Chapter 4
Banana and Mango Value Chains

Harsh Wardhan, Sandip Das, and Ashok Gulati

4.1 Introduction

Fruits are high-value agricultural crops, mostly managed by individual farmers in India unlike in the West where large private corporations are involved in production and exports of fruit crops. India's fruits production increased significantly from 28.6 million metric tonnes (MMT) in 1991–92 to 96.8 MMT in 2018–19. Among fruits, mango and bananas are the most important crops with 50% share in fruits acreage as well as value dominated by mango (Fig. 4.1).

While Andhra Pradesh, Gujarat and Tamil Nadu are the largest banana-producing states in India, Uttar Pradesh, Andhra Pradesh and Bihar are the three largest mango-producing states. However, Maharashtra is an important producer and exporter for both. Despite being the largest producer of both bananas and mangoes, India's position in the trade of both these fruits is unremarkable. India exported around 103 thousand MT of bananas and another 46 thousand MT of mangoes during TE 2017–18, which is less than 1% of total production of the two crops. The processing capacity of these two crops is also limited in India. A significant volume of these fruit crops is wasted every year due to lack of proper post-harvest mechanisms. Banana and mango value chains did not witness the kind of success that was seen in grapes, which was led by Mahagrapes. Is it possible to develop banana and mango value chains on same lines as grapes model?

In order to answer this, the chapter strives to study and analyse banana and mango value chains in the CISS–F framework. The study identifies the challenges faced by the sector at each stage of the value chain from cultivation to marketing. It also discusses how policy reforms can strengthen these value chains to stabilise prices and ensuring fair share to farmers while guaranteeing healthy and affordable fruits to the consumers. It is expected that the results of this study and the policy recommendations suggested in the end would be useful for the policy planners formulating

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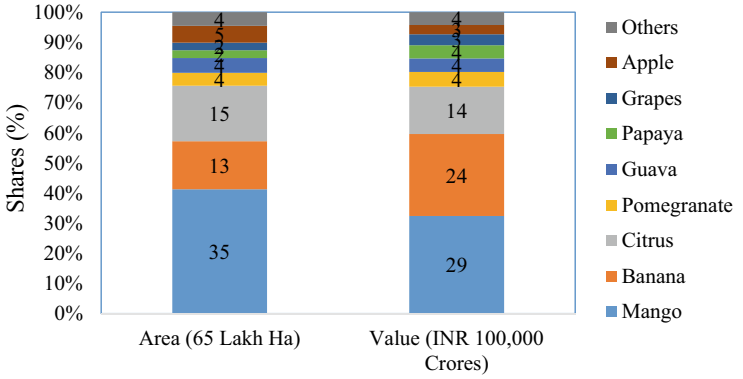

Fig. 4.1 Share of fruits in area and value. *Source* DoAC&FW and NAS (Various issues)

policies aimed at creating an efficient value chain models for banana and mango for India which then can be scaled up for other fruits.

4.2 Overview of Banana and Mango Economy

4.2.1 Banana

Global Overview of Banana

Banana is the most important fruit crop in the world in terms of acreage and production. Among all agricultural commodities, it is the seventh largest traded commodity in the world after wheat, maize, soybean, rice, barley and sugar. Being a tropical fruit with its origin in Asia, banana is a convenient fruit for people across the world as it is affordable, nutritious and available everywhere throughout the year. Bananas are eaten in ripened form as a fruit or dessert; and raw form (known as plantains) as a vegetable is used for cooking. Globally, around 5.5 million hectares was under banana crop in TE 2017, with India alone accounting for 15% of the total area. Other top countries with high banana acreage include Brazil, Tanzania and Philippines. In terms of production, India is the largest producer of bananas contributing to more than a quarter of global production of 114 MMT during TE 2017. Despite being a leading producer of most fruits and vegetables, China accounts for 10% of the total banana production, followed by Indonesia, Brazil, Ecuador and Philippines (Fig. 4.2).

While average world productivity of banana was 21 tonnes per hectare (tn/ha) during TE 2017, India (35 tn/ha) recorded a higher yield than most of the countries including Brazil (14 tn/ha), USA (15 tn/ha), China (28 tn/ha) and Mexico (29 n/ha). Countries that recorded higher yields than India also saw significant increases in their yields in the 10 year period between TE 2007 and TE 2017 (Fig. 4.3). For example,

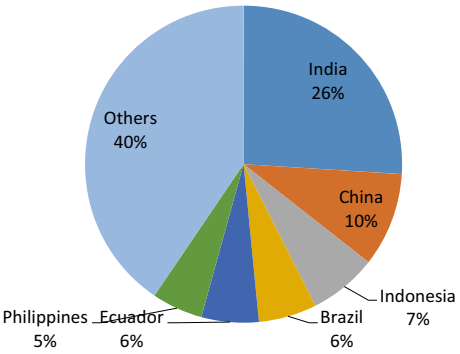

Fig. 4.2 Country-wise share of banana production (TE 2017). *Source* FAOSTAT (2019)

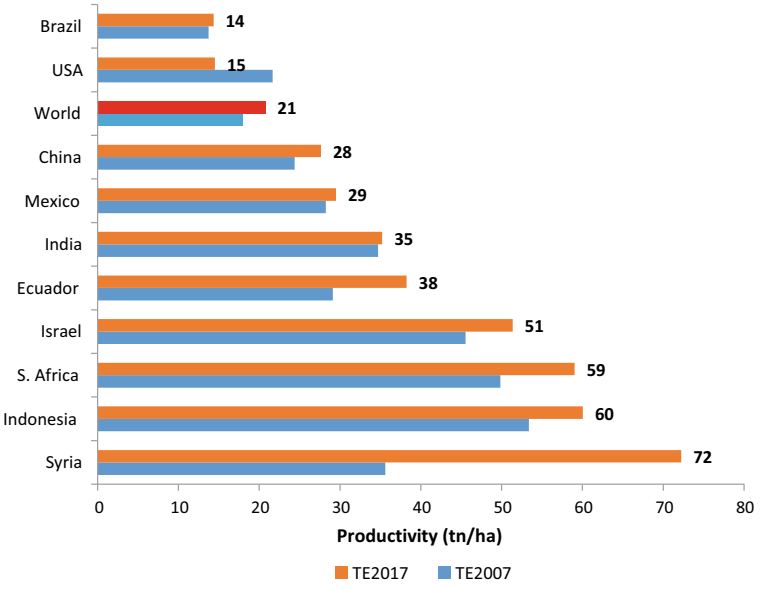

Fig. 4.3 Banana productivities in selected countries. *Source* FAOSTAT (2019)

Ecuador, which is the world's largest exporter of bananas, had much lower yields (29 tn/ha) than India whose yield levels have almost been stagnant.

Domestic Overview of Banana

Domestic production in India is dominated by Andhra Pradesh (16%), Gujarat (15%), Tamil Nadu (11%) and Maharashtra (12%) (TE 2018–19). Banana acreage is dominate by Karnataka (12%), Kerala (11%), Andhra Pradesh (10%) and Tamil Nadu

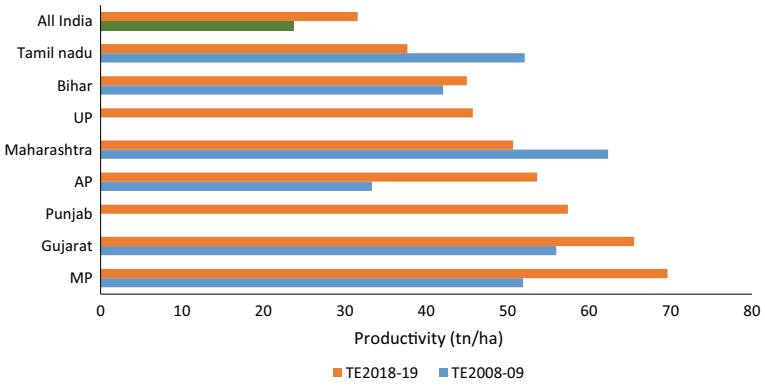

Fig. 4.4 Productivity of selected banana-producing states. *Source* DoAC&FW, NHB

(10%) (TE 2018–19). A decade back, traditional banana-producing states like Maharashtra and Tamil Nadu used to feed north, east and south India, respectively. Now due to area expansion and increase in productivity of bananas, states like UP, Bihar and Madhya Pradesh are also catering to domestic demand.

