Value Chain Study

MANGO

(Cluster Saharanpur, UP)

under

Mission for Integrated Development of Horticulture (MIDH)

2017-18

Prepared jointly by

NATIONAL COMMITTEE ON PLASTICULTURE APPLICATIONS IN HORTICULTURE (NCPAH)

PRECISION FARMING DEVELOPMENT CENTRE (PFDC), ICAR-CISH, LUCKNOW

राज्य औद्यानिक मिशन, उत्तर प्रदेश

निदेशालय उद्यान एवं खाद्य प्रसंस्करण विभाग, उ0प्र0

उद्यान भवन, 2–सप्रू मार्ग, लखनऊ

Tel. 0522-4044414, 2623277 Fax : 0522-2621382 email : dirhortiuttarpradesh@gmail.com

From,

Director /Mission Director (NHM),
Horticulture and Food Processing,
Uttar Pradesh,
Lucknow.

To,

Shri K K Kaushal,
Joint Project Director, NCPAH
New Delhi.
E-Mail- krishna.kaushal@ncpahindia.com

Letter No. 8815-18 / Value Chain Study /Mango/ 2017-18 / Dated : 28 Feb, 2018

Subject:- Consent of SHM on draft report (Value Chain Study).

Sir,

I would like to draw your attention on draft report based on value chain study for Mango Cluster at Saharanpur which is submitted to you by principal scientist & project investigator PFDC.

After evaluation of draft, it is observed that report consists all the parameters like training for quality production, management of diseases and pets, marketing of fruits, post harvest managements, storage facilities including cold Storage, ripening chamber, pack house along with establishment of quality control lab as per international codex.

So in my opinion the said draft report on Mango (Saharanpur Cluster) may kindly be accepted for further consideration.

Yours faithfully

28/2/18

(S.P. Joshi)
Mission Director

Copy for information to:-

1. Under Secretary, (M.I.D.H) Government of India, Krishi Bhawan, New Delhi.
2. Shri Naresh Modi, Project Director, NCPAH New Delhi.
3. Dr. V. K. Singh, Principal Scientist at Project Investigator PFDC, Lucknow.

(S.P. Joshi)
Mission Director

Value Chain Study Saharanpur -Mango Status, Bottlenecks & Strategies Detailed Project Report (DPR)

Executive Summary

The economic importance of fruit crops has been increasing over the years, due to the increasing demand. Increasing demand arise from the increase in income, population growth changing consumption pattern and growing awareness for better nutrition. India ranks first in the mango production and area under cultivation. Productivity of mango continues to be low, quality of produce needs improvements, resources use efficiency requires up gradation, post-harvest losses continue to be high and there is growing regional disparity in production and use of technologies. Although several advanced technologies have been developed in mango, the extent of their adoption is very low. Technologies such as canopy architecture, canopy modification in old and senile mango orchards, judicious water and nutrient management to increase the productivity and scientific methods for harvesting and post-harvest management like pre-cooling, sorting, grading, packaging and marketing have not yet been adopted by a large majority of mango growers. The project proposal, therefore, should aims at developing appropriate environment friendly production systems for quality production of mango using scientifically developed protocols for judging proper maturity of fruits, harvesting methods, post-harvest management practices. Efforts will also be made to ensure time up of producers with processors and entrepreneurship development for promotion of processing which is quite meager, in respect of mango.

The following researchable gaps have been identified:

- Accredited nurseries are not sufficient available: weakest link
- Mango orchards are mostly old and unscientifically managed in terms of irrigation, trees nutrition, canopy, bearing, disease and pest management which results in low and poor quality fruit production.
- Use of traditional methods for judging maturity, harvesting, packaging, transport and marketing cause major post-harvest losses leading to low income to the producer.
- In adequate infrastructure for proper post-harvest handling and management of produce at producer's site.

- Cold chain logistics unavailable.
- Underdeveloped market information feedback loops which is leaving farmers with very little understanding or incentive for improving their productivity or quality.
- Limited portion of the mango produce is processed, as there are very few mango processors and commercially viable value added products.
- There is a good demand in major domestic and export markets for quality fruits of mango cultivars, viz. Dashehari, Langra and Chausa.
- Poorly resourced horticulture research stations, Saharanpur and dearth of extension support in mango production.

Based on the identified gaps, the research proposal aims at focusing on the following objectives:

- Enhancing productivity and quality of mango through good agricultural practices.
- Reducing post-harvest losses, enhancing shelf life through scientific pre and post-harvest management practices.
- Strengthening of processing of mango entrepreneurship development and tying up with processors.
- Facilitating the producers in getting domestic and international market access for their produce by creating market linkages/ chain/production cluster have been identified.

The study was conducted with the help of Officers, State Horticulture Department and KVK, Saharanpur, which is the lead producer of mango with a production of 259460 MT and productivity of 10.00 t/ha covering an area of 25946 hectares. There were 5 main clusters viz., Behat, Nakur, SaroliKadim, Sarshawa Nagar and Rampur. Mango remains a main stay among the fruit production system in the area. However, export of mango is very limited due to slow value ethnic market. Value chains encompass the full range of activities and services required to bring a product from its conception to sale in its final markets whether local, national, regional or global. Value chain includes input suppliers, producers, processors, and buyers. They are supported by a range of technical, business and financial service providers. The study was based on following actors and process involved in mango value chain for increasing the income of producer.

Introduction

The country needs about 100 million tons of fruits annually to meet the total fruit demand as against the present production of 46 million tons. This warrants increase in production, productivity and efficient post-harvest management. Despite huge production, post-harvest losses are very high due to shorter shelf life, inefficient marketing systems and limited processing facilities. Export of mango is limited because of shorter shelf life, absence of cold chain facilities, pest problems. Recently, USA, China and Japan opened their market for Indian fruits, so the scope for exporting commercial varieties of mango from the country has increased manifold. The fruit yield can be raised up to 6 times of the national average by adopting improved production technologies. A majority of the agriculture markets are regulated, however, most of the reforms are yet to be implemented. The market intelligence in respect of produce, its variety and respective prices are highly inefficient as the updation of information, even where computer based system has been implemented, has time lag, which could make the system redundant in the decision making process.

At present major pest and diseases are being controlled through pesticides which are mostly toxic, pollinators and create environmental pollution. Fruit fly and stone weevil are main constraints in export of mango. Moreover, in most of the importing countries insecticide treated fruits are not preferred due to the pesticide residue. The IPM technology has become necessity to control the pests and limit residues. Improper handling, storage, transport and marketing have resulted in enormous post-harvest losses in mango. The best way to check the losses is to go use of proper post-harvest management protocols and process the fruits various value added products and byproducts. There is a scope for diversified products basket but also to increase the level of processing. The marketing margins in different channels have been quantified and are being told to stakeholder for creating an efficient marketing system. Similarly, losses during post-harvest system are being quantified. Mango are most important fruits, still most of these fruits are transported medium to long distance in wooden boxes, which have been found to be inefficient in protecting these fruits from the vagaries of transportation system. These aspects along with observation of market efficiency need in depth investigation in order to make suitable interventions in consortium mode. The outcome of the proposal would complement existing resources and augment availability of these valuable process/products for promoting export, enhancing income, generating employment and overall development of the fruit industry.

In the proposed project, efforts are being made to increase the profitability of fruit growers not only by increasing production and productivity of mango but also by tying up with processing industry and ensuring better access to domestic and export markets. It will go a long way in improving economic conditions of the mango farmers in the country.

Review of Literature

A brief review of work in relation to the objectives of DPR

Canopy management in mango

Quality production and export of mango suffer from several limiting factors of which declining productivity of old and dense orchards existing in abundance (35-40%) has become a matter of serious concern for the orchardists. In such orchards selective pruning and thinning of crowded branches for proper air circulation, improved photosynthetic efficiency, fruit yield and quality has been reported in many fruit crops by earlier researchers (Lal *et al.*, 2001).

