, sandy loams and red loams. The black soils constitute 72% chalka and red loams 19%. The total groundwater potential is 2.13 hecto meters while the annual draft is only 0.10 lakh hecto meters. Canals, tanks, tubewells and borewells constitute major source of irrigation.

District Rural Development Authority(DRDA) is the State Designated Agency(SDA) to implement the project in Adilabad district. The need-based project on the basis of gaps identified in the Benchmark Survey was approved by the Project Approval Committee (PAC) in its meeting held on 19 May 2001 at a project cost of Rs 235 lakhs.

The District-level Horticulture Coordination Committee under the Chairmanship of District Collector with Project Director, DRDA, as a convenor has been constituted for overseeing the implementation and to take necessary policy measures for smooth implementation of the project. ATMA Society will monitor the implementation of the project components at mandal and village levels. Horticulture Consultants and Social Mobilizers are to be hired. In view of the predominance of black cotton soils and its tendency of compaction during summer, irrigation support during lean monsoon period is important. The irrigation development is being integrated with the on-going development programmes as well as externally aided projects in the district. Participation of commercial banks for irrigation development for tapping groundwater form crucial component. The Horticulture Development Society, and mandal level and village level Horticultural Cooperative Societies are expected to federate the marketing component. Till the marketing system is streamlined, Raythu bazars at Adilabad, Nirmal and Mancherial would be strengthened by providing cooling chambers.

Almora (Uttaranchal)

Almora district in Kumaon region is situated in northern part of Uttaranchal. The total geographical area of the district is 3,698.3 km^2. The district has development blocks with headquarters at Almora. About 92% of its population hails from rural areas and 8% live in urban areas. Based on the gaps identified through the benchmark survey in technology adoption, input support, infrastructure, marketing, etc. the project formulated by the SDA was approved by PAC and finally sanctioned with an outlay of Rs 235 lakhs for 2001-02. The project is being implemented in 34 villages in 3 compact areas of Tarikhet, Lamgara and Kapkot.

For transfer of technology, 3 Producer Groups' Facilitation Centres (PGFC) will demonstrate technologies for cultivation, polyhouse nursery raising, rainwater harvesting, drip irrigation, post-

harvest management and organic farming. Pumpsets, drip irrigation and rainwater-harvesting tanks are proposed for organizing irrigation facilities in the selected compact area. For on-farm handling of the produce, collection, grading and sorting centres are also being set up in collaboration of NDDB. To overcome the problem of transport of produce from orchard/fields to road head, Roapway Trolleys are proposed.

The strategy for implementation of the project include capacity building activities at farmers' level and formation and strengthening of Producers' Groups. For ensuring participation of target group farmers, Producer Groups at village level will be set up. The PGs could be both formal and informal in nature. These groups once in command of the development process will also help easy exist for the project authority without impairing flexibility of the project. To ensure that benefits of the project inputs reach large farmers community assistance would be provided through PGs formed in each village under the project command area. The SDA would function as a catalyst for formation of these groups and provide necessary support. Common facilities/infrastructure will be created in close association with the FIG's and the operation and maintenance will also be their responsibility.

For making the project successful, Government of Uttaranchal, has issued an order that the experienced work force available in Department of Horticulture is utilized under the project and all the targets and activities of the project will also be considered as targets and activities of the Horticulture Department in the project area in addition to their own responsibility. District-level Project Monitoring Committees have been formed for Almora and Bageshwar districts to assess and monitor project activities time-to-time.

The SDA has taken up initiative for formation of PGs at village/cluster level. A total of 53 Farmers' Self-Help Groups called "DAGRI" groups have been formed. The DAGRI is a word derived from the Kumaon dialect which represents Group of Friends who works together for a developmental cause. For formation of the DAGRI Group, a participatory approach has been adopted.

Project-orientation Workshop was organized on 7 and 8 September 2001 at Hawalbagh for officers and staff associated with the project. In this workshop, Work Plan for implementation of project activities for the next 3 months were drawn up. Vegetable seed requirement at village level was assessed. Similarly, for capacity building, 4 demonstration/training programmes were organized at villages Bhairyur and Shama in Kapkot Compact Area and at villages Toli and Chautara in Lamgara block wherein practical training was provided for making organic composts, viz. biodynamic compost, cow pet pit, vermiculture and liquid compost.

Bastar (Chhattisgarh)

Bastar district of Jharkhand has 14 development blocks. The area of the district is 8755.79 km^2. The population of the district is 11.09 lakhs and 90% live in rural areas. More than 80% people residing in the district are tribals, 60-70% of them falling below the poverty line. The climate is sub-humid with hot summers and cool winters. The temperature ranges from 30.6 ^{0}C in January to 41.1 ^{0}C in May at maximum level and 4.4 ^{0}C in December-January to 19.4 ^{0}C in July. Average rainfall is

1296.6 mm. More than 90% of rainfall is received from June to September. The important horticultural crops are tomato, sweet potato, brinjal, potato, okra, colocacia , mango, etc. In Bastar, fruits and vegetables are brought to the "Haatt Bazaars" in small quantities by the farmers for selling.