Western countries have large area under corporate plantations for bananas, and many big corporate players like Dole, Chiquita, Fyffes and Del Monte control more than 80% of the world's banana trade. However, in India, banana plantations are primarily smallholder venture. This has disabled any yield growth potential. India's banana yield recorded a positive growth during the decade of 1990s before falling for a brief period in early 2000s. The yield increase has been attributed to tissue culture technology and precision farming. While traditionally, bananas are grown using vegetative method which involves planting baby shoots growing near the stem of mother plant as seeds, in tissue culture method, a tissue of banana plant is grown artificially in a controlled environment and multiplied in laboratories before transplanting. This tissue culture method that penetrated the Indian banana cultivation practices resulted in disease free, uniform and short duration crops. The largest producing state, Andhra Pradesh, along with Gujarat and Madhya Pradesh witnessed large increases in yield levels. Madhya Pradesh (70 tn/ha) has the highest productivity for banana, followed by Gujarat, Punjab and Andhra Pradesh in TE 2018–19. Maharashtra and Tamil Nadu recorded a fall in their respective banana yields during TE 2018–19 compared to TE 2008–09 (Fig. 4.4).

Banana Trade Pattern

Banana is the largest trading fruit crop in the world with global demand of 20.6 MMT in TE 2017. However, the four largest banana-producing countries do not even feature in the top ten banana exporting countries list. Ecuador, the fifth largest banana producer, is the world leader in banana exports and accounts for 28% of global exports. India which produces more than a quarter of world banana production, exports a meagre 0.5% and ranks twentieth. Philippines, Guatemala and Costa Rica are other important banana exporting countries (Fig. 4.5). USA is the largest banana

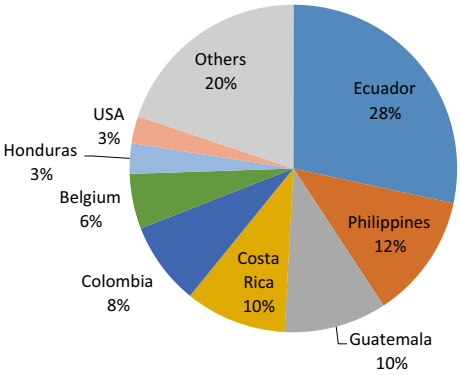

Fig. 4.5 Share in global banana exports (TE 2017). *Source* UN Comtrade Database (2019)

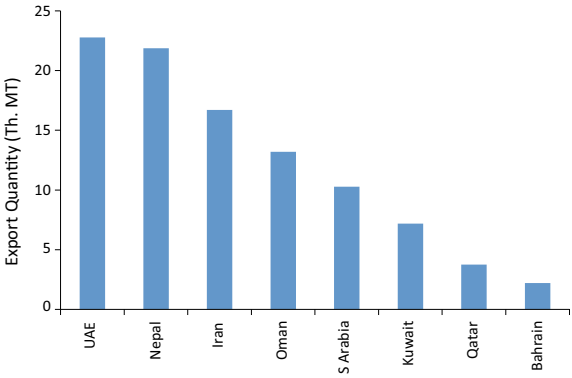

Fig. 4.6 Major export destinations for Indian bananas (TE 2017–18). *Source* APEDA (2018)

importing nation in the world with almost 42 lakhs MT of bananas imported during TE 2017, which is almost 22% of world banana imports. Other countries that import considerable quantities of banana include Germany, Russia, Belgium, UK, China and Japan, each importing (7–5%) of total banana imports (Fig. 4.6).

India exported 103,000 MT of bananas during TE 2017–18. Indian bananas are mostly exported to Middle Eastern countries and neighbouring countries like Nepal. UAE with around 23,000 MT is the largest importer of Indian bananas, followed by Nepal with 22,000 MT. While bananas are also exported to Pakistan in large numbers, the trade figures keep fluctuating because of political tensions. For example, Pakistan imported 21.7 MT of bananas in 2013–14, 7243 MT in 2014–18 and 32.4 MT in the following year. There were no imports in 2016–17, and 685.3 MT of bananas were imported in 2017–18.

Processing of Bananas

Like other fruits, bananas can be processed into a number of edible and non-edible products. Each part of a banana plant can be turned into a value-added product. Edible products that can be produced from the fruit include banana puree, paste, powder, candies, barfee, biscuits, juice and concentrate, wine, beer, chips, wafers,

jams and jellies. Banana figs or dehydrated bananas are highly nutritious products which can be produced by small-scale industries. Inedible but useful products that can be produced from the pseudostem, scutcher and other parts include banana fibre, paper, bio fertilizer and vermi-compost.

Few pilot projects for banana figs ('Sustain' project by Bayer Material Science Company, Solar-dried Banana Fig by Thottiam Banana Producers Group, Tiruchirappalli and Madhur Fruits) have been started with the help of training and transfer of technology provided by National Research Centre for Banana (NRCB), an ICAR Institute in Trichy, Tamil Nadu. NRCB, along with Navsari Agricultural University, Gujarat, has also taken initiatives to utilize banana pseudostem waste for fibre extraction and production of yarn and textiles (NRCB). Anakaputhur Jute Weavers' Association (AJWA), 'Banana Star' of SSKJ Trading Pvt. Ltd., Trichy, and Tapti Valley Banana Cooperative Society, Jalgaon, have undertaken projects to utilize banana pseudostem for producing value-added products.

In India, bananas are mostly consumed as fresh fruit with very limited quantity available for value-added products. About (3 to 4)% of the total banana production is processed in India. Banana chips are the most popular form of value-added product, especially in the southern states of India. Nendran, Robusta and dwarf Cavendish varieties are the most suitable varieties for banana chips. While majority of banana chips are produced in the unorganized sector as local brands, organized sector comprises of well known brands like Haldiram's, MTR and Balaji. India has an excellent opportunity to cater to export demand for value added banana products.

4.2.2 Mango

Global Overview of Mango

The mango tree appears to have originated in Malaysia or the Indo-Burmese region (UNCTAD 2016) and reached Southeast Asia between the fifth and fourth centuries BC and then spread all over the world. There are at present more than 100 mango-producing countries with 1000's of varieties grown in different countries. Asian countries, especially India, Pakistan, Bangladesh, China, Indonesia and Thailand, account for 67% of the mango production (2017 data). India is the world's largest mango-producing country with a share of 38% of the global mango production (FAO) (Fig. 4.7).

India's mango yield at 9 tn/ha, is at par with global average (TE 2017). However, the productivity is lower than key growing countries such as Brazil (18 tn/ha) and Israel (23 tn/ha) (Fig. 4.8).

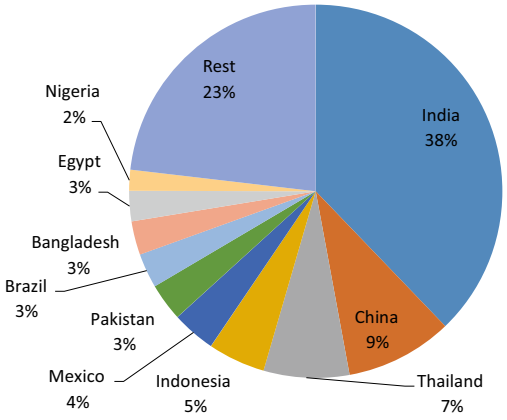

Fig. 4.7 Top mango-producing countries (2017). *Source* FAOSTAT (2019)

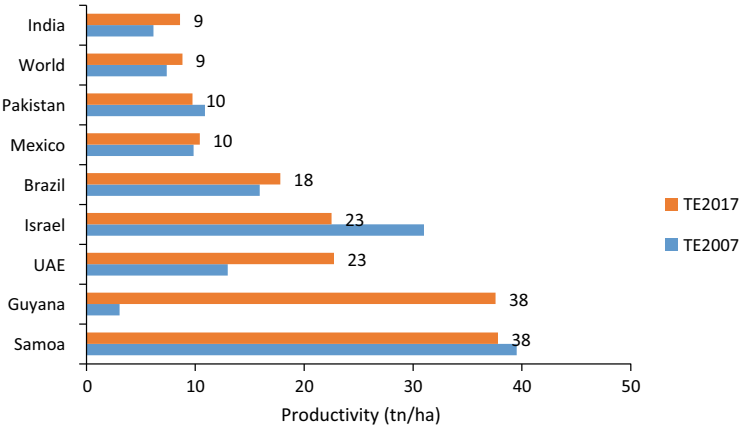

Fig. 4.8 Mango productivity in selected countries. *Source* FAOSTAT (2019)

Domestic Overview

Mango, also referred as 'king of fruit' owing to its taste and high nutritive value, is the most popular fruit in the country. Grown as both homestead and commercial farming, India has the largest variety of mango cultivars in the world. Although mangoes can grow in a wide variety of climate, it grows best in tropical and subtropical climatic conditions and needs a good amount of rain during the growth period and a dry spell during the flowering period. Table 4.1 presents the crop calendar for mangoes in different states. The peak season for mangoes in different states in India is between April to July.