Nutrient and water management

Studies on leaf sampling techniques has shown that a sample of 6-7 months old, 30-40 normal and healthy leaves from middle of the shoot, representing almost all elevations on the crown from all directions reveals the correct nutrient status of the tree. Critical limits of N, P, K, Ca, Mg, S, Fe, Mn, Zn and Cu has been worked out which are 1.23, 0.06, 0.54, 1.71, 0.9, 0.12 per cent and 171.0, 66, 25, 12 mg/g, respectively. Optimum levels of leaf N have been worked out in the range of 1.40 to 1.54 per cent for maximum production. Beneficial effect on growth, flowering, fruiting and fruit quality can be achieved with foliar sprays of Zn (0.8-1.0% ZnSO4 + half quantity lime) in the orchards thriving on sandy soils. Drop of young fruitlets in mango is also attributed to Zn deficiency, besides deficiency of promoters and excess of inhibitors during early and fast rate of fruit growth. Boron deficient soils are commonly found in mango-producing areas of India and its application to deficient mango trees increases fruit set (Ram et al., 1989). Application of organic manure in addition to balanced nutrients is important in the maintenance of soil fertility which play vital role in tree growth and productivity. Soil testing as the sole basis for making fertilizer recommendations has limited applicability with mango due to its large root distribution, perennial habit, rootstock effects and differential fruiting. Soil and leaf analysis should, therefore, be complementary for determining the optimum dose of nutrients. At present, newer

fertilization practice is "Fertigation" using liquid fertilizers in tank. Common mixture are 12:2:8 and 8:2:4 of N, P_2O_5, K_2O, respectively. Several factors which determine the response of irrigation like soil type, season, region, stage of tree growth and varieties, should be taken into account while making irrigation schedules. Juvenile mango plantation, responds well to irrigation (10950 litres/tree/year) whereas bearing trees (5-9 years old) require a minimum of 20280 litres/tree/year. Normally, non-bearing trees up to 4-5 years of age are irrigated at 10 days intervals during summer because of their undeveloped root system. 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 March to June, depending upon the soil type and depth, rainfall and its distribution. For judicious water use, drip irrigation is being used in mango growing. PFDC, CISH (2017) has recommended the irrigation schedule in mango which should be used for quality production.

Management of diseases and pests

At present, major pests and diseases are being controlled through pesticides which are mostly toxic to human beings, pollinators and create environmental pollution. Fruit fly and stone weevil are main constraints in export of mango. Moreover, in most of the importing countries insecticide treated mangoes are not preferred due to the pesticide residue. The IPM technology has become necessity to control the pests and limit residues. An IPM module has been developed by CISH to safe and effective management of disease and pests in mango. As regards, pesticide residue analysis a rapid and efficiency extraction-cleanup method for gas liquid chromatographic (GLC) determination of residues of four synthetic pyrethroid insecticides (permethrin, cypermethrin, deltamethrin and fenvalerate) in fruits like mango and grape was developed by Awasthi (1985). In case of fungicides, carbendazim residues persisted throughout the ripening period of the fruits and dissipated with a half-life of 19 days in the whole fruit (Awasthi and Sharma, 1997). Therefore residual analysis is needed as farmers are applied insecticides and fungicides at their wish.

Post-harvest handling, value addition and quality standards

In recent years, India has made considerable progress in the production of fruits. However, due to improper post-harvest management and lack of processing facilities, approximately 30% of nutritious commodity is lost. The core requirement to reduce post-harvest losses is to enhance shelf-life of fresh fruits by delay in ripening. In order

to augment the supply of this nutrition supplement, a major proportion of the losses could be saved through efficient post-harvest management including value addition (Joshi, 2000). Krishnamurthy and SudhakarRao (2001) gave pre and post-harvest handling, maturity of fruits, pre-cooling, grading standards, different types of packaging, transport, ripening and marketing of fruits in India and export markets. There is an urgent need to make the exporters aware of the international requirements in relation to the exports of different fruits (Verma, 2005). The CODEX essentially incorporates basic quality concerns of the foreign markets.

Marketing of fruits

Marketing problems are more common in fruit due to their high degree of perishability; season bound availability and bulky nature. A few traders with huge marketing margins create havoc in fruit trade. There is need for streamlining the marketing operations to provide an incentive for boosting the production and assuring proper income to the growers. Following constraints are common in Indian marketing system:

- About 75% of the farmers sell their produce at the farm level to the village merchants, retailers, big producers or to the pre-harvest contractors. They can't afford to transport their produce to distant markets (mandies) on account of the non-availability of transport facilities, expensive transport, malpractices in the market such as heavy deductions, free sample of the produce, etc.
- High and unjustified market charges levied on the producer-seller, delayed payment and lack of open bid system.
- Small growers are unorganized. They lack group action and bargaining power. As a result, the traders exploit these farmers.
- Information regarding the demand, supply, price, market outlook, knowledge of the consumer's preference, marketing channels and practices are important for the marketing of the produce, which are not available at the moment.
- The exploitation of the farmer by commission agents and traders is very much prevalent in wholesale markets.

Various stakeholders require market information for decision making at farm level in respect of what to produce, harvest time and quantum, where to market, which variety to market in respective market; by researchers and policy makers for analyzing market efficiency, regulatory/administrative prices and mechanism decision. The study on margins of the producer indicated that it declined with increase number of

intermediaries. The producer received lower share in the consumer rupee when the orchards were sold to pre-havest contractor vis-a-vis shelf harvest and trading. The trading through pre-harvest contractor also led to deterioration in the production capacity of the orchard as the intermediary did not take adequate care of the orchard. Over ripening, pressing and rotting of the fruits was the major factor causing losses in the post-harvest system at different levels, i.e., farmer, trader and retailer levels. Only 85 per cent of the harvested fruits could reach the consumer in the prime natural condition and the rest were damaged in various intensities. About 2 per cent of the fruits had to be discarded due to one or the other reason. An efficient market information system was also suggested (Verma et al., 2005). The market information system was virtually non-existent.

Linkage between the exporters and producers was non-existent at Saharanpur. Farmers felt that the exporter will not give right price for their produce. Therefore, farmers sell their fruits directly to KisanMandi, Azadpur Fruit Mandi, Delhi, etc. Some farmers sold their produce through middle men while some to local buyers. The produce is marketed through trucks with loading capacity of about ten tons. In order to minimize the transportation cost, transporters also practice overloading. Majority of the farmers acquired market information through various sources of mass communication, middle men and local markets. Thus, there is an urgent need to link the farmers with exporter through meeting/awareness programme. There is need to establish co-operative collecting site of the produce for easy marketing.

Objectives of study

- Enhancing productivity and quality of mango through good agricultural practices.
- Reducing post-harvest losses, enhancing shelf life through scientific pre and post-harvest management practices.
- Strengthening of processing of mango through entrepreneurship development and tying up with processors.
- Facilitating the producers in getting domestic and international market access for their produce by creating market linkages.

Global Scenario of Mango Production Including India

The mango (*Mangifera indica* L.) is the most important fruit of India. It is grown over an area of 1.23 million hectares in the country producing 10.99 million tonnes. It accounts for 22.1% of total area (5.57 million hectares) and 22.9% of total production of fruit (47.94 million tonnes) in the country.