The State Govt. has identified Baster Horticulture Development Society, Jagdalpur, as the State Designated Agency(SDA) to implement the scheme in Bastar district. The Commissioner, Bastar Division, is the Chairman of the Society. The project for Integrated Development of Horticulture in Bastar district has been sanctioned with an outlay of Rs 236.82 lakhs for 2001-2002. More than 80% of the population in the district are tribals. Besides increasing area expansion in the fields, the project envisages expansion of area under Baaddis also. Villages under various blocks have been identified for expansion of area under different crops:

Crop	Block	Villages
Mango	Bakawand, Kasndagaon	Bajawand, Tarapur and Taliagaon Kadkodi, Karanji and Bolbola
Cashew	Bakawand Darbha	Badedevra, Karpawand and Tarawand Naganer, Lendra and Gadamguda
Banana	Lohandiguda	Kumhil, Chandanpur and Takdaguda
Vegetables, potato and onion	Lohandiguda	Taragaon, Mandar, Alnar
	Bakawand	Tarapur, Taliagaon, Talnar
	Tokapal	Tekmeta, Deorgaon, Karanji
	Bastar	Bhatapal, Bharabale, Bharni
	Kondagaon	Samjalpur, Kusma and Bhadanar
Root and tuber crops	Darbha	Keshapur, Chingpal
	Bastar	Bahanpur and Bale Kalapal

It is proposed to set up 4 collection points at Bastar. Lohandiguda, Tarapur area in Jagdalpur Tehsil, Kondagaon and Narainpur. At all these collection points, facilities like sheds, LCVs and plastic crates shall be provideed.

Ranchi (Jharkhand)

Ranchi district in Jharkhand has an area of 7,593 km^2. The district is characterized by undulating wavy topography as it is part of Chotanagpur plateau. The district of Ranchi comprises lower Chotanagpur plateau and Ranci plateau. Soils of Ranchi are generally characterized as uplands, medium land and lowland. The uplands are red brownish-red in colour, light textured, well-drained acidic in reaction. Medium lands are yellowish in colour, light to medium textured and moderately acidic and the low lands are greyish in colour, heavy textured, neutral to soil reaction and poorly drained. The plateau is characterized by uneven topography and steep slopes. The average rainfall of the district is 1,500 mm of which 80% precipitate during June - September during the south- west monsoon and rest about 18% precipitate during retreating of south-west monsoon and summer rains. Onset of monsoon normally begins from June and continues up to September and when south- west monsoon recedes.

The area under fruits is about 2,900 ha and under vegetables including potato 11,584 ha. Jackfruit, papaya, guava and mango are widely cultivated in Ranchi as soil and climate are congenial for their production. Litchi is also choice fruit. Litchi has been established in areas where regular irrigation and proper fencing has been ensured. Custard-apples grows better in-situ near by home steds or in the forest with least effort. Green peas, frenchbean, cauliflower, cabbage, capsicum and tomato are principle vegetable crops grown in the district. Besides, rose, commercial cultivation of marigold, gladiolus, gerbera, aster and chrysanthemum also been taken up.

About 11 commercial banks are operating in Ranchi district. Bank of India is the lead bank. Besides, there are land development banks. About 40 registered/ unregistered fruit, vegetable growers' societies are functioning in the vegetable-growing areas of the district and 23 NGO's are also working in the district. The Chotanagpur Cooperative Vegetable Marketing Federation Limited (VEGFED) and different fruits and vegetables growers' societies have been formed but they are not able to compete with middleman and vegetable traders. There are 7 cold storages in Ranchi where potato, tamarind and mahua are stored. There is no precedence of storage of vegetables to overcome the situation of glut during main season.

The State Government has identified Birsa Agriculture University, Kanke, as the State Designated University to implement the scheme in the district. The project with a total outlay of Rs 235 lakhs for 2001-2002 has been sanctioned incorporating components identified as gaps through the Techno-Economic Feasibility Study.

Dahod/Panchmahal (Gujarat)

Dahod district in Gujarat has 9 talukas and 997 villages about 91.87% of the total population of the district live in rural areas, 71.36% of the population being Scheduled Tribes. The average rainfall varies from 800 to 1000 mm. The long dry spells and erratic nature of rainfall result in frequent drought. The soils are medium black with shallow depth and fertile in nature. However, undulating terrain and intense rainfall cause severe soil erosion. The area covered under irrigation is 9.14%. The main source of irrigation are wells, irrigation tanks and lift irrigation. The lift irrigation has remained the most secured source of water as most of the wells are shallow. The medium irrigation schemes such as Vankleshwar dam in D. Bariya, Umariya dam in Linkheda, Machan dam in Jhalod talukas contribute to canal irrigation. Rivers constitute the major source of surface water apart from tanks. Drip and sprinkler irrigation are most feasible when it comes to dryland horticulture.

At present, the area under fruit crops is 550 ha, producing 3,245 tonnes. The area under vegetables is 935 ha, with a production of 19,800 tonnes. The area under spices is 1,170 ha, with a total production of 9,020 tonnes. There are about 13 growth centres in the district with marketyards. The major vegetable markets centres are Dahod and Limdi. 97.98% of the villages are connected with all weather roads. The Techno-Economic Feasibility Study has brought out that horticulture is the first generation crop in the region and farmers are not aware of appropriate technologies involved in cultivation, nurturing and other essential input management services.

The State Govt. has identified N.M. Sadguru Water and Development Foundation, Dahod as the State Designated Agency (SDA) to implement the scheme in Dahod/Panchmahal districts of Gujarat. The project prepared for implementation during 2001-2002 was considered in the meeting of the Project

Approval Committee on 5.9.2001. The project with an outlay of Rs 147.04 lakhs has been sanctioned for implementation in the district. The project is proposed to be implemented in 63 villages of 8 blocks, the details are given.