Table 4.1 Harvesting pattern in the leading mango growing states

	February	March	April	May	June	July	August
AP / Telangana	•	•	✓	✓			
Gujarat			•	✓	✓	•	
Karnataka			•	✓	✓	•	
Maharashtra		•	✓	✓	•	•	
UP / Bihar				•	✓		•

✓ Peak season

• Lean season

Source: (NHB, 2017)

In terms of production, Uttar Pradesh is the largest mango producing state in India with a share of 22%, followed by Andhra Pradesh (19%), Bihar (10%), Karnataka (9%) and Telangana (6%). These top five mango producing states together contributed 66% of the total mango production in TE 2018–19 (Fig. 4.9).

However, there is a lot of variability in terms of productivity. Rajasthan has the highest yield of mangoes at 18.1 tn/ha even though it has one of the smallest area under mangoes. UP, being the largest mango producer, has second highest productivity levels at 17.1 tn/ha, followed by Punjab (16.9 tn/ha). Maharashtra, which is home to the famous Alphonso variety of mangoes, has one of the lowest yields at 3.7 tn/ha (Fig. 4.10).

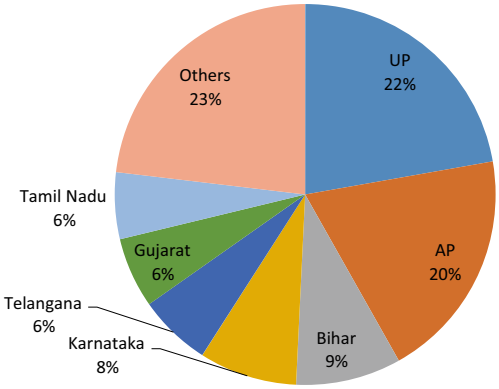

Fig. 4.9 Production (MMT) in top mango-producing states. *Source* DoAC&FW (2019)

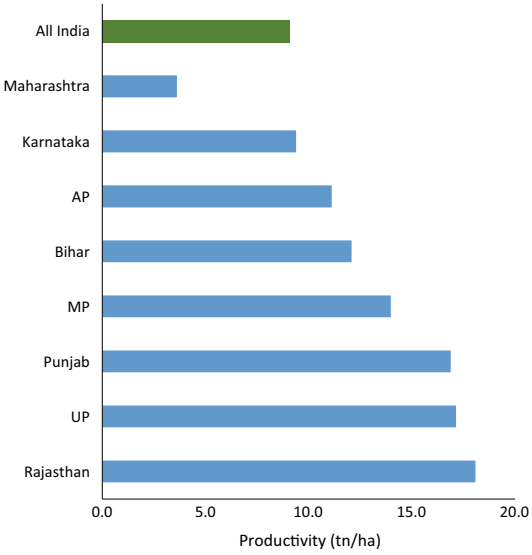

Fig. 4.10 Productivity of mango in selected states (TE 2018–19). *Source* DoAC&FW (2019)

Mango Trade Pattern

Global mango trade was virtually non-existent prior to 1960s. World demand for mango, especially in the USA, European Union (Netherlands, France, England, Portugal, Spain, Belgium, Denmark and Sweden), is increasing steadily. With the peak mango season being between April and July in India, the harvesting continues for 8–10 months in a year in Brazil, Columbia, Kenya and Venezuela. The season is also quite long in Burkina Faso, Costa Rica, Indonesia, Jamaica, Mexico, Nicaragua and Puerto Rico.

South American countries—Mexico, Puerto Rico, Dominican Republic, Brazil, etc., accounted for 39% of global trade (exports) in TE 2016. Asian countries—Thailand, Philippines, Pakistan and India accounted for 30% exports (Fig. 4.11).

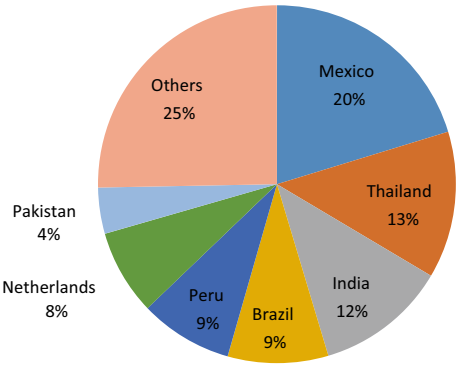

Fig. 4.11 Share in global exports (mangoes, mangosteen, guavas)—TE 2016. *Source* FAOSTAT (2019)

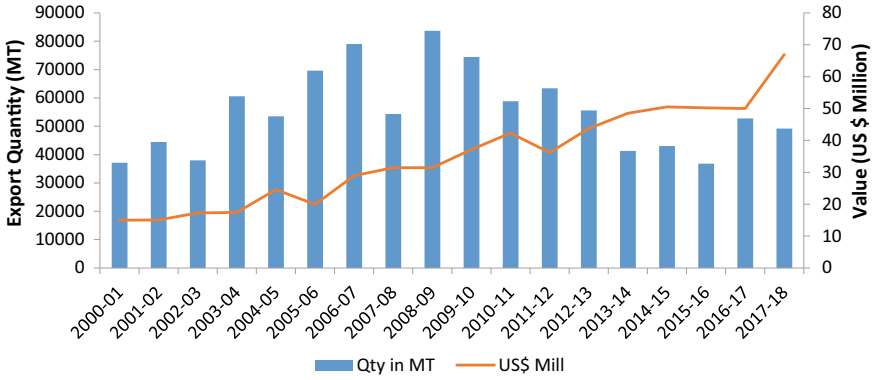

Fig. 4.12 India's mango exports (value and volume). *Source* APEDA (2018)

The USA, European Union, United Arab Emirates are the key mango-importing countries. Key globally traded mango varieties includes Tommy Atkins, Kent, Keitt, Palmer, Amélie, Irwin, Maya/Aya and Indian varieties, Alphonso, Kesar, Chausa and Totapuri.

India is also a prominent exporter of fresh mangoes and exported 46.4 thousand MT of fresh mangoes in TE 2017–18 (Fig. 4.12). Although mango exports constitute less than 1% of the total production indicating a high level of self-consumption, it has 12% share in global mango exports (TE 2016). According to Commerce Ministry officials, although variety-wise mango exports data is not available officially, the popular varieties exported are Alphonso (Maharashtra), Kesar (Gujarat and Maharashtra), Totapuri (Maharashtra, Tamil Nadu, West Bengal, Karnataka and Andhra Pradesh) and Banganapalli (AP, Maharashtra, Tamil Nadu and Karnataka). Indian mangoes are mostly exported to UAE, UK, Saudi Arabia, Qatar, Nepal and the USA.