It is very well adopted to tropical and subtropical climate and thrives well to almost all regions of the country from sea level and altitude of 1500 meter, i.e., from Cape comerin to Himalayas. However, it can grow commercially in an altitude about 600 MSL (Saini and Singh, 1998). Temperature, rainfall, wind velocity and altitude are the main climatic factors, which influence its growth and fruiting behaviour. Most of the mango varieties thrive in places with good rainfall (75 to 375 cm per annum) and dry season. The distribution of rainfall is more important than its amount. Rain during fruit development is good but heavy rains cause damage to proper maturity process of fruits. It grows well on wide variety of soils, but the loamy, alluvial, well drained, aerated and deep soil rich in organic matter with a pH range of 5.5 to 7.5 are most favourable for mango cultivation (Gangolly *et al.*, 1957). India rank first among world's mango producing countries accounting for 52 – 63% of the total mango production of 19 million tonnes (Negi, 2000). In India, the Uttar Pradesh has the largest areas of 0.27 million hectares under mango cultivation. But Andhra Pradesh has the highest productivity of 12 tonnes per hectare (NHB Data Base, 2003 – 2004). Recently it is reported that Uttar Pradesh has highest productivity (10.5 Mt. / ha) in comparison to Andhra Pradesh (8 Mt. / ha.) (NHB Data Base, 2005). While Andhra Pradesh produces 3.07 metric tonnes of mango, Uttar Pradesh, Bihar and Karnataka, produce 2.3, 1.79 and 0.92 metric tonnes respectively.

All the cultivated Indian mangoes belong to the single spp. *Mangifera indica* L., which is the most important member of the family Anacardiaceae. The other species of mango are *M. sylvatica, M. caloneura, M. pentandra, M. caesia, M. foetida* and *M. ordorata* also contribute to the edible fruits, though of relatively inferior fruit quality. Particular cultivars of mango grow well commercially in a specific region of the countries as per their adoptions in a particular climate. The main commercial cultivar in northern India particularly in Uttar Pradesh is mostly confined to Dashehari, Langra, Chausa, Lucknow Safeda and Bombay Green. However, Dashehari, Chausa and Langra by for the most delicious and leading commercials cultivars best suited to the cold and dry

climate of U.P. These cultivars form a prominent component of the export trade and place a vital role in the economy of the state. However, the quality production of these cultivars remained below the potential level. The most important commercial cultivar 'Alphonso' for export is located in Maharashtra (Ratnagiri) and Gujarat (Bulsar). Important pocket of Himsagar another top great cultivar is in West Bengal, whereas Banganpalli, Neelum, Bangalora and Suvarnarekha around in Andhra Pradesh and Tamilnadu (Bose *et al.*, 2001).

There are many bottlenecks, which limit the mango production in different fruit producing countries. Among the several constraints, the alternate and erratic (shy) bearing in most of the commercial cultivars like Dashehari, Alphonso, Banganpalli, the occurrence of malformation, high fruit drop and its low retention, clustering (jhumka) of fruit are the main limiting factors for low production and productivity of mango in India (Singh and Misra, 2002). The quality of fruits at harvest has a decisive influence on its postharvest quality. The initial quality at harvest cannot be improved to any greater extent but can be maintained after harvest by proper postharvest management. Pre-harvest factors that have been found to predispose mango to physiological disorders include growing conditions and location, orchard condition at harvest, while postharvest storage conditions such as temperature, oxygen, CO_2 level, packaging etc. are contributing factors to the occurrence of disorder. There are numerous preharvest factors, which decide the quality of produce at harvest. Quality of produce particularly fruit of mango, however, suffers from a wide range of physiological disorders which reduces its quality production and become a limiting factors for export (Singh, 2005). Physiological disorders occurs in most of mango growing areas of the world and are of increasing importance because of the expansion of worldwide mango production and the need to assess fruit quality for international trade.

China ranks first in the fruit production in the world accounting for 4,44,651 MT production followed by India and Brazil and its share in the fruit production is 13 per cent while India contributes 10%, Brazil contributes 8 per cent and USA contributes 6 per cent of total fruit production. India leads the world in production of mango, banana, sapota and has the highest productivity of grape. It is estimated that fruit production will touch 98.00 million tonnes by the year 2021 (Anonymous, 2004).

Amongst the several fruit crops, India is the largest producer of mangoes and in the intervening years, it has become well established as fresh fruit to processed product in the world market but contributes almost insignificantly (0.11% of total domestic production) towards export (Chadha, 2000). However, other countries like Mexico, Philippines and Venezuela, which produce for less, export 4% of their total production. Therefore, to achieve the target of required quality fruit production, the aim of fruit research strategies would be to generate superior technology. The productivity and quality of majority of fruit crops continued to remain below the potential level except for grapes, banana and papaya. Further WTO regime has necessitated the increased production of quality fruit for export as well as to complete the internal market with the imported fruit.

Amongst the fruit crops, mango (*Mangifera indica*L.) is the most important fruit of India. It is grown over an area of 1.23 million hectares in the country producing 10.99 million tonnes. It accounts for 22.1 per cent of total area (5.57 million ha) and 22.9 per cent of total production of fruits (47.94 million tonnes) in the country. The leading mango growing states in India are Uttar Pradesh, Andhra Pradesh, Bihar, Orissa, West Bengal, Maharashtra, Gujrat and Tamil Nadu. Though Uttar Pradesh has the largest area of 0.27 million hectares under mango, Andhra Pradesh has the highest productivity of 12 tonnes per hectare. While Andhra Padesh produces 3.07 million tonnes of mango, U.P., Bihar and Karnataka produce 2.39, 1.79 and 0.92 million tonnes, respectively.

Mango is very well adapted to tropical and subtropical climates. It thrives well in almost all the regions of the country from sea level to an altitude of 1500 m from sea level, i.e., from Cape Comerin to Himalayas. However, it cannot be grown commercially in altitude above 600 m from sea level (Saini and Singh, 1998). Most of the mango varieties thrive in places with good rainfall (75 to 375 cm per annum) and dry season. The distribution of rainfall is more important than its amount. Rain during fruit development is good but heavy rains cause damage to ripening fruits. It grows well on wide variety of soils, such as lateritic, alluvial, sandy loam and sandy. Although it grows very well in high to medium fertility soils, its cultivation can be made successful even in low fertility soils by appropriate management especially during early stages of growth (Gangolly *et al.*, 1957). Very poor and stony soils Hill slopes should, however be avoided. The loamy, alluvial, well drained, aerated and deep soils rich in organic matter with pH range of 5.5 to 7.5 are most favorable for mango cultivation. The mango genus

Mangifera belongs to the family anacardiaceae and is endogenous in north – east India and North Burma, in the foot Hills of the Himalayas and is said to have originated in the Indo-Burma (Mukherjee, 1985).

There are several species of *Mangifera* but almost all the edible cultivars of mango belong to the single species *mangifera indica*, which originated in the Indian subcontinent. The other species *M. sylvatica, M. zeylanica, M. gracilipes, M. khasiana, M. lanceolata, M. griffithii, M. microphylla, M. sclerophlla, M. maingaui, M. longipetiolate, M. foertida, M. caesia, M. superba* have been reported from different part of the country. The few other species, which contribute edible fruits though of relatively inferior fruit quality, are *M. Cassia, M. Foetida, M. Ordorata* which are confined to the Malaysian region. Different cultivars of mango grow well commercially in a specific region of the countries, the main commercial cultivars grown in different region are summarised below as per climatic conditions.

Commercial Cultivars of Indian mango at a glance

Region	**Cultivar**
Northern	Dashehari, Langra, Chausa, Bombay Green and Lucknow Safeda.
Eastern	Himsagar, Langra, Fazli, Lakshmanbhog, Krishnabhog and Gulabkhas.
Western	Alphonso, Pairi, Kesar, Rajapuri, Mankurad and Jamadar
Southern	Bangalora, Neelum, Svarnarekha, Pairi (Peter), Banganpalli, Mulgoa and Alphonso.

In India more than 1000 varieties existing today and share about 56% of total mango production in the world. Its production has been increasing since independence, contributing 39.5% of the total fruit production of India.