Block	Village
Dahod	Rozam, Jekot, Kharedi and Bawka
Garbada	Matwa, Aambli, Chandavad, Bharsada, Vadva, Panddi, Vijaghad and Abhalod
Limkheda	Kheriya, Katholiya, Degavada, Pipli, Waghnala, Randhikpur, Dhadhela, Sakriya, Chunddi, Malekpur, Dabhada, Hirapur, Vanjariya, Singvad, Chaparvad and Dhabudi
Morvahadaf	Vandeli and Khudra
Dhanpur	Khokhara, Kundavada, Simamoi, Vakasiya, Pipodra, Bhorva, Pipero and Chorbariya
Bariya	Antela, Rama, Kaliyagota, Rebari, Juna Bariya, Meghamuvadi and Gunamuvadi
Jhalod	Dungri, Vankol, Kadval, Vansiya, Kunda, Dhalsimal, Nenki, Dungra, Motakaliya, Sutharvasa, Mundha, Chakisna, Pipaliya and Thala, Jetpur
Ghoghamba	Ruparel, Khanpatla and Sajora

HUMAN RESOURCE DEVELOPMENT IN HORTICULTURE

Jose C. Samuel* and H.P. Singh**

Horticulture has emerged as a key sector in agriculture, which is highly technology-driven coupled with hi-tech interventions. For meeting the growing demands of this sector, it is necessary to have skilled manpower at different levels. Moreover, the acquired skills require to be updated periodically. In the expanded scenario of horticultural development during the Eighth Plan, the acute shortage of trained manpower was a serious constraint. Horticultural production technology witnessed the introduction of hi-tech measures like microirrigation, protected cultivation, micropropagation, etc. Moreover, in the scenario of limited availability of natural resources like land and water, the focus would be on precision farming for deriving maximum returns per unit area. Organic farming is another area receiving attention globally. In order to face the challenges of rapid development in horticulture sector it would be necessary to generate adequate number of trained manpower.

LIMITATIONS OF EXISTING TRAINING PROGRAMMES FOR HORTICULTURE

A number of agricultural universities and training institutions in the country are turning out a large number of graduates with specialization in horticulture (Table1).

Table 1, Available infrastructure for HRD in horticulture

Organization	No.
State Agricultural Universities (which offer course curriculum at graduate/PG level on horticulture)	26
ICAR Crop/Commodity Institutes/National Research Centres (NRCs)	15
All India Coordinated Research Projects (AICRPs)	14

Trainees performing air laying of fig

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The courses offered by these institutions tend to be theoretical with very little practical input. The students receive little or no hands-on experience. Nor are they trained adequately in the management aspects of horticultural gardens and farms, thus becoming little attractive to employers who look for people trained in the practical aspects of hoticulture capable of performing supervisory and managerial functions. Horticulture is now turning into a high technology activity. The gardeners or the *malis* who actually work in the fields have also to be trained in the advanced methods of cultivation and use of various technically superior and efficient equipments and implements.

The present courses being offered to the gardeners are not only numerically few but also highly inadequate content-wise. Consequently, age-old practices continue to be adopted, resulting in low productivity.

The estimated requirement of different categories of skilled manpower in horticulture sector was reported by Pandit Sundertal Sharma, Central Insitute of Vocational Education, Bhopal in 1996 (Table 2).

Table 2. Requirement of skilled manpower for horticulture

Crop/area	Increase in area (ha)	Additional manpower required ('000)
Fruits	1.00	25.00
Vegetables	0.50	50.00
Plantation crops	0.50	15.00
Spice crops	0.08	8.00
Medicianal and aromatic plants		1.00*
Plant/seed production		5.00
Nursery management		10.00
Tissue culture	100 m. plants	1.00
		5.00*
Floriculture		1.50
Landscaping		2.00
Post-harvest handling and Marketing		1.00
Fruit and vegetable [reservation		1.00
Mushroom cultivation	30,000 tonnes	2.00
Total		**127.50**

Presently, there is a wide gap between the demand for trained managers and supervisors as also *malis*, and their supply. This gap is only likely to widen as horticulture progresses at a pace faster rate than hitherto. If the initial push given in the Eighth Plan by way of larger outlays is to help horticulture take off, in a big way and realize its full potential then the aforesaid gap needs to be bridged.

Shearing operation at N.G. Ranga Agricultural University, Hyderabad

SCHEME ON HRD IN HORTICULTURE

Keeping in view the urgent need to fill the gap on the availability of trained manpower in the horticulture sector, a Central Sector Scheme on Human Resource Development in Horticulture was launched in the Department of Agriculture and Cooperation (DAC) during the Ninth Plan (with effect from 1999-2000) at an outlay of Rs 5.00 crores. The scheme mainly aims at promoting the rapid growth of horticulture by bridging the gap of knowledge and skill both managerial and technolocal by training people to become entrepreneurs or self-employed in the horticulture sector and to create skills for employability in horticultural units/farms and upgrade the knowledge of departmental staff in the field of horticulture. Therefore, emphasis has been laid for more of hands-on training rather than theory classes.

The scheme has 4 components. They are:

- Training of supervisors
- Training of gardeners
- Training of entrepreneurs
- Training of departmental staff.

Supervisors' and Entrepreneurs' Training

The training programme for the supervisors and entrepreneurs is being organized through selected SAUs/ICAR institutes. Presently, 7 Institutes have been identified for organizing the training programme for supervisors and 3 Institutes for entrepreneurs.

Institutes where HRD programme being implemented during Ninth Plan

Supervisor's training

- Acharya N.G. Ranga Agricultural University, Hyderabad, Andhra Pradesh
- Dr, Y.S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh
- Indian Institute of Horticultural Research, Bangalore, Karnataka
- Mahatma Phule Krishi Vishva Vidyalaya, Rahauri, Maharashtra
- Birsa Agricultural University, Ranchi, Bihar
- N.D. University of Agriculture and Technology, Faizabad, U.P.
- Krishi Vigyan Kendra, Chamoli, Jaipur, Rajasthan

Training on harvesting of banana at Mahatma Phule Krishi Vishwa Vidyalaya, Pune

The details of assistance being provided for conducting training programme to supervisors and entrepreneurs are given in Table 3.