Processing of Mangoes

Mango pulp is prepared from selected varieties like Totapuri and Kesar. Mango pulp or concentrate is used for making juices, jams, fruit cheese and various other kinds of beverages. It is used for puddings, bakery fillings and flavours for food industry. Mango puree/pulp is a smooth and thick product which is processed in such a way that the insoluble fibrous parts of the ripe mangoes are broken up. It retains all of the fruit juice and a huge portion of fibrous matter, which is found naturally in the raw fruit. Two main clusters of mango pulp industries are located in Chittoor, Andhra Pradesh, and Krishnagiri, Tamil Nadu. There are around 65 processing units with backward linkage facilities with farmers. Few processing units are located in Maharashtra and Gujarat. India is a major exporter of mango pulp, exporting to countries such as UAE, Europe, Singapore and Malaysia. India produced 3.5 LMT of mango pulp annually, around 50% of the estimated 7 LMT of global mango pulp production. India exported 1.2 LMT of pulp worth 108.3 million USD. Major players of mango pulp in India include Jain Irrigation Systems, ITC, Mother India Farms and ABC Fruits.

4.3 Competitiveness

India is the largest producer of both bananas and mangoes; however it is not a major banana exporter and has a limited presence in the global mango trade. Is it because the domestic consumption itself is high, there are quality issue or India is not competitive enough in the global market? This section will answer the above questions by analysing the competitiveness of Indian bananas and mangoes. There are two ways of looking at competitiveness—one at international level and the other at domestic level.

4.3.1 International Competitiveness

In this section, we will analyze international competitiveness for banana and mango value chains in India, by estimating Nominal Protection Coefficients (NPCs).

Banana Exports from India: Problems and Prospects

We have analysed India's position in global banana economy and compared it with other important nations in Table 4.2. It is clear that India has a dominant position in terms of both acreage and production of bananas, it even has a high productivity compared to other important banana producing countries; and it has a meagre presence in world trade of bananas. Ecuador which has around 20% of India's banana acreage is exporting almost 30% of world's banana exports. With global demand of bananas at 19 MMT worth USD 13.4 billion, India supplies only 0.4% and ranks 21 among all banana-exporting countries.

Table 4.2 Comparison of India with other banana countries (TE 2017)

	India	China	Ecuador	USA	World
Area (Th. ha)	841	396	175	0.3	5489
Rank	1	5	8	105	
Production (MMT)	30	11	7	0.004	114
Rank	1	2	5	98	
Productivity (tn/ha)	35	28	38	15	21
Rank	19	33	18	66	
Exports (Th. MT)	94	11	6153	579	22 MMT
Rank	21	50	1	8	
Imports (Th. MT)	0	1000	Neg	4195	19 MMT
Rank	–	6	131	1	

Source FAOSTAT (2019), UN Comtrade Database (2019)

A typical export chain for Indian bananas has been described in Fig. 4.13. India primarily exports Cavendish varieties of bananas via Nhava Sheva sea port, also known as JNPT (38%) and Nendran variety from Kerala via Cochin (13%), Trivandrum (12%) and Calicut (5%) airports as well as Tuticorin sea port (11%). A sizeable quantity of bananas is also exported to Nepal via land route from Nautanwa, Uttar Pradesh–Nepal border (Fig. 4.14). Banana exports to Pakistan is very volatile and are mostly traded through the barter system of trade, wherein Indian bananas are exchanged for Pakistani dry fruits.

While Europe, North America and China are major importers of bananas, their banana demand is met by Ecuador, Philippines and other major exporting countries. Europe does not prefer Indian bananas because of quality issues—heterogeneous size, black or brown spots and improper post-harvest handling. Quality issue, coupled with inadequate infrastructure like integrated pack houses for banana exports, has resulted in negligible participation of India in global banana trade. There are only three APEDA-recognized pack houses in India (APEDA 2017). The absence of sea protocol prevents India to export via sea to Europe. Since transportation through air freights make bananas costlier, India has a long way to go in exploring the promising banana markets of Europe.

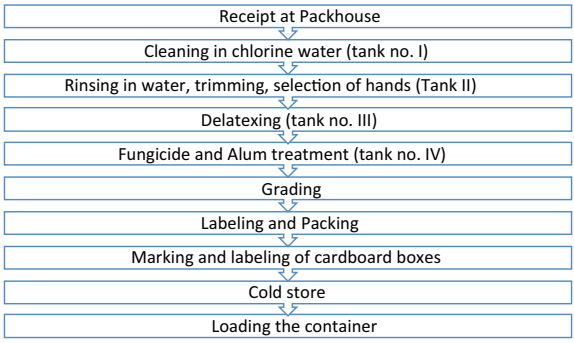

Fig. 4.13 Processes for banana exports. *Source* APEDA

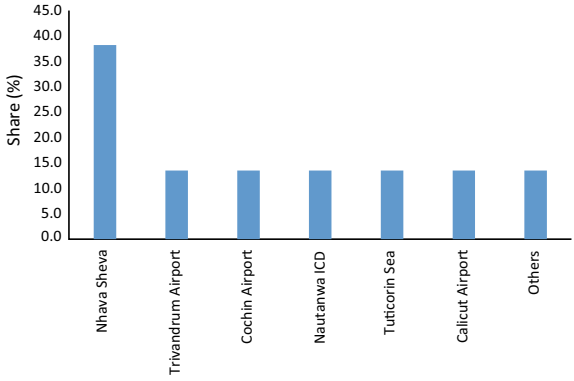

Fig. 4.14 Port-wise banana exports from India (TE 2017–18). *Source* APEDA (2018)

Nominal Protection Coefficients for Bananas

Competitiveness can be measured using Nominal Protection Coefficient (NPC), which is the ratio of average price received by the farmer and the adjusted border price. To calculate NPCs for Indian bananas, we have used the methodology adopted by (Saini and Gulati 2017) in their study on Price Distortions in Indian Agriculture, described in Sect. 1.2.

For domestic price estimation, weighted average wholesale prices for bananas have been taken from Agmarknet. Since, Cavendish variety of banana is the most traded variety in the world as well as from India, we have used wholesale prices of the states producing these varieties. We have not considered the *Nendran* variety of bananas from Kerala even though it is an important variety exported from India because they have higher prices and not comparable to Cavendish bananas in terms of price, size and quality. Unit value of banana exports from India has been taken as a proxy to the international fob prices.

Figure 4.15 shows that NPC values for banana have always remained well below 1, signifying exportability of bananas. This shows that Indian bananas have been competitive throughout the study period. In 2006–07, NPC value was very close to 1, and since then, NPC values have consistently declined. It implies that the export competitiveness of Indian bananas has been increasing. This is validated by the increasing export. Average NPC value for the entire period was 0.51 with a coefficient of variation (CV) of 0.41. Despite with a very comfortable value of NPC, India's true potential of banana exports could not be reached.

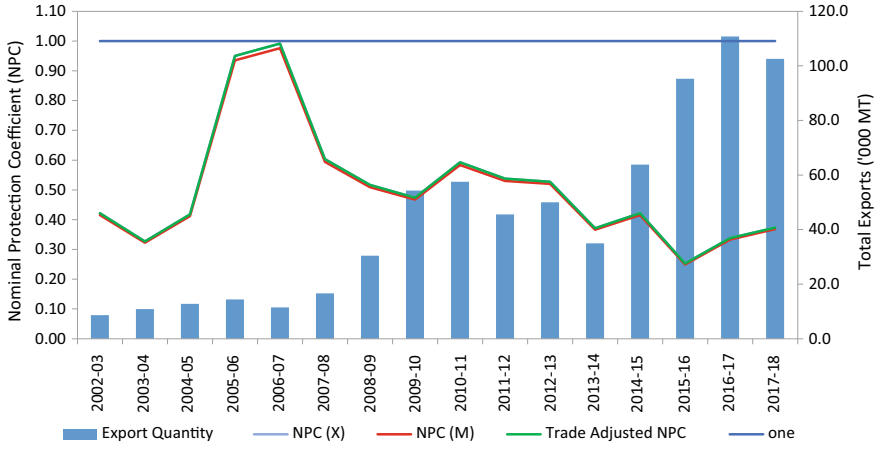

Fig. 4.15 Nominal protection coefficients for importable and exportable hypothesis for bananas. *Source* Authors' calculation using data from Agmarknet, NHB, DGFT and Field Visit

Trade Policy of Bananas

Although bananas are export competitive in the international market, Indian farmers are unable to reap benefits of this fact. They are largely small holding farms for whom access to export market are non-existent.