Commercial mango varieties grown in different states

States	**:**	**Commercial Varieties**
Andhra Pradesh	:	Banganpalli, Suvarnrekha, Neelum and Totapuri
Bihar	:	Bombay Green, Chausa, Dashehari, Fazali
Uttar Pradesh	:	Dashehari, Langra, Chausa, Bombay Green
Gujarat	:	Kesar, Alphonso, Rajapuri, Jamadar, Totapuri

Karnataka	:	Alphonso, Totapuri, Banganapalli, Pairi, Neelum and Mulgoa
Madhya Pradesh	:	Bombay Green, Dashehari, Fazli, Langra and Sundarja
Maharashtra	:	Alphonso, Rajapuri, Kesar and Pairi
Punjab	:	Chausa, Dashehari and Malda
Tamil Nadu	:	Alphonso, Totapuri, Bengenpalli and Neelum
West Bengal	:	Fazli, Gulabkhas, Himsagar, Kishenbhog, Langra and Bombay Green

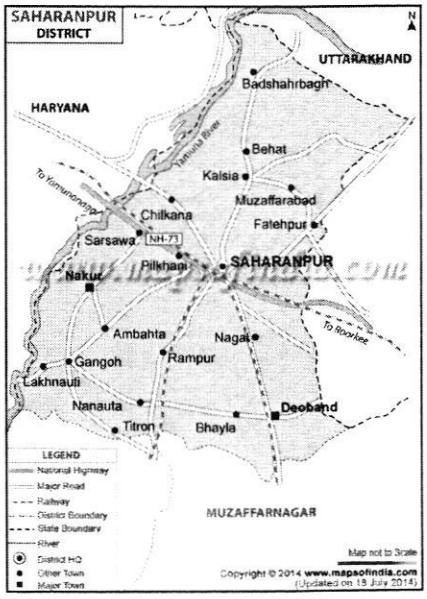
There are few major bottlenecks, which limit the mango production in different fruit producing countries. Among the several constraints, the alternate and erratic bearing in most of the commercial cultivars like Dashehari, Alphonso, Banganpalli. Incidence of malformation, low retention of fruit, heavy fruit drops clustering (Jhumka) of fruits are the main limiting factors for low production / productivity of mango in India. The fruit of mangoes have been an esteemed item of the diet along with a tree a subject of great variation. Its fruits are put to multifarious uses right from the early to ripening stage. Chemo preventive (anti-cancer) compound, *Lupeol* was recently isolated in mango fruit and it is established that this compound is effective in preventing several kind of cancer (Anon., 2007). No other fruit can be put to so many diversified uses as mango. Proximate composition of nutrients in mango pulp, kernel and leaves of mango are summarized below:

Inspite of having various importance's the fruits of mango suffer from a wide range of physiological disorders, which reduces the quality of fruits. In another fruit crops various physiological disorders like bitter pit and internal flesh breakdown in Apple (Atkinson *et al.*, 1980), blossom end rot in tomato and pepper (Winsor and Adams, 1987) and also in watermelon (Singh *et al.*, 1975; Cirulli and Ciccarese, 1981), mesocarp discolouration and pulp spot in avocado (Lelyveld *et al.*, 1984; Bower and Cutting, 1987), yellow pulp in banana (Melin and Aubert, 1973) have been reported. In mango, although disorders have been reported over many years, investigations into its fruit defects have been less wide spread, mainly because research resources have been more limited and until recently, production of mango has been less intensive in developing countries where the bulk of crop is grown.

High quality tropical fruits, when exported to distant markets, are limited by their postharvest characteristics. Any success in improving post-harvest quality by extending shelf life or preventing postharvest decay is advantageous in enlarging markets and broadening consumer appeal. Many approaches are being utilized to extend post-harvest life and maintain quality, however, amongst them selecting for slower ripening lines, modification of ethylene responses or reducing softening rate in fruits are best approach to extend the shelf life and maintain quality. The alteration of the time of ripening, whether by hastening or delaying ripening might be expected to affect the incidence of physiological disorders. Paper bagging of fruit before one month of harvesting was found effective to control the softening to some extent. White plastic bagging with appropriate perforation was found effective to minimise the incidence of softening particularly in Dashehari mango (Singh *et al.*, 2005). Joyce (1997) reported that the plastic bags hastened the fruit water loss, softening and colouring of fruit, whereas paper bags had not apparent influence compared with unbagged control fruit on weight loss or ripening characteristics.

Mulching culture reduced the incidence of spongy tissue within ripe fruits compared with the clean cultivated control (Burondkar *et al.*, 1994). The efficacy of plastic black (100 μ thick) and banana leaf mulch on the incidence of softening of tissue in Dashehari mango was studies and related associated physiological and biochemical parameter were also worked out. Among the mulches, the plastic mulch was found to be more effective to produce the superior quality of fruit with minimum incidence of softening of tissue around stone in mango (Singh *et al.*, 2005). In several report it was indicated that the Ca and K has little effect on fruit quality but they have positive impact on lowering the internal breakdown. However, with increasing leaf N concentration, ripe back ground yellow skin colour decreased and jelly seed incidence increased. Thus growers who wish to improve the quality of fruits should concentrate more on reducing high N concentration than attempting to elevate Ca and K concentrations through soil and foliar application (Mekenzie, 1995).

Saharanpur Cluster of Mango Production



Per capita availability of mango is quite low in India owing to low productivity and post-harvest losses which account for about 20–25 per cent (Anon., 2013) of production. Therefore, it is imperative to educate the producers about the technological advances available and also help them by in acquiring the same. There is also need to maintain supply chain management in the mango production belt which will help in preventing the exploitation of farmer and enable enhanced income. On this basis of value chain study on both backward and forward linkages of the production cluster of major mango belt at Sharanpur of Western Uttar Pradesh primary institutional and infrastructural gap in the value chain/production cluster have been identified. The study was conducted with the help of Officers, State Horticulture Department and KVK, Saharanpur.

Saharanpur is the lead producer of mango with a production of 259460 MT and productivity of 10.00 t/ha covering an area of 25946 hectares. There were 5 main clusters viz., Behat, Nakur, SaroliKadim, Sarshawa Nagar and Rampur. Mango remains a main stay among the fruit production system in the area. However, export of mango is very limited due to slow value ethnic market. Value chains encompass the full range of activities and services required to bring a product from its conception to sale in its final markets whether local, national, regional or global. Value chain includes input suppliers, producers, processors, and buyers. They are supported by a range of technical, business and financial service providers. The study was based on following actors and process involved in mango value chain for increasing the income of producer.

Supply of Mango plants, Varieties & Nurseries

Many nurseries are operating in Saharanpur but only two are accredited with 2-3 stars by NHB, Govt. of India. This seems to be the weakest link in the value chain since certified planting material from registered nurseries is scantly available to mango growers. As per our observation no commercial nurseries are offering improved varieties/hybrid of mango. There is no tracking/traceability system of plant sold from

the respective nurseries. Old propagation techniques i.e. veneer grafting and anarching are mostly being used by the nursery men. The improved propagation technique, i.e., wedge grafting prevalent among nursery men throughout the country is not practiced. Polybags for raising the grafted plants are not popular at this place. Traditional methods are mostly preferred for raising the grafted plants. The main cultivars of this area are Chausa, Dashehari and Langra. However some orchards of Mallika and Amrapali cultivars do exist. All these cultivars are sufficiently available in the local nursery. Price of grafted plants varied from Rs 30.00 – Rs 35.00 depending upon cultivars.

Common nursery practices (Veneer grafting)

Bottlenecks of Nurseries;

1. Lack of improved varieties/ hybrid of mango with commercial nurseries.
2. The number of accredited nursery in Saharanpur cluster are only two; resulting lesser availability of certified planting material.