2. *Enterpreneurs' training*

- Dr, Y.S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh
- Indian Institute of Horticultural Research, Bangalore, Karnataka
- Mahatma Phule Krishi Vishva Viyalaya, Rahauri, Maharashtra

Table 3. Details of assistance to institutes organizing supervisors' and entrepreneurs' training courses

Activity	Amount (Rs.)
Stipend for 25 trainees @ Rs 1000/ month for 12 months	3,00,000
Course material to trainees @ Rs 500/trainee	12,500
Support for infrastructural development (one time for the entire project duration)	
Addition/alteration of hostel	3,00,000
Addition/alteration of classroom	2,00,000
Setting up of greenhouse	2,00,000
Drip irrigation	1,00,000
Tools and implements	1,00,000
Audio Visual Aids	1,00,000
Total	10,00,000
Operational support to institute	
Support for temporary staff	1,50,000
Honorarium for guest lecturers	1,00,000
Printing of training material	50,000
Advertising etc.	50,000
Transport hiring, TA/DA, contingencies	1,25,000
Contingencies	25,000
Total	5,00,000
Grand total	**18,12,500**

Gardeners' Training

The Gardeners' training will be organized through Krishi Vigyan Kendras, SAUs, ICAR institutions and NGOs of repute. Presently, the following 6 institutes have been identified for conducting training courses for gardeners

- Ramakrishna Mission, Divyayan Krishi Vigyan Kendra, Ranchi, Bihar
- Punjab Rao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra
- Rajendra Agricultural University, Samasthipur, Bihar
- Agri-Horti Society, Public Gardens, Hyderabad, Andhra Pradesh
- Punjab Agricultural University, Ludhiyana
- Krishi Vigyan Kendra, Ujwa, NHRDF, Delhi.

The minimum qualification for supervisors and entrepreneurs for attending training programme would be Higher Secondary and for gardeners, Class-VII (Middle) standard. An indicative course structure for different training programmes at supervisory level as well as gardeners' level has been worked out by a Committee under the Chairmanship of Deputy Director General (Extension), ICAR. The details of assistance available for conducting gardeners' training are given in Table 4.

The training institutions have been given the option to draw up the course details within this structure in consultation with the DAC. The main thrust of the scheme will, however, be to provide hands on practical training to the participants.

Training of supervisors on tree pruning in apple orchard at YSPUAF, Solan

A Project Approval Committee constituted in the DAC under the Chairmanship of Horticulture Commissioner scrutinized the project proposals received from various institutes for imparting Supervisory level, Entrepreneur level and Gardener level training. The States which already have a strong horticultural production base and having institutional set up for training in horticulture have been included in the Scheme for organizing the training programmes in horticulture. Supervisors' training are being held in six SAUs while Gardeners' training are being held in five institutes. All the States and UTs have been covered for providing in-service training of horticultural staff.

Table 4. Details of assistance to institutes organizing gardeners' training course

Activity	Amount (Rs)
Stipend for 25 trainees @ Rs 800/month for 12 months	2,40,000
Course Material to trainees @ Rs 250/trainee	12,500
Support for infrastructural development (one time for the entire project duration)	
Addition/alteration of hostel	2,00,000
Addition/alteration of class room	1,00,000
Supply of equipment for gardening	1,00,000
Audio Vosual Aids	1,00,000
Nursery establishment	1,00,000
Total	**6,00,000**
Operational support to institute	
Support for temporary staff	75,000
Honorarium for guest lecturers	50,000
Printing of training material	25,000
Advertising etc.	25,000
Transport hiring, TA/DA	62,000
Contingencies	12,000
Total	**5,00,000**
Grand total	**13,52,500**

The institutions identified for training have the basic infrastructural facilities like classrooms, staff, hostel facilities, etc. Having regard to this fact, the training institutions will be provided assistance for strengthening their infrastructure for conducting the training programmes under the scheme. Based on the willingness of the participating institutions, proposals will be invited directly from these institutions. Funds to the tune of Rs 18 lakhs for supervisory level training and Rs 13 lakhs for gardeners' training is released to them after getting the Memorandum of Understanding.

The courses is of one-year duration for supervisors and of 6 months for gardeners and of 3 months for entrepreneurs. In order to attract the candidates and more importantly retain them and prevent their dropout, a monthly stipend is being provided to them in the form of boarding and lodging charges in the Institute concerned. The courses is residential. At the end of the training, supervisors are awarded a Diploma in Horticulture and Gardeners and Entrepreneurs a Certificate of Training in horticulture. In all, 25 supervisors, 50 gardeners and 20 entrepreneurs can be trained in each participating institution annually. These trained people emerge as potantial candidates for employment by the firms engaged in horticultural development.

Training of Departmental Staff

Under the Scheme, about 15–20 in-service personnel can be trained in the local institutes annually by the State Departments of Horticulture/Agriculture. For training of trainers and in-service personnel, each state has to maintain a panel of candidates. The candidates would be nominated for training based on the training programme which are announced by the Training Institutes. Candidates, particularly trainers who are required to train others could be deputed for training abroad also, to limited extent, for which assitance would be made available for meeting the travel cost and course fee. The State Departments of Horticulture/Agriculture concerned would function as the nodal department for this purpose. Funds are being made available to the State Horticulture/Agriculture Departments for meeting the expenses of the departmental candidates based on their specific proposal.

If the state wants to organize specialized training courses on horticulture related subjects, assistance will be provided for the same to the Institutes concerned directly based on the recommendation of the state (s). Concerned Such training would generally be of short duration of 7-10 days for 20 to 25 participants.