Whatever little exports India manages in bananas is because of steps taken by government agencies in terms of policies and infrastructural development.

India follows open export policy where banana exporters get an incentive of 7% of FOB value under the Merchandise Exports from India (MEIS) Scheme. Import duties on bananas at 30% helps control import and enables the farmers to cater to domestic demand. To promote banana exports, APEDA provides subsidies for creation of ripening chambers, reefer vehicles, pack houses and cable system of handling. There is also a provision for assistance in projects for quality development (certifications, handheld devices for traceability, water, soil and pesticides testers, laboratory upgradations) and market development (trial shipments and brand registrations).

Mango Exports from India: Problems and Prospects

India exports mangoes to around 60 countries. However, the major export destinations for Indian mangoes are United Arab Emirates, United Kingdom, Nepal, Saudi Arabia, Qatar and the USA. Japan and South Korea are new markets for Indian mangoes. Mango exports to the USA, Europe, Japan and South Korea are sourced from APEDA-approved pack houses. All consignments to EU, South Korea and Japan have to undergo hot-water treatment (HWT) or vapour heat treatment (VHT). South Korean government annually deputes Quarantine Inspectors to India for verification of mango consignments which undergo HWT or VHT.

As per norms agreed upon between India and USA, all the mangoes to be shipped have to undergo irradiation process at the Maharashtra State Agricultural Marketing Board facility at Vashi (Mumbai) and Lasalgaon. An official from USDA takes a sample of the mangoes for testing at the irradiation facility. Irradiation is mandatory for the mango exports to USA as the process eliminates pests like stone wheeler and fruit flies.

According to a leading exporter, Indian mangoes are mostly consumed by Asian origin population in the USA. The distinct feature of Indian mango is that it is 'thin-skinned' and has a flavour, while imported mangoes from Mexico and other countries are 'thick-skinned' without much flavour. During our interaction with exporters, we found out that Indian mangoes have a maximum shelf life of around 28 days, while it takes about 20 days to transport mangoes from India to USA through sea route. According to APEDA officials, sea protocol has not been formulated yet because of less shelf life of mangoes. As all the consignments of mangoes are transferred through air, air-freight costs are high compared to mangoes imported from South American countries to USA. For mango exports to Europe, mangoes are put through hot-water treatment and vapour treatment. For shipment to South Korea, its mandatory to conduct a pest risk analysis. APEDA has mandated the mango growers registered with it to adopt global Good Agricultural Practices (GAP) norms for ensuring quality produce. Increasingly, consumers across the globe are demanding food products

sourced from GAP-affiliated farmers. GAP prescribes specific cultivation method for maintaining health of the fruit plant as well as ensures rational use of nutrients.

Nominal Protection Coefficients for Mangoes

Although Gujarat and Maharashtra has only 6.4% and 3.1% share in India's mango production, respectively (TE 2017–18), they are popular for the 'Alphonso' variety of mangoes, which is globally known for its taste, fragrance and vibrant colour. We have used prices of Alphonso mango from Ratnagiri (Maharashtra) and Navsari (Gujarat). Transportation cost from Ratnagiri and Navsari to JNPT have been calculated as a weighted average cost using production ratios. Trading margins, port handling charges and international reference prices (derived from unit value of exports), estimated under the exportable and importable hypotheses. Interaction with exporters and traders reveals that the trading or marketing margins are 10% of the domestic price because of perishable nature of the commodity as well as seasonality of the mango crop.

The NPC numbers in Fig. 4.16 clearly indicates that India's mango exports have been competitive only during five years between 2002–03 and 2017–18. EU in 2014 had banned Alphonso mangoes, brinjal, taro, bitter gourd and snake gourd imports from India as pests including fruit flies were found in some of the consignments. The ban was for the period from 1 May 2014 to December 2015. However, EU lifted the export ban on mangoes, earlier than planned.

The mangoes exported from India to the USA, European Union, Japan, etc., are sent through air route, thus making them costlier than mangoes sourced from countries like Mexico, Ecuador or Philippines. Often the cost of air freight is more than the farm gate price of mangoes. Thus, India cannot compete in USA and EU markets because of high air freight cost. However, India can promote mangoes in USA, EU, Japan and Korea where purchasing power of consumers is higher than

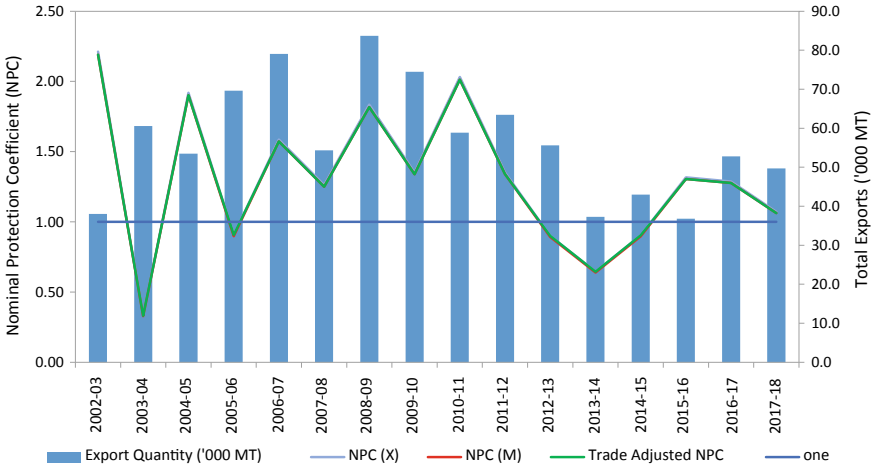

Fig. 4.16 Nominal protection coefficient for mangoes. *Source* Authors' calculations

Middle East countries to promote the unique flavour, colour and taste of Indian mangoes abroad.

4.3.2 Domestic Price Formation

Banana Domestic Value Chain

Bananas are produced in India throughout the year in almost all major states, unlike grapes and pomegranates that are concentrated only in Maharashtra. However, most of the produce is consumed well within India.

In India, Andhra Pradesh, Gujarat, Tamil Nadu and Maharashtra are the four largest banana-producing states that supply bananas all over India. For years, Maharashtra and Gujarat held a dominant position in banana trade, supplying most of the bananas to north India. A horticulture special train that started in 2012 used to transport bananas from Jalgaon to Azadpur *mandi* in Delhi. From there on, bananas were loaded on to trucks and supplied to various other states in north India.

The train however was suspended in 2016 because of changes in trading pattern, better road and highway connectivity, emergence of other major banana-producing regions (like Andhra Pradesh, Uttar Pradesh and Madhya Pradesh), and long duration and high costs associated with transporting via train. Further, there were hassles of transporting, loading and unloading bananas from truck to train and again from train to trucks during the arrival at the destination. Since other north Indian markets started receiving bananas via trucks directly from Jalgaon, Delhi market could not absorb the high arrivals, and hence, the train services stopped.

Jalgaon (part of the productive and irrigated region of Khandesh) supplies more than 50% of its bananas to Delhi. Rest are sent to other northern and western states of India like Himachal, Punjab, Uttar Pradesh, Madhya Pradesh and within Maharashtra. Jalgaon is also known as the 'Banana city' of India because of its large banana production, contributing about 50% of the total state production of Maharashtra. The presence of many small and major rivers from the Satpura range like Tapi has made Jalgaon very favourable for banana cultivation. Apart from this, Jain Irrigation (JISL) has developed and provided drip irrigation, sprinkler technologies and most importantly the tissue culture technology to the farmers that catalyzed a banana revolution in India.

Even though banana can be cultivated throughout the year, the peak harvesting months for bananas in Jalgaon has been observed to be June–July. During this time, prices are very low as mango arrivals are also at peak during this time.