Strategies:

- Improved propagation technique i.e, Wedge grafting should be adopted for round the year production of Mango plants.
- Polybags for raising the grafted plants should be popularized.
- Number of accredited nurseries to be enhanced along with improved variety.
- Traceability system of plants sold from the respective nurseries should be documented.

<u>Plantation and cultural Practices</u>

Cultural practices (Field preparation)

Farmers adopted good planting techniques for new plantation. Time of planting, planting distance, size of pits, filling of pits, training and pruning were adopted as per standard package of practices. They kept planting distance at 10 x 10 m or more for the

commercial mango varieties. Training and pruning was done in the initial stage of growth for the development of good canopy.

Bottlenecks of cultural practices

1. Farmers are not adopting high density planting of Mango particularly the regular bearing variety such as Amrapali & Mallika which can enhance the productivity and fetch more income.
2. Farmers are not preparing the pits and filling material for the new plantation according to recommendation.

Strategies:

- Awareness programme should be organized for adoption of New Technologies
- Multiplication of the improve variety in certified nursery should be propagated/added.
- Traceability system of plants sold from the respective nurseries should be documented.

Water

Conventional surface irrigation method is pre-dominantly followed in orchards without any critical water application in mango. Irrigation given 3-4 times after fruit set. The adoption of drip irrigation system varied from 0 to 25 per cent in mango but mostly in young orchards. Farmers have consented for drip irrigation with state Horticulture Department and got it installed as per guidelines provided by registered firm. Generally farmers lack technical knowhowan use of fertilizer and irrigation schedule through drip method in crop.

Drip installed in young orchard

Bottle necks

Conventional surface irrigation method is pre-dominantly followed in orchards without any critical water application in mango.

Strategies:

- Modern irrigation System such as Drip irrigation system should be adopted.
- Awareness programme should be organized for adoption of New Technologies by the State department.

- Farmers should take the help of Directorate of Horticulture for adoption of drip irrigation system.

Fertilizers

Growers purchased fertilizers from the society and most of fertilizers used were of insoluble form. More than 90 per cent of the farmers followed fertilizers schedule of their own. They are applying the major fertilizers (DAP, urea, N, P, K) in basin. Fertilizers through drip in mango are lacking. Only in some new orchards drips were installed. Most of the farmers have not applied micro nutrients. Few farmers applied recommended major/micro nutrients which improved quality of fruits. Interestingly, being the progressive mango growers, no one had applied fertilizer based on the soil and leaf nutrient content test report although they got soil tested of orchards for nutrient level regularly. Symptoms for deficiency of micro-nutrient like cracking and internal necrosis were observed in some of the orchards but most of them did not take any corrective measures. More than 90 per cent of the farmers followed fertilizers schedule of their own. Time of application of fertilizer was not correct as observed in some of the orchards. Lack of awareness and technical knowledge were the major issues for quality production.

Bottle necks

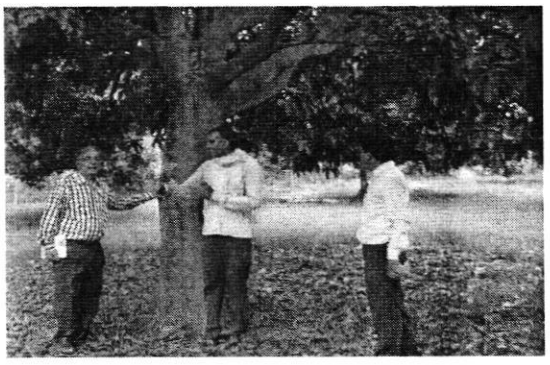
Lack of awareness and technical knowhow for use of Recommended Doses of Fertilizer (RDF) and their uses at right time and right amount. Farmers are not taking any corrective measures of symptoms appearing due to deficiency of Micro nutrient.

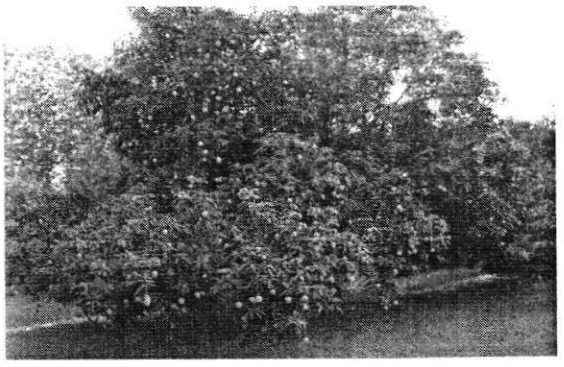
Strategies:

- Awareness programme should be organized for judicious use of RDF at right time based on the soil and leaf nutrient content.
- Fertigation should be promoted for judicious use of fertilizer through Drip irrigation system.

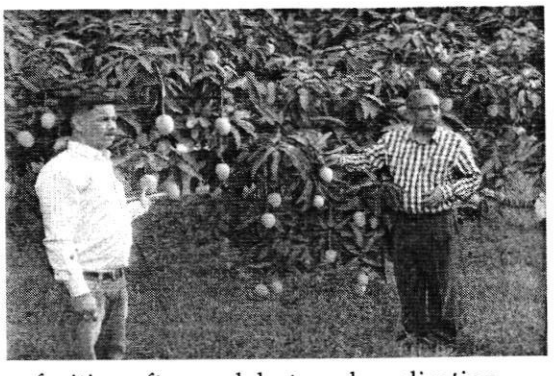
Plant growth regulators and other practices for enhancing quality production

All the important commercial cultivars of mango in Uttar Pradesh viz., Dashehari, Chausa and Langra are cultivated commercially at Saharanpur. They were alternate bearing in habit. Baseline survey indicated that 60-65 per cent mango farmers were using our technology for the control of biennial bearing in these mangoes cultivars which involve soil application of paclobutrazol (PP333) during the month of September for the control of alternate bearing. However, none of the farmers have tested its residual level in soil and fruit. Residue of paclobutrazol does not persist in ripe fruit as per our analysis. Paclobutrazol was procured from genuine source. Most of the orchards are old and tending towards senility. However, for getting quality production farmers adopted our technologies such as centre opening, light pruning in middle aged tree (15 – 25 years) and rejuvenation (> 30 year old) in old and senile orchard. They are using motorized power chain saw for this purpose. Copper oxychloride and other recommended cultural practices were used after pruning and rejuvenation.





a) Soil Center opening in Langramango (b) Fruiting after center opening



a) Soil application of paclobutrazol (b) Profuse fruiting after paclobutrazol application

Pesticides

Most of the farmers purchased branded pesticides and they had knowledge about the efficacy of pesticides. Some of the farmers sprayed them as per recommendation but other farmers uses indiscriminate spraying (10-12 spray) of pesticides. Though most of the farmers were aware of pest and disease problems in mango but they were not confidant in identifying the exact cause of the damage. Spraying was taken up without proper knowledge of the chemicals and most of them are dependent on local dealers for advice. Environment friendly pest control method was not practiced by the farmers. Hardly any farmer has done pesticide residual analysis for fruits. Shoot gall psylla, leaf webber, thrips, powdery mildew, anthracnose and shoulder browning are the main insect and disease problem in this area especially in those orchards where fruits were harvested late, i.e., after rains. Environmental friendly pest control method was not practiced by the farmers. Hardly any farmer has done pesticide residual analysis for fruits. Shoot gall psylla, leaf webber, thrips, powdery mildew, anthracnose and shoulder browning are the main insect and disease problem in this area especially in those orchards where fruits were harvested late, i.e., after rains. Farmers are not aware about the proper control of Shoot gall psylla, leaf webber, thrips, powdery mildew, anthracnose and shoulder browning.

Bottle necks

1. Lack of awareness on the integrated pest management and and the bad effect of pesticide.
2. Schedule for pesticide spray and dose of pesticide are not exactly known to the farmers except to few farmers adopting the recommended schedule

Strategies:

- Environmental friendly pest control should be practiced by the farmers
- Pesticide residual analysis for fruits should be adopted.
- Farmers should be aware about the proper control of Shoot gall psylla, leaf webber, trips, powdery mildew, anthracnose and shoulder browning etc.