Current Status

The summary details of the progress achieved by various Institutes in organizing the training programmes for supervisors, entrepreneurs and gardeners are given below :

Type of training	Target (No. of courses)	Achievement (No. of courses)	Courses in progress
Supervisors	13	5	8
Enterpreneurs	5	4	1
Gardeners	22	10	12

So far, 411 people have been trained (123 supervisors, 46 entrepreneurs and 242 gardeners). The training programme for Departmental Staff has been availed by the State Governments of Haryana, Kerala, Maharashtra, Meghalaya, Mizoram, Nagaland, Orissa, Rajasthan, Sikkim and Uttar Pradesh. The performance of the Shceme was reviewed in a National Workshop held at Hyderabad on 7-8 September, 2001. The major recommendations of the workshop are:

- HRD scheme has been well received. It needs to be extended to other States.
- Trained personnel should find preference in employment in State Departments.
- Trained people should get preference in sanction of NHB and other institutional assistance.
- There is a need to keep track of the trained personnel.
- There is a need to conduct aptitude test for admission to various training programmes.
- Trainees should be exposed to all aspects of horticultural development for building their confidence.

CONCLUSION

With the launching of the Central Sector Scheme on Human Resource Development in Horticulture with effect from the year 1999-2000, a beginning has been made to bridge the gap between the requirement and availability of trained manpower in horticulture sector, particularly at the supervisory and gardener's level. The programme could be considered only as a pilot project wherein 6 institutes are offering courses for horticultural supervisors and 5 institutes for gardeners. The available programme will be able to generate about 150 supervisors and 250 gardeners per year, which would be covering hardly a fringe of the manpower requirement. However, depending upon the sucess of the programme, the Scheme could be enlarged to cover more institutes during the Tenth Plan.

PROCEEDINGS OF NATIONAL HORTICULTURE CONFERENCE, 2001 HELD AT SCOPE BUILDING, CGO COMPLEX, NEW DELHI ON 16-17TH NOVEMBER, 2001

In order to review the performance and, to deliberate upon the emerging issues for shaping the horticulture development programmes in Tenth Plan, a two-day National Horticulture Conference-2001, was organised by the Deptt. of Agriculture & Cooperation at New Delhi on 16th & 17th November, 2001. The Conference was attended by about 200 delegates comprising Secretaries/ Directors of State Govts, Directors of ICAR institutes, representatives from various Departments/ Central Ministries, State Agricultural Universities and others concerned with the development of horticulture in the country.

Hon'ble Secretary (A&C), Shri J.N.L. Srivastava set the tone of the deliberations by inaugurating the conference. He mentioned that the Working Group on Horticulture for the Tenth Plan has submitted its report which was also presented to the Steering Committee in Planning Commission and was well appreciated. He also expressed great satisfaction that most of the issues relating to the development of horticulture in the country have been included in the agenda of the Conference. He desired that issues relating to credit and risk management should also be addressed. He further emphasised that the horticulture has to play a leading role in the emerging scenario to achieve the growth rate of 4% in the agriculture sector, which could be achieved only if horticulture sector achieves a growth rate of 6-7% per year. He informed about various reforms being introduced by the Deptt. of Agri. & Coopn. including several Bills passed in the last session of Parliament.

Looking back to the past investments in horticulture, he said that these investments have been rewarding in terms of increased production and productivity of horticulture crops. He further stated that many issues still require to be addressed for sustainable development of horticulture, particularly end-to-end approach, production of quality planting material, production management system, careful handling of produce and efficient marketing. He expressed his satisfaction with various programmes taken up by the Department of Agriculture & Cooperation for horticulture development and said that in many of the programmes targets have already been achieved. On the approach for the Tenth Plan, he emphasised convergence and synergy of programmes of various departments to achieve targeted goals. He impressed upon the participants on the need for forming crop commodity associations and self-help group of farming for meeting emerging needs of horticulture development in the scenario of higher competition in liberalized economy.

Shri Hemendra Kumar, Spl. Secretary (A&C), Department of Agriculture & Cooperation gave an account of progress made in the preceding year in various programmes of horticulture. He stressed the importance of horticulture in the agrarian economy of the country with its contribution of more than 25% to agricultural GDP just from 8.5% of area. He informed that during the year, Technology Mission on horticulture for North Eastern region has been launched and its impact is becoming visible in the region. He also said that human resource development programme initiated by the Department in bringing in employment opportunities and creating availability of trained manpower has been

successful in bridging the gap in skilled personnel in this field. With respect to development of infrastructure, he expressed his satisfaction on the programme initiated by the National Horticulture Board, especially with respect to Credit-linked Subsidy Scheme for creation of cold storage.

Addressing the august gathering, Special Secretary (A&C) stated that varying agro-climatic conditions and diversity of crops provide ample opportunities for growing large number of horticultural crops and the country had competitive advantage in many of the crops. The important issue is to harness the potential through systematic development addressing all the issues in the chain. He opined that recommendation of Working Group on Horticulture would help in getting maximum financial support for this sector in the Tenth Plan.

Welcoming the Chief Guest and other delegates, Horticulture Commissioner, Dr H.P. Singh gave a brief account of the horticulture sector including FAO-assisted programme being implemented by the Department. He also highlighted the past achievements and identified future challenges and expressed his confidence that horticulture would play a pivoted role in improving the quality of life of agrarian population of the country by harnessing the existing potential of horticulture. He also emphasised upon the need for adopting a mission approach in a partnership mode to address all the links in the chain of development.