Unlike vegetable marketing at *mandi* premises, bananas are traded directly from the farms by post-harvest contractors, commission agents or directly by traders. Sorting, weighing, washing and packing are all done at the farm level itself before loading on to trucks. Nowadays, box packing is preferred over traditional way of transporting loose bunches of bananas. This has considerably improved the quality of bananas and also reduced wastages. The price in Jalgaon is based on the prices displayed at Yawal APMC *mandi* board. The price for a day is decided the evening

before at 5 pm based on price prevailing in nearby Burhanpur *mandi* of Madhya Pradesh (where open auction for bananas takes place), traders in big *mandies* like Delhi, Andhra, Karnataka and actual demand position of Jalgaon. Farmers in Jalgaon claimed that the price received by them is far less than the *mandi* price. A farmer's role in marketing ends once the bananas are sold at farm gates.

Efficiency of Domestic Banana Value Chain

For our analysis of farmer's share in consumer rupee, we have considered Jalgaon to be the production centre and Delhi as the consumption centre for bananas. During TE 2017–18, arrival of bananas at Azadpur *mandi* was around 75,000 MT. Delhi primarily sources its bananas from Maharashtra (Khandesh), Uttar Pradesh, Andhra Pradesh, Gujarat and Madhya Pradesh. According to Fig. 4.17, Uttar Pradesh is the main supplier during the months of September to November and Andhra Pradesh during February to April. Maharashtra is the major supplier of bananas to Delhi throughout the year except September and October.

For farmer's price, we have considered the average of wholesale prices prevailing in Jalgaon and Burhanpur for *Khandesh* variety of bananas from Agmarknet. The wholesale price for Delhi was also taken for *Khandesh* variety of bananas from Agmarknet. Retail price for Delhi was taken from National Horticulture Board (NHB). For all the above, average of 3 years prices have been taken (2015–16 to 2017–18). Data for costs of other intermediaries were collected during interactions at the time of field visit; details for which are in Annexure 4.1.

As shown in Fig. 4.18, farmer's share in consumer rupee is estimated at 35.5%. The mark-ups for other intermediaries are 29.6%, 16.3% and 18.6% for trader, wholesaler and retailer, respectively.

All intermediaries incurs their share of cost. While, trader has to pay transportation cost of bananas from Jalgaon to Delhi which is a major cost incurred, wholesaler has to bear the cost of labour, ripening and transportation from *mandi*. However, as bananas are sold by retailers to consumers mostly on carts, they face the cost of perishability. During festivals, due to high demand for bananas, prices tend to increase. However, this is not due to low supply, but rather an artificial increase in prices by retailers.

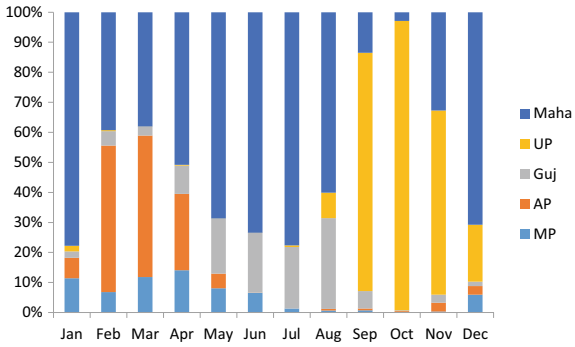

Fig. 4.17 Source-wise banana arrivals to Azadpur, Delhi (TE 2017–18). *Source* Authors' calculations using data from Azadpur APMC office

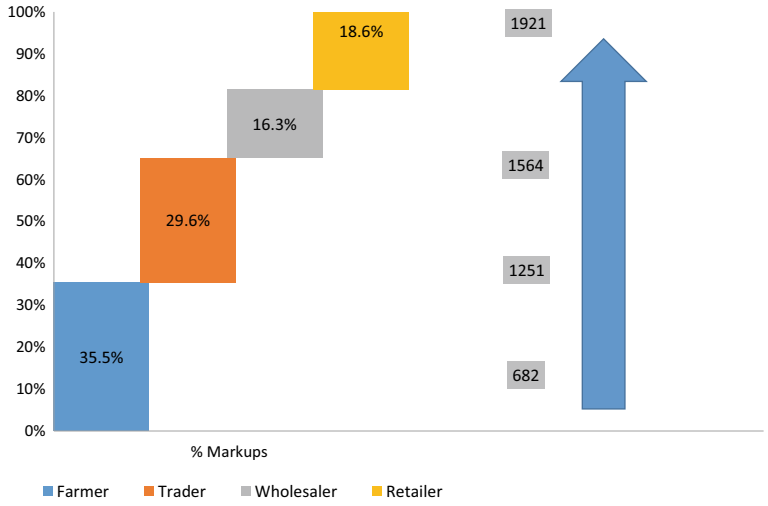

Fig. 4.18 Mark-ups for banana value chain (Jalgaon to Delhi). *Source* Authors' calculations using data from Agmarknet, NHB and Field visit

Banana Processing Value Chain

Bananas can be processed to banana puree, banana concentrates and banana puree-based ready-to-have beverages. While puree is prepared by mashing the banana pulp, without adding any additives, concentrate is prepared after evaporating the water from the puree. Concentrates are generally exported for B2B trade to reduce transportation cost.

In India, bananas are directly procured from traders or farmers at prevailing market rate. The following is the flow for banana processing:

$$\begin{aligned}&\text{Fresh fruit from fields} \rightarrow \text{Sorting}\\ &\rightarrow \text{Ripening chamber(4 days, 18 °C)} \rightarrow \text{Wash}\\ &\rightarrow \text{Peeling and Puree Extraction} \rightarrow \text{Final Product}\end{aligned}$$

Banana puree prices have declined over the years from USD 850/tonne in 1995 to USD 500/tonne, because of competition as bananas are now available at throw away prices. As per Jain Irrigation officials, processing of bananas is viable only when prices are less or equal to INR 6/kg. Beyond this price, bananas are not processed and the facilities at processing plants are used to process other fruits and vegetables.

Domestic Mango Value Chain

A typical mango value chain model is depicted in Fig. 4.19. The first stakeholder in the mango value chain is the pre-harvest contractor (PHC) who enters into a contract with a farmer around four months prior to the harvest season, based on the flowering of the trees. The PHC enters into contracts with several farmers for

Fig. 4.19 Traditional value chain for fresh mangoes

achieving economies of scale by being an aggregator. With this, farmers transfer their production and marketing risk to the PHC. During our interaction with farmers in Maharashtra as well as in Uttar Pradesh, it has been found that farmers do not market their products directly.

In the next step, PHC transports the harvested mangoes to the wholesale markets (APMCs) in big cities or consumption centres. These markets or *mandis* where commission agents are registered with APMCs buy the mango consignment from PHC. The commission agent also provides facilities for sorting and grading and overseeing of auctions. Lastly, retailers—small vendors or neighbourhood retailers sell the fruits to consumers after buying from the commission agents. Although small vendor and neighbourhood markets are still the main outlet for fruits and vegetables, there are several organized retailers or supermarkets which are expanding their base.

Mangoes going for exports do not follow this value chain. The exporters registered with APEDA purchase from the farmers and export after following requisite phyto-sanitary norms. The APMC *mandis* and PHCs are not involved as exporters directly purchase the mangoes from the farmers to ensure the quality standard.

Efficiency of Mango Value Chain

For studying the efficiency of the domestic value chain, we have considered Malihabad, Lucknow district, as key mango producing region and Delhi as a major consumption region. Uttar Pradesh is the country's biggest mango producer, and Lucknow is a key mango-growing region. We have taken the prices of 'Dasheri' variety of mango as it is the most popular variety consumed in the domestic market. The wholesale price of 'Dasheri' mango variety for Lucknow is sourced from Agmarknet, while the retail prices of Delhi are taken from National Horticulture Board. All the prices are taken for the peak mango season (April–June) for TE 2017–18. For arriving at mark-ups for all the stakeholders in the value chain, *mandi* fee and official commission charges have been taken from Malihabad as well as Azadpur *mandis*. Other expenses such as packing and loading charges, cost of transportation, wholesalers and retail margins are based on our interactions with *mandi* officials, traders as well as retailers in Uttar Pradesh and Delhi.

It clearly indicates that India's domestic mango value chain is inefficient as only about 20% of the consumer rupee spend on mangoes goes back to farmers (Fig. 4.20). The multiple retail channels including wholesalers as well as small vendors get a major share of consumer rupee. Mango being highly perishable, retailers take the risk of high wastage in the absence of adequate storage infrastructure.