INM/IPM practices

Among the farmers located at different mango cluster, 50 per cent farmers tested their soil regularly for nutrient status but no one took up any corrective measures. No one had tested leaf nutrient content. Most of the farmers followed fertilizer schedule of their own. Time of application in some of orchard was found wrong as they were applying fertilizers during the month of January. Appropriate suggestions were given for its

application in future. More than 50 per cent farmers had not applied any micro nutrients. Deficiency of micro nutrients like cracking of fruits, internal necrosis and jelly seed incidence were observed particularly in tree ripe Langra and Dashehari mango. Application of B and Zn at critical phenological stages was suggested to the growers. Lack of awareness on the integrated nutrient management, integrated pest management and water management was the major handicap. Farmers used farmyard manure as organic source of fertilizer. They have good cattle population and prepared FYM traditionally on their own orchard. Vermicompost and other organic sources were not practiced. Orchardists used DAP and MOP as inorganic source of fertilizers. Use of straight fertilizers as a source for N, P and K was not followed by the farmers.

Bottle necks

1. Lack of awareness on the integrated nutrient management, integrated pest management and water management was the major constraints.
2. Management of alternate bearing particularly in Chausa& in Langara being the major cultivars of Mango at Saharanpur not properly adopted. Most of the orchards are old and tending towards senility.

Strategies:

- Residual analysis of PGR & pesticides should be analysed in fruit and soil regularly.

INM & IPM based on soil & leaf tissue test should be adopted.

- Training for adoption of technologies such as Central opening, light pruning in middle aged tree (15 – 25 years) and rejuvenation (> 30 year old) in old and senile orchard should be regularly organised.
- Safe use of paclobutrazol (PP333) based on residue retain in the soil should be popularized in mango orchard.
- Copper oxychloride and other recommended cultural practices should be used after pruning and rejuvenation.

Pre-harvest bagging of fruits

One farmer located at Behat cluster having 100 acre of mango orchards followed the fruitbagging practices before one month of harvesting. Korean bags costing Rs. 3.75 were used. The farmer informed us that there was no incidence of disease, pest and physiological disorders in bagged fruit was observed and he could realize Rs. 100/kg fruit from Chausa and Langra cultivars using the technology. News paper bag as

recommended by the Institute was not being used by them as they assume that printed paper bag may have deleterious effect on fruit.

Bottle necks

Farmers do not know about the benefits of pre-harvest begging of fruits. Times of begging (on the basis fruit growth) are also issues.

Strategies:

- Farmers should be aware about the benefits of bagging and production of disease free mango.
- Field demonstration should be done by SHM in the late harvesting mango cultivar such as Chausa & Langra which are late and export varieties.

Harvesting and Post-Harvest Management

Cleaning, sorting and packing practices etc.

Harvesting time

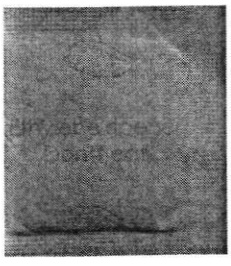
Most of the farmers followed visual methods to know the maturity indices for harvest of mango. Harvesting time of three main commercial cultivars of Saharanpur, i.e., Dashehari, Langra and Chausa were from 15 June – 15 July; 10 July – last of July month and third week of July to August, respectively. In general the farmers were facing shoulder browning (smudgy fungal blemishes or surface blackening) on surface of fruits in late maturing mango varieties like Chausa which were largely harvested after rain. This melanised fungal growth downgrades the fruit's eye appeal by spoiling green fresh look of mangoes and appears at the time of maturity after rains. An effort towards removing this melody was made at CHES (IIHR), Bhubaneshwar by dipping the fruits after harvesting in a mixture of chemicals. They claimed that this dipping removes 90-95 per cent smudginess from the fruit surface and the process was validated

at mango growers' field of Saharanpur but the farmers have not adopted this technology. They were not in favour to dip the fruit after harvesting. However, some farmers were spraying carbendazim at the rate of 2.0 kg per tanker (2000 L) thrice for its control. We have advised not to spray such chemical on the fruits when fruits attained maturity for harvesting.

Harvesting tools

Few farmers used harvester especially designed for plucking mango with 1.0 cm of pedicel as per recommendation for export and to avoid the sap oozing. Harvesters were purchased from Ahmedabad, Gujrat. ICAR-CISH harvester designed for harvesting the mango fruits was not adopted by the farmers due to lack of awareness and availability. However, majority of farmers followed manual method of harvesting and did not use any tool.

Chemicals used for ripening

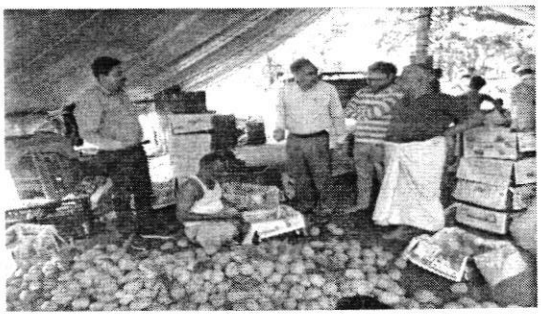


Chinese Pudia as ethylene ripener

Proper and safe protocols for ripening of fruits were not followed in almost all the cluster. However, some traders and merchants used ethylene ripener (Chinese pudia) (10 kg / packet) for ripening the fruits. Others used calcium carbide @ 300-600 g per 20 kg box, which is harmful chemical and not permitted officially. Other farmers did not use any chemical for ripening.

Pre cooling of mangoesm

None of the farmers practiced pre cooling of fruits before packing. However, the exporters practiced and insisted for pre cooling as it is necessary for export.

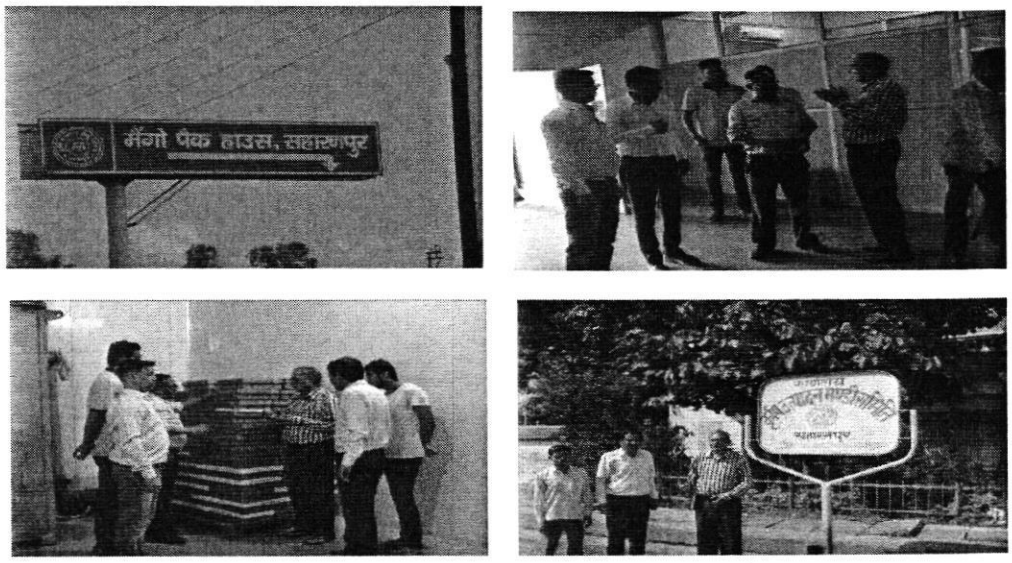


Sorting / grading / cleaning

Sorting and grading were not being practiced by the farmers. Only the trader/exporter practiced sorting and grading of fruits. However, all the surveyed orchardist adhered to cleaning and sorting of damaged fruits only and proper grading before packaging.