The Session covering the presentation on National Issues was chaired by Shri Hemendra Kumar, Special Secretary (A&C), DAC. The issues deliberated upon during the session included Agri Export Zones, policy reform of horticulture development, FAO perspective for horticulture development in India and research support for meeting the clients' needs in emerging scenario of horticulture development in India. The resource speakers gave presentations covering these aspects. The approach for promoting export through Agri Export Zones was appreciated, particularly since it provides for convergence and partnership which is essential for promoting horticulture exports. However, it was felt that there should be identification of core sector in a manner so as to address the policies at the national level. Various policy issues which are impediments for development of horticulture was spelled by Shri J.P. Negi, MD, NHB. States were requested to look into the matter as many of the policies needed reforms. A request was also made for amendments in excise and forest laws in a manner that they accelerate development of horticulture rather than becoming impediments. Research support on ICAR System was presented by Dr. G. Kallo, Dy. Director General (Hort.,), ICAR. During the discussions, it was emphasized that for research policies re-orientation is needed to meet the needs of clients in emerging scenario. There is a need to have feedback mechanism so that research programmes are oriented to have the satisfaction of the clients.

The experiences of horticulture development in Tamil Nadu, UP and Maharashtra were presented by Sh. S.K. Chaudhary, Commissioner (Hort.), Chennai, Shri M.M. Sinha, Director (Hort.), Lucknow, Shri Shivaji Rao Deshmukh, Secretary (Agriculture), Mumbai respectively. Experience in diversification in agriculture in UP was presented by Shri Mahender Singh. The presentations clearly indicated that there is overall awareness for the development of horticulture in the states wherein central interventions have played a very crucial role. However, the institutional support system for the horticulture in many of the states is weak and needs to be strengthened. It was also very clear that potential of horticulture has not yet been fully harnessed, as immense opportunities for its development exist through systematic approach. Thrust on the horticulture identified by the Tamil Nadu Government especially with respect to wasteleand development and integration efforts were well appreciated. Shri S.S. Mehta, Salem in his presentations regarding his experiences as a farmer highlighted how Amla, which was not known in Tamil Nadu a decade ago, has become important, especially in degraded sodic soils. He emphasised upon the role of Government to function as a facilitator in research and development to supplement the

efforts being made by farmers. Technical infusion backed by infrastructure and credit support shall play a very curcial role. He also said that although many of the farmers are getting very good price for Amla in the state, because awareness about its usefulness has been created, a group of farmers is ready for sale of Amla at 1/3rd of existing market price, as the venture will still be economical. He emphasised upon creation of more awareness regarding usefulness of Amla for increasing its demand so that more cultivation can be taken up.

Integrated development of apple was presented by Dr R.P. Awasthi, Vice Chancellor, Dr Y.S. Parmar University of Horticulture & Forestry, Solan. Strategies for the development of mango was presented by Dr. S.N. Pandey, Project Coordinator (Fruits), Lucknow, and Approaches for the Development of Litchi to meet the Domestic and Export Needs was presented by Shri J.S. Kanwar, Professor in Horticulture, Punjab Agricultural University, Ludhiana. Paper on Processing of Horticulture produce was presented by Mrs. Vibha Puri Das, J.S, Ministry of Food Processing Industries. Paper on Integrated Development of Onion was presented by Dr K.E. Lawande, Director, NRC on Onion & Garlic, Pune. All these presentations called for integrated approach for the development starting from the quality planting material till the produce reaches the consumers. The resource speakers also identified certain policy issues which are required to be addressed besides the researchable and developmental strategies. Quality of the produce was one of the important aspects impressed upon by all the speakers. During discussions, it was pointed out that many of the States purchase the planting material through tender, which has been detrimental to the quality of the planting material. After deliberations, it was decided that for the procurement of planting material, first there should be technical evaluation of the bid and then the financial tenders be called for. This process would eliminate supply of spurious quality of plants.

Other topical issues presented in the conference included cool chain management, WTO issues, marketing of horticultural produce and quality standards for horticulture produce. The presentations identified the need to reduce post-harvest losses through cool-chain management. Although the system would require high investment, it would ultimately improve the quality and profitability of farmers. While discussing WTO issues, it was clarified that an agreement is conducive for better access to the market of horticulture produce as many trade-distorting factors would get removed. At the same time, provisions are also available to safeguard the interest of our farmers. As far as horticulture is concerned, many of the crops are highly competitive. However, a concern was also expressed regarding reduced competitiveness compared to earlier analysis, way back in 1994 and today, which calls for improvement in productivity and quality. Banana was identified to be highly competitive in world trade. Thus, there is need to have a specifically addressed strategy for the export of banana. Innovative marketing system based on the experiences of Kerala was presented, which has similarity with the approaches identified by the department, having backward and forward linkages, termed as Alternate market. This approach requires to be replicated to have consumer-driven market which can provide better income to the farmers.

An approach for Bio-Dynamic Farming presented by Dr. R.K. Pathak, Director, CISH, Rahmankhera, Lucknow attracted lot of discussions as this farming system is highly innovative although based on farmers' wisdom. The presentation highlighted scientific basis of bio-dynamic farming. He impressed upon its large scale adoption. During discussions, it was agreed that support would be provided through National Horticulture Board (NHB) for pilot testing of bio-dynamic farming system & training. Since organic farming is becoming important in converting our weaknesses into the opportunities, the approach of bio-dynamic farming finds a special significance. Efficient quality standards existing in the country and being stipulated by CODEX and International Standards

Organisation (ISO) were presented with a clear message that if we want to be competitive we need to lay much emphasis on quality management system also.