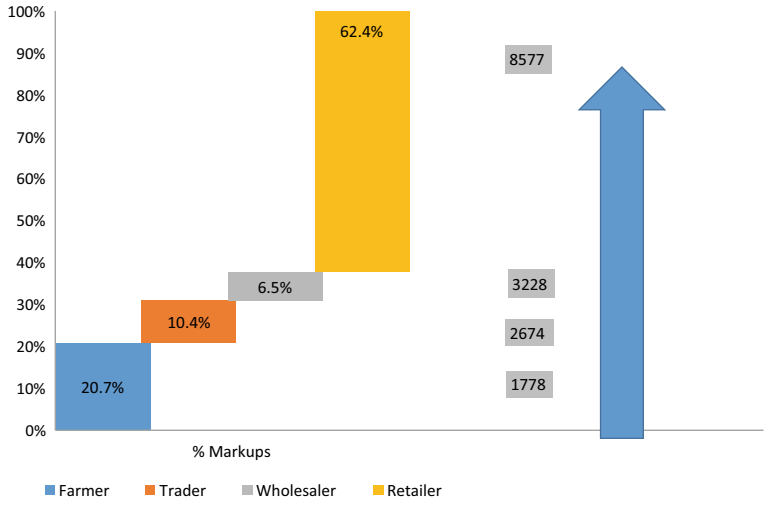

Fig. 4.20 Markups for mango value chain. *Source* Authors' calculations

4.4 Inclusiveness

This section examines the extent of small farmers' participation in the banana and mango value chain. The inclusiveness is measured in terms of farmers' participation in the production and marketing process.

4.4.1 Inclusiveness in Production

India is predominantly a smallholder economy as 86.1% of its farmers are small and marginal, operating on less than 2 hectares of land, according to the latest Agriculture Census Report 2015–16. While they hold just 46.9% of the total operated area in India, large farmers with just 0.6% share hold 9.1% of the land.

Horticulture production is mainly driven by small and marginal farmers, because of the short duration of the crop, high labour intensive operations, and higher profitability. According to Agriculture Census of 2015–16, a major share of farmers growing banana and mango in the country are 'small and marginal'. This implies that out of close to 20.4 lakhs banana growers and around 58 lakhs mango farmers, 86.2% and 93.5%, respectively, belong to 'small and marginal' category (Tables 4.3 and 4.4).

In Andhra Pradesh, which is the largest banana-producing state, 86.8% banana farmers are small and marginal and only 0.2% of them are large farmers. Maharashtra on the other hand, has 69.2% small and marginal farmers and another 21.4% semi-medium. Even the largest banana (Jalgaon) and mango (Chittoor)-growing districts

Table 4.3 Share of different farm sizes for banana

	Small and marginal	Semi-medium	Medium	Large	All classes
India	86.2	9.3	4.0	0.5	100
Tamil Nadu	87.2	9.1	3.3	0.4	100
Andhra Pradesh	86.8	10.0	3.0	0.2	100
Maharashtra	69.2	21.4	8.6	0.8	100
Jalgaon	69.4	22.0	7.8	0.3	100

Source: DoAC&FW (2020) Agricultural Census, 2015–16

Table 4.4 Share of different farm sizes for Mango

	Small and marginal	Semi-medium	Medium	Large	All classes
India	93.5	4.4	1.8	0.2	100
Uttar Pradesh	88.4	8.3	3.3	0.1	100
Andhra Pradesh	80.2	14.2	5.0	0.5	100
Maharashtra	68.9	18.0	10.9	2.2	100
Chittoor	78.6	16.2	4.8	0.4	100

Source DoAC&FW (2020) Agricultural Census, 2015–16

in the country have majority of farmers belonging to small and marginal category. This indicates that banana and mango cultivation is inclusive in nature.

While banana crop provides income throughout the year, mango is a seasonal crop with April–July as the peak season. Farmers continue to grow perishable fruits like banana and mango despite fluctuations in prices. Interaction with farmers as well as experts indicated, that small farmers still opt for horticultural crops as returns are far more than growing cereals. Increase in incomes, urbanization and rising consumption of fruits and vegetables have contributed to sustained demand for fruits and vegetables.

4.4.2 Inclusiveness in Marketing

Smallholders have inadequate farming and extension services and low level of technology adoption, and they lack capital and have poor business skills resulting in lower income. However, forming of farmer collectives like FPOs can be a good deal for small and marginal farmers. Not only cost of production can be reduced due to bulk procurement of necessary inputs, but also marketing cost can be reduced due to bulk transportation to markets. (NABARD 2017). NABARD supported creation of around 4000 FPOs across the country at the end of FY'18 of which over 2000 are registered entities actively doing business in agricultural activities. As many as 507 FPOs are engaged in bulk input procurement and distribution, while 223 FPOs are involved

in aggregation and marketing of fruits and vegetables (NABARD press note, July 2018) NABARD provides grant support to existing FPOs towards capacity building, market linkages, etc., along with the credit support of business development. The central government also plans to create 10,000 FPOs by 2024.

Status of FPOs

According to NABARD, FPOs are farmers' collectives, with membership mainly comprising small or marginal farmers (around 70–80%). Majority of these FPOs are in the nascent stage of their operations with shareholder membership ranging from 100 to over 1000 farmers and require not only technical handholding support but also adequate capital and infrastructure facilities including market linkages for sustaining their business operations.

The Small Farmers' Agribusiness Consortium (SFAC), under MoAC&FW, also promotes formation of FPOs for ensuring that smallholders have stake in marketing of their produce. Out of the total 897 FPOs supported by SFAC, only 38 are related to banana and mango. These FPOs are located mostly in Karnataka, Tamil Nadu, Uttar Pradesh, West Bengal and Madhya Pradesh.[1]

During our field visits in Jalgaon, Maharashtra, we interacted with a number of FPOs who are engaged in marketing of banana and other agricultural produce. Out of total 41 FPOs in Jalgaon district as per records, only 14 FPOs were operational and only few of them were functioning with business plans. We identified three kinds of FPOs, *visionary FPOs,* which work like a proper company with a business plan in mind and not dependent on government subsidies and provide good-quality planting and fertigation to member farmers, ensuring quality produce; *non-visionary FPOs* which were established through Government of India or World Bank funds, facilities like ripening chambers with help of ATMA scheme, MIDH schemes and shares of member farmers. Then, there are *dysfunctional FPOs* most of which were established to avail government subsidies and are not functional any more.

For ensuring that smallholders have control over the marketing channels, agencies such as NABARD, SFAC and state governments must play a pro-active role in promoting FPOs and strengthening the dysfunctional FPOs. There is a huge opportunity for creation of FPOs dedicated to banana and mango plantation and the focus should be on imparting marketing skill so that FPOs are run professionally.

Currently, traders buy bananas directly from the farms. The bananas are sorted, weighed, washed, packed in cardboard boxes (16 kg) and loaded on trucks at the farm itself. Our interactions with agents who buy banana at the farm gate in Jalgaon as well as traders in Azadpur *mandi* in Delhi reveal that farmers' role in marketing ends once the produce (in this case banana and mango) is sold at the farm gates. This deprives the farmers in playing active role in price discovery.

In case of mangoes, there have been some attempts to create an electronic platform in Lucknow. The E-network platform, an online marketplace which connects consumer with farmer, removing middlemen, reducing farm-to-table time and most

[1] http://www.sfacindia.com.

importantly, ensuring fresh produce reaches consumers (http://mangifera.res.in/e_market.php). However, our research reveals that such marketing networks have been limited in their outreach so far. In case of mango trade, the pre-harvest contractor (PHC) continues to play critical role in marketing thus limiting farmers' direct interface with the markets.

Exporters of mangoes and bananas enter into buy back agreement prior to the harvesting season. However because of phyto-sanitary norms insisted by many importing countries, the exporters also provide agricultural inputs and advisory for ensuring quality produce. With majority of banana and mango growers being small and marginal, there is a minimal or often no post-harvest management infrastructure available at farm level. Small farmers find it expensive to access any post-harvest infrastructure facility, leading to high wastage and deterioration of quality, ultimately resulting in lower price yields. This necessitates expanding the role of farmer co-operatives or FPOs to create post-harvest infrastructure directly accessible to the farmers.