Packing practices

None of the farmers used standard CFB boxes for packing and storing however exporter used standard CFB boxes. Locally made 5 kg ordinary mango boxes are mostly used for packing. Some very progressive farmers used plastic crates of 13 kg and 25 kg capacity for packing.

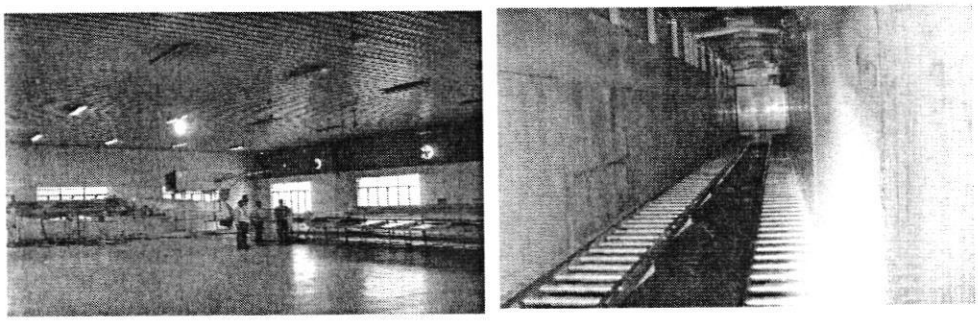


Packaging house for export and discussion with exporter

Packing box for export (a); Packing of fruits for internal market at producing site (b)

Primary processing

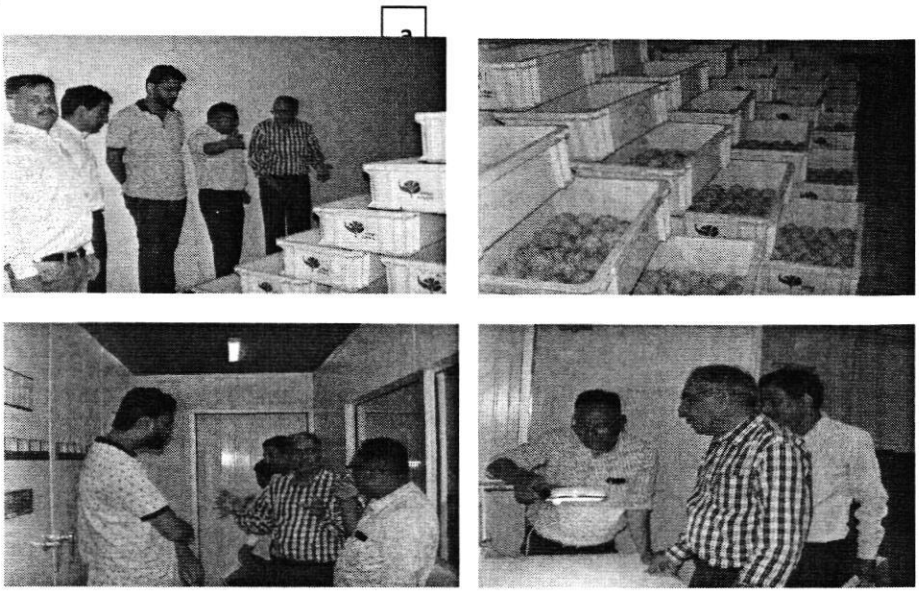
There exists no small scale processing unit of mango, however, some of the farmers showed their interest to have such unit. A small proportion of mango (1.5%) is processed in to value added products such as mango pulp, jams, chutneys, amchoor and drink. Awareness is needed to the farmers for making more value added house hold products.



Modern pack house: Export chain of packaging line (a) VHT (Vapour Heat Treatments) System (b)

Storage facilities

Cold storage/ripening chamber facility does not exist in Saharanpur area. Besides this, majority of the farmers have limited knowledge of handling, storing and transportation. However, mandi of Saharanpur have good working packaging and exporting line of mango.



Bottlenecks of Harvesting and Post-Harvest Management

Lack of awareness and availability about harvesting tools. Awareness among farmers about pre-as well as post-harvest technologies & export better linkages between exporter and growers required.

Strategies:

- Awareness programme should be organized for harvesting tools, pre-as well as post-harvest technologies & export better linkages between exporter and growers required.
- Harvesting at proper maturity and use of harvesting tools
- Ripening of mango fruits with recommended method
- re-cooling, sorting, grading and packaging of fruit in CFB boxes/plastic crates and safe transport of produce
- Tying up of target mango growers with processing industries for processing of produce into mango pulp

- Strengthening of market linkages by organizing buyers-growers meet/interaction.
- Tying up of producers with the market agencies in the country and exporters

Value chain for exporting the mango from pack house Market linkages

Marketing problems are more common in fruit due to their high degree of perishability, season bound availability and bulky nature. A few traders with huge marketing margins create havoc in fruit trade. There is need for streamlining the marketing operations to provide an incentive for boosting the production and assuring proper income to the growers.

Following constraints are common in Indian marketing system:

- About 75% of the farmers sell their produce at the farm level to the village merchants, retailers, big producers or to the pre-harvest contractors. They can't afford to transport their produce to distant markets (mandies) on account of the non-availability of transport facilities, expensive transport, malpractices in the market such as heavy deductions, free sample of the produce, etc.
- High and unjustified market charges levied on the producer-seller, delayed payment and lack of open bid system.
- Small growers are unorgranized. They lack group action and bargaining power. As a result, the traders exploit these farmers.
- Information regarding the demand, supply, price, market outlook, knowledge of the consumer's preference, marketing channels and practices are important for the marketing of the produce, which are not available at the moment.
- The exploitation of the farmer by commission agents and traders is very much prevalent in wholesale markets.

Various stakeholders require market information for decision making at farm level in respect of what to produce, harvest time and quantum, where to market, which variety to market in respective market; by researchers and policy makers for analyzing market efficiency, regulatory/administrative prices and mechanism decision, etc.

The study on margins of the producer indicated that it declined with increase in the number of intermediaries. The producer received lower share in the consumer rupee when the orchards were sold to pre-havest contractor vis-a-vis shelf harvest and trading. The trading through pre-harvest contractor also led to deterioration in the production capacity of the orchard as the intermediary did not take adequate care of

the orchard. Over ripening, pressing and rotting of the fruits was the major factor causing losses in the post-harvest system at different levels, i.e., farmer, trader and retailer levels. Only 85 per cent of the harvested fruits could reach the consumer in the prime natural condition and the rest were damaged in various intensities. About 2 per cent of the fruits had to be discarded due to one or the other reason. An efficient market information system was also suggested (Verma et al., 2005). The market information system was virtually non-existent. Linkage between the exporters and producers was non-existent at Saharanpur. Farmers felt that the exporter will not give right price for their produce. Therefore, farmers sell their fruits directly to KisanMandi, Azadpur Fruit Mandi, Delhi, etc. Some farmers sold their produce through middle men while some to local buyers. The produce is marketed through trucks with loading capacity of about ten tons. In order to minimize the transportation cost, transporters also practice overloading. Majority of the farmers acquired market information through various sources of mass communication, middle men and local markets.

Thus, there is an urgent need to link the farmers with exporter through meeting/awareness programme. There is need to establish co-operative collecting site of the produce for easy marketing.

Precision Farming and scope for Plasticulture Applications

Bottlenecks

Fertigation

In India, growth of adoption of microirrigation system has taken place during last decade and mostly horticultural farmers are adopting this technology to save irrigation water and enhancing the water, use efficiency, although, fertigation offers numerous advantages but it is not being used widely due to the reasons given below:

1. There is lack of research and developmental information in respect of its rate of application, amount applied and frequency adopted. However, research efforts are being focused on this aspect but there is a lack of information in respect of varied agroclimatic conditions and crops.