The overview of progress made in implementation of the Technology mission for Integrated Development of Horticulture in North-Eastern Region was presented by Shri J.S. Mann, Addl. Commissioner (Hort.), DAC. He mentioned that 57% of the funds earmarked for current year have been made available to states. So far, awareness campaigns have ben organised which has made significant impact. Shri J.P. Negi, MD, NHB gave a detailed account of programmes being implemented by NHB and mentioned about achievements of targets. Dr P. Rethinam, Chairman, Coconut Development Board, Cochin identified the approaches for sustainability of coconut and said that coconut is a versatile crop and to make it more sustainable, it needs to be identified as a food crop rather than an oil crop. He emphasized upon product diversification and mixed farming. He said that there is need for creating an awareness about the usefulness of coconut water and other coconut products to enhance consumer base which presently is less than 12 coconut per year per individual in the country. Increase in consumers is expected to bring about the sustainability in coconut production.

On the current scenario of Micro Irrigation, Dr. Ashwini Kumar stressed the need to bring in 15 million ha under micro-irrigation in a phased manner to achieve vertical growth in horticulture crops. Although high cost is involved in adoption of micro-irrigation, it economizes water use, fertilizer use, and improves quality of produce besides reducing the load of diseases. Since water saving is creation of water, any investment in this sector is more rewarding as it will bring additional private investment for improving the yields.

Programmes of human resource development were presented by Dr. Jose C. Samuel wherein he highlighted the need for human resource development in horticulture. He reviewed the progress, which is highly satisfactory in achievement of targets. People trained under the programmes have got employment or they have become entrepreneurs on their own. Integrated Development of Horticulture in Tribal and Hilly Areas was presented by Shri Paramjit Singh, DC (Hort.) who said that out of 6 districts proposed in the programmes, 5 districts have been covered. Specific progress has been made in implementation of the programmes, especially in Almora, Ranchi and Adilabad. This programme is expected to improve livelihood of tribal and hilly areas. Dr. Jose Samuel critically analysed the scheme of Macro Management and its implementation and highlighted its importance in the horticulture sector. Further, analysis made by him suggested decline in the status in financial allocation for horticulture. The allocation should have been higher if horticulture had been identified as important sector in many of the states. Presently in many States, horticulture contribution is more than 60% of GDP of agriculture, yet the share of horticulture in the Micro Management mode is less than 15%. From this analysis, it was emphasised that the matter must be sorted out at the state level to prioritize horticulture development through enhanced allocation in Work Plans.

Dr. U.B. Pandey, Director, National Horticulture Research & Development Foundation (NHRDF), Nasik highlighted importance of the vegetables in improving the economic condition of farmers. He stressed nutritional security through vegetable production and highlighted programmes of the Ministry which has made ecellent impact in improving production and productivity in vegetable production. He presented programmes being implemented and highlighted issues to be addressed during Tenth Plan.

Deliberations and discussions in the conference were summed up by the Horticulture Commissioner. He said that past investments in horticulture have been rewarding in terms of increased produciton and productivity and availability of horticultural produce added with enhanced exports. He said horticulture development has been coined as "Golden Revolution" as announced by Hon. Union

Minister of Agriculture, Shri Ajit Singh. Although we are proud to see the start of 'Golden Revolution', this brings major challenges for the sustainability. The working Group appointed by the Planning Commision under the Chairmanship of Dr. K.L. Chadha, National Professor, IARI has worked out a detailed plan of action to achieve sustainability of 'Golden Revolution' through thrusts in identified areas. The thrusts include institutional support system, policy reforms and fianancial support in various programmes of the development such as infrastructure. Through these programmes, very high level of employment opportunities are expected to be generated among different sections of people added with high public investment. To achieve total growth, all the links in the developmental chain have to be addressed in a manner that total development is achieved. Missing of any link may be detrimental in achieving targeted goal. He referred to the suggestions of Hon. Secretary (A&C) with regard to achieving 7% growth and said that the deliberations during the Conference have addressed most of the issues which can be taken up for shaping the Tenth Plan proposal for horticulture development in order to have sustainability of 'Golden Revolution', as announced this year. He gave a brief account of all presentations and also highlighted various issues.

In this concluding remarks, Shri Hemendra Kumar, Spl. Secretary, DAC, appreciated efforts made for the success of the Conference and clarified queries raised by the participants. With regard to release of funds, he said that efforts are made by the Centre to release funds in the beginning of a financial year. During this financial year, 50% of release have been made so that programme can be taken up early. Problems associated with states must be sorted out by the States concerned. He said, seed and planting material, marketing, infrastructure, dissemination of information, post-harvest management, storage and providing support system are some of the key issues which required to be addressed for effective development of horticulture. He informed about zero-based budgeting done by the Department as well as Planning Commission and about the report of Expenditure Reforms Commission. He said, horticulture sector has been identified as very important sector for achieving the growth of 4% in agriculture sector. He opined for a better deal for horticulture in Tenth Plan and expected financial support to the tune of 3-4 times of Ninth Plan allocation. He, however, cautioned that programmes should have approach in totality with synergies and convergence. He indicated that hybrid variety, value addition, diversification, exports & hi-tech agriculture are some issues which will usher in development. He mentioned about efforts being made by the Deptt. of Agri. & Coopn. to organise the un-organised sector through commodity associations wherein the department would play a catalytic role. He mentioned about Micro Management Scheme and said that Deptt. of Agri. & Coopn. has been deliberating on various issues depending feedback and has taken decision that the programmes of horticulture would be reviewed by the Division at the planning stage as well as implementation stage. All the States were required to set a definite percentage of total allocation for the horticulture sector. He said, if there is need and if states feel, separate discussion could be organised for the credit support system. Finally, he apprciated the efforts made in the conduct of this confernce and thanked all the delegaes and resource speakers for their efforts.

Vote of thanks was proposed by Shri J.S. Mann, Addl. Commisioner (Hort.), DAC who thanked the Secretary (A&C) for his guidance and setting the tone of the conference. He thanked Special (A&C) for his encouragement, Horticulture Commissioner for his leadership and to Shri J.P. Negi, MD, NHB for all the support in the conduct of this conference. He also thanked all concerned, directly or indirectly for the conduct of this conference.

Dr. H.P. Singh thanked Secretary (A&C), Special Secretary (A&C) and Shri J.P. Negi, MD, NHB and said that to have a sustainable 'Golden Revolution', we all should work together in partnership mode through synergies and convergence of effors. He also infromed about the private initiatives

taken for dissemination of the technology through expositions and exhibitions and said that this is the sign of development of horticulture which is taking place. He expressed his hope that horticulture will live to the expectation as we look upon.

The summary decision points emerging from the deliberations are as follows:

- Horticulture sector would play a leading role in he coming years and should strive to achieve a growth rate of 6-7% p.a. enabling to achieve an overall growth rate of 4% in the agriculture sector.
- Attempt should be made for achieving convergence of programmes being implemented by different departments for the development of horticulture.
- An end-to-end approach, starting from planting material to marketing should be adopted for the development of horticulture.
- Commodity Associations and Self-Help Groups should have a larger role to play in the promotion of horticulture.
- Policy issues which are posing as a hindrance to horticulture development need to be addressed for introducing reforms.
- APEDA is promoting the concept of Agri Export Zones, which need to be supported by the State Governments for promoting export of horticulture produce.
- There is need to have a specific strategy for the export of banana.
- Marketing has been a weak link in the horticulture sector. Alternative marketing system and marketing advocated in Kerala need to be promoted for ensuring remunerative price to the farmer and quality produce to the consumer.
- Bio-dynamic farming is a form of farming based on traditional knowledge. There is scope to promote the concept. Pilot scale testing would be onducted by CISH, Lucknow with NHB assistance.
- There is need to introduce product diversification and popularization of coconut and coconut products for ensuring sustainability.
- The state Governments need to avail of the HRD scheme of Horticulture Division to get their Department Statff trained on Horticulture.
- The State Governments should earmark sufficient funds for the horticulture sector in the Work Plan under Macro Management scheme for the Tenth Plan as well as for 2002-03.

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Dr. H.P. Singh

Born on 2nd July, 1950, Dr. H.P. Singh, obtained his Doctorate in Horticulture from the University of Agriculture Sciences, Bangalore. In his career spanning 29 years, Dr. Singh has served in various capacities i.e. Scientist, Project Coordinator, Director, Chairman and now Horticulture Commissioner. Dr. Singh has contributed significantly to Horticulture Research and Development, and has set an example as Research Manager, which has brought him National and International recognition. He is recipient of several awards for his contribution to Horticulture Research and Development which includes International awards-Kalpavriksha Award - 2001 of Asian and Pacific Coconut Community (APCC), Jakarta, Indonesia and Pisang Raja-1996, ASPNET (INIBAP), Philippines and many National awards, such as All India Kitchen Garden Association Medal-2002; Recognition award of Chotanagpur Hoticulture Society-2002; Dr. M.H. Marigowda National Award-2001; Ranade Memorial Senior Scientist Award-1998; G.L. Chadha Memorial Gold Medal-1996; Kadali Puraskar-1996; Sheveroy Foundation Award-1995 etc. The National Academy of Agriculture Sciences (NAAS) has also recognized the services of Dr. Singh to Horticulture Research and Development by conferring him a "Fellow of NAAS". He is credited with the establishment of Central Horticultural Experiment Station, Ranchi and was instrumental in the establishment of National Research Centre of Banana, Trichy. He has developed a number of varieties of fruits and the technologies which are widely accepted and adopted. Dr. Singh is associated with various professional societies in various capacities and he is also closely associated with International Organisations as Chairman of various Committees for the development of horticulture. Dr. Singh has widely travelled in India and abroad. He is credited to have published more than 250 research papes and book chapters. He has edited 17 bulletins and 17 books. As Horticulture Commissioner, he is engaged in providing direction for horticulture development in India.

Shri J.P. Negi

Shri J.P. Negi, IAS (1975, H.P.) has a distinguished career of about 25 years in various capacities in the State of Himachal Pradesh. He has held several important assignments like Dy. Commissioner Shimla; Director of Industries; M.D., HPMC and Commissioner of Health & Ayurveda, which enabled him to have deep insight into the various horticulture related issues. He has been closely associted with apple development in Himachal Pradesh. He took over as Executive Director of National Horticulture Board (NHB) in October 1997 and since then he has been an inspiring force for the growth of the organization. Through his initiatives and efforts many of the schemes and programmes of the NHB were restructured including the launching of the scheme for construction of cold storages. The horticultural database released periodically by the Board under his guidance has been well-received throughout the country, which is also made available on CD Rom. He had edited several periodicals and books on horticulture and environment. He was awarded the President of India Silver Medal for outstanding work in census operations.

Dr. Jose C. Samuel

Dr. Jose C. Samuel, born on 22nd April, 1948, obtained his Doctoral Degree from the University of Roorkee. In a career spanning 29 years, he has contributed significantly in the field of soil & water conservation, watershed management and horticulture. Presently working as Deputy Commissioner in the Ministry of Agriculture, he has been involved in monitoring and development programme on horticulture i.e. fruits, micro-irrigation, apiculture, medicinal and aromatic plants. He has played a key role in the development of programme on human resource development. He has published 54 articles and has edited two books.

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