2. In India, there is a subsidy policy for normal NPK fertilizers in specified grades, however, for fertigation the requirement of fertilizer is in different grades and it should be 100% water soluble for its effective application the fertigation material is either not available in desired form or available at higher price, than the conventional fertilizer.

3. Once the fertigation practice is being followed along with drip irrigation system causes higher clogging. The farmers must be trained to adopt fertigation along with other chemigation technique.

Strategies

1. The worlwide adoption of micro irrigation should be linked with horticultural crops, because of economic considerations. The biggest advantages of micro irrigation technology is due to its low rate of water application, besides other advantage of saving of irrigation water, better quality and enhancement of yield.

2. The additional advantage of micro irrigation is that it could be coupled with the fertigation programme and due attention of planners are required to couple this activity for saving of fertilizer for better quality produce and enhanced yield.

Micro Irrigation

Bottlenecks

Micro irrigation technology has been recognized as an answer to meet the increasing demand of water for fertigation, especially for horticultural crops as this method has about 95 percent efficiency. It ensures increase in crop yield, higher quality of crop, less water and energy consumption. However in some of the state like UP farmer are well aware about the benefits of micro irrigation in quality of different agricultural and horticultural crops.

Strategies

Micro irrigation system in India could be promoted effectively if the issue of research, development and promotion could be taken up simultaneously. Some of the important issues are:

1. The system should be designed to suit the agro climatic conditions of the area and specific care should be taken for the existing orchard so as sufficient soul mass is provided wetting to avoid soil moisture stress.

2. The adequate measured are required to avoid clogging

Government initiatives for existing supply chain of Mangoes.

Pack house

Mango, being a highly perishable commodity, can't be stored for long periods. There is only one pack house at Saharanpur with a capacity of 5 tonne/day. This pack house is certified and recognized as per standard guidelines of APEDA. It is equipped with Vapour Heat Treatment (VHT) which is recent technology for eliminating the larvae of

fruit flies present in the raw mangoes as per export requirement to some developed countries like Japan, USA, Australia, etc. with capacity of 5 MT per batch.

Pack house needs following improvements

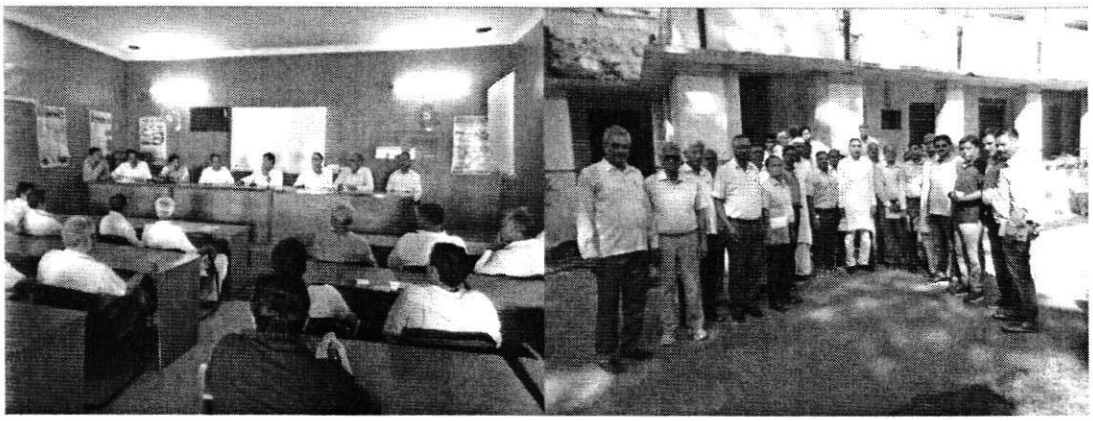
- Pack house need ripening chamber at least with 15 MT capacity.
- Need dehydration plant (one number) for keeping the fruit for longer period without using any chemical treatment.
- Need quality control lab (one number) as per international codex.
- Pack house is on contract for requisite period by M/s Dhillon Fresh Export, Navi Mumbai. Firm exported 140695 kg of mango to UK, Italy and Germany till 2nd week of July, 2017. Surprisingly, no fruit from Saharanpur was purchased by exporter may be due to low rate offered. One exporter purchased Chausa mango from Kunda, Pratapgarh district of U.P. for export. Therefore significant pushup is needed to interlink the local growers with exporters.

Issues

- Chausa cultivar in Saharanpur has immense potential for export due to high shelf life as compared to Dashehari and Langra. Human resource development is a key factor in enhancing export of Chausa.
- There were no ripening chamber, cold storage, controlled atmosphere (CA) storage, primary processing centre, mobile processing centre etc. at Saharanpur. However, standard method for sorting, grading packaging lines are available in pack house.

Awareness programme organized

An awareness program cum brain storming session of progressive farmers (35 nos) of mango clusters along with Joint Directory, Deputy Director, Horticulture; DHO, Scientist of Horticulture Centre and scientist of KVK, Saharanpur was organized at Horticulture Research Centre, Company Bagh. ShriMahavir Singh Rana, Ex. MLA, minister also participated in this programme. Stakeholders of the commodity were sensitize on different issues related to quality production of mango. Growers decided to form a "Farmer Producer Company" to disseminate the knowledge and to bring down the cost of cultivation. Monitoring and constraint analysis of Producer Company will be tracked once it is formed.



Awareness programme of mango growers

उद्यान वैज्ञानिकों ने किया आम के बागों का निरीक्षण

लखनऊ के वैज्ञानिकों ने देखे बाग

लखनऊ से आए वैज्ञानिकों ने किया बागानों का निरीक्षण

Major issues in the value chain at Saharanpur

- Lack of organizational setup, co-ordination amongst growers is lacking.
- Lack of proper infrastructures such as packing sheds or collection points.
- Transportation barriers of fruit for trader during some peak period of harvesting of Chausa fruits due to some unavoidable circumstances.
- Cold chain logistics unavailable.
- Underdeveloped market information feed back loops which is leaving farmers with very little understanding or incentive for improving their productivity or quality.
- Poorly resourced horticulture research stations, Saharanpur and dearth of extension support in mango production.

Recommendations for future improvement

- Several initiatives needs to be taken to resolve the problems existing in the value chain which includes setting up of an optimal crop management system, developing post-harvest infrastructure, entrepreneurial management and expertise and finally improving post-harvest operations related to handling, storage and marketing of produce.
- Market strategy should be developed to provide necessary information and guidelines to mango growers so that they can market their produce in a profitable manner as per the requirements of the customer.
- Nearby international markets should also be tapped for the export of Chausa which is leading cultivar in Saharanpur with fairly good shelf life.
- Small and cost effective pulping units should be installed in the mango cluster areas of Saharanpur to utilize the C and D grade fruits.
- Training should be conducted for orchardist at farm located in cluster area to enhance their capacity to adopt appropriate production technology and prepare marketing strategy.
- Associated government department may be sensitized to ease the policies with respect to export of mango and declare these products as 'priority product' for export.

Reference

Anonymous (2013). In: Post Harvest Profile of Mango. GoI, MoA, Directorate of Marketing and Inspection, p. 1-144.

Acknowledgements

We gratefully acknowledge the MIDH, Ministry of Agriculture and Farmers Welfare, Govt. of India and NCPAH, MoA&FW, New Delhi for financial assistance to collect this information. We are grateful to Director, Horticulture and Food Processing & SHM, Uttar Pradesh and staff of Horticulture Research Station, Saharanpur for support and coordination. We are highly grateful to our Director, ICAR-CISH Lucknow for providing all the logistic support to PFDC, CISH Lucknow and team to conduct these study.