Producers Organizations Promoting Institutions (POPI)

NABARD has been encouraging formation of Farmer Producer Organizations promoted by Producers Organizations Promoting Institutions (POPI). Any legal entity such as an NGO, bank, government department, co-operative society, association or federation can become POPI. A POPI has to ensure that requisite technical and managerial capabilities are transferred to members of the FPOs so that they are able to work with an independent and sustainable business model.

Financial support is available to POPIs through SFAC and NABARD. NABARD provides financial support to the FPOs through Producers Organisation Development Fund based on project cost with a ceiling of 20% grant (NABKISAN).

4.4.3 Promotion of Small Scale Industries

A large number of value-added products can be manufactured from banana fruit, pseudostem and other waste products from banana cultivation in small-scale cottage industries. Setting up of these industries helps small farmers to get additional return for the waste or by products of banana tree. This also provides significant employment opportunities for landless agricultural labourers. The government must provide thrust on extending credit for setting up of these industries. Jalgaon has a large number of small units of banana chips, but the chips are not of a good quality. The traditional frying pans should be replaced with oil sprays like the ones used at big wafer making companies. Quality standardization with branding can help farmers and processors earn higher prices. Loans should be made available for machinery infrastructure and marketing of value added products.

4.5 Sustainability

In this section, we evaluate the financial and environmental sustainability of banana and mango value chain models.

4.5.1 Financial Sustainability

Financial sustainability is achieved when the net returns from a particular business is larger than the net costs. Similarly, farmers will be financially sustainable if the prices they receive for their produce are higher than the costs incurred, and they are compensated for the fixed as well as variable costs.

Financial Sustainability of Banana Value Chain
Banana being a cash crop because of its high value has been a lucrative option for farmers. This is especially true for Jalgaon, which is a hub for banana production because of the climate and geographical location. With advancement in technology, especially tissue culture and precision farming, banana farmers have been able to increase the yield levels significantly. While the national average of banana yield is 35 tn/ha, Jalgaon farmers grow 80 tonnes of bananas in one hectare. The presence of Jain Irrigation Systems Limited (JISL), which pioneered banana tissue culture in India along with their drip irrigation technology proved to be a boon for banana farmers of Jalgaon.

Tissue culture technology has helped reduce the planting to harvesting period from about 18 months to (9.5–11) months as the roots get developed in the laboratory and sent for primary and secondary hardening in nurseries in a controlled environment (greenhouses). Over time, as JISL tissue culture plants started spreading to other parts of the country, and with better road connectivity, Jalgaon's monopoly started diminishing. Jalgaon is now facing a stiff competition from other major banana-producing regions.

In order to be competitive, there have been several changes in the way bananas are cultivated and traded. Banana cultivation is done under high density with 6ft x 5ft spacing between each plant on a raised bed. Raising the bed helps in better utilization of water, fertilizer and helps in draining excess water. Mulching helps in avoiding excess water reaching the roots, especially during rainy season. Farmer receive 50% subsidy for drip irrigation technologies as well as rotavators. To make things more mechanized, there are mobile apps for controlling the timing of drip. A sapling of tissue culture banana is sold for INR 14, of which INR 4 needs to be paid at the time of purchase, and the rest INR 10 is paid after planting.

Unlike vegetables, especially tomatoes, onions and potatoes (TOP), where price stability has been a major concern and farmers are forced to throw their produce on roads, banana farmers have not faced such a situation.

Benefit–cost ratio has been evaluated for banana farmers in Jalgaon. For this, cost of cultivation data for Grand Nain variety was used from a study done by Banana

Table 4.5 Cost and returns for Jalgaon banana farmers (TE 2018–19)

S. No	Item	Cost/Price
1	Cost of production of grand nain (INR/ha)	262,532
2	Yield of grand nain at Jalgaon (q/ha)	800
3	Cost of production (INR/q)	328
4	Overhead Cost (INR/q)	100
5	Total Cost incurred by the farmer (1 + 2) (INR/q)	428
6	Price received by farmer (INR./q)	682
7	Returns earned by the farmer (INR/q)	254
8	Benefit–cost ratio (B:C Ratio)	1.6

Source Shaikh et al. (2016), Agmarknet, Field Visit

Research Centre at Jalgaon, which is INR 2,62,531 per hectare. Now using yield level of 80 tn/ha for Grand Nain variety in Jalgaon and average price data for TE 2018–19 for peak harvesting months from Agmarknet, we calculate the net returns of farmers. Farmers on an average earned about INR 254 per quintal. The benefit–cost ratio comes out to 1.6, indicating banana cultivation is profitable (Table 4.5).

Financial Sustainability of Mango Value Chain

In this section, we calculate the cost of the cultivation of mango to assess the financial sustainability of the value chain.

Usually, farmers take up planting of orchards after early monsoon rains in late June or early July, as trees planted during this season sustain well with higher survival rates. On an average, around 100 trees are accommodated in a hectare, using traditional spacing practice. Mango tree starts giving fruit from 5th year onwards. Following our interaction with mango growers in Maharashtra and officers at Indian Institute of Horticultural Research (IIHR), affiliated to Indian Council for Agricultural Research (ICAR), we calculated the cost of production and return accrued to farmers.

Table 4.6 clearly indicates that if mango orchard is well maintained and the grower undertakes self-marketing, mango cultivation is highly economical and viable. The study by IIHR states that on an average, commercial cultivation of mango yields an annual return of 2.38 on investments in orchards (Sudha Mysore 2016). The cost of cultivation has been estimated for orchard growing Totapuri variety of mango, which is widely used in the processing industry.

As the mango trees start giving fruits after five years of plantation, the farmers incur various costs including physical establishment of orchard, planting of sapling, land preparation, manure application, farm yard manure, inter-cropping operations, etc., for four years. For inter-cropping purposes, farmers take up leguminous crops like gram, cereals like wheat or oilseeds like mustard or sesame or groundnut, etc.

Kesar is a premium variety of mango whose demand has been rising globally as well as in the domestic market. Table 4.7 indicates that commercial cultivation of Kesar fetched 2.25 returns on investment, thus making it a highly profitable proposition. The estimates were arrived at after extensive interactions with farmers and

Table 4.6 Average annual returns on mango orchard (INR/ha), Karnataka

Cultivation cost	Value (INR/ha)	Per cent of total cost
Material inputs: farm yard manure, fertilizer, pesticides	15,325	39.02
Labour	6240	15.89
Total operating cost	21,565	54.37
10% interest on working capital	2156	5.43
Total cultivation cost	23,721	59.80
Marketing cost: transportation (avg. distance of 100 km) and commission at INR 0.3/kg	6580	16.59
Rent on land	8000	20.17
Establishment cost	1361	3.43
Total cost of production	39,662	100
Average yield	12,600	
Average price (INR/kg)[a]	7.5	
Gross returns (INR)	94,500	
Net return (INR)	54,838	
Cost-benefit ratio	2.38	

[a]Totapuri variety, orchard age is in the range of 10–12 years. Orchard is self-maintained and marketed
Source Authors' calculation using data from field visit and (Sudha Mysore 2016)

Table 4.7 Cost of cultivation and returns for Maharashtra mango (Kesar) farmers INR/quintal

Item	Cost/Price (INR/q)
Cost of production	3630
Overhead cost	1250
Total cost	4880
Price received by farmer	11,000
Returns earned by the farmer	6120
Benefit cost ratio (B:C Ratio)	2.25

Source Based on interaction with farmers from Jalna district, Maharashtra and district agriculture officials, all data are from 2018 when farmers got around INR 110 per kg for Kesar mango

officials of the agriculture department in Jalna, Maharashtra. However, mango cultivation is seasonal activity as India's peak mango season is during April–June. Thus, the farmers need to have robust inter-cropping system for ensuring sustained income from agriculture.

4.5.2 Environmental Sustainability

Water Usage

Banana is a water-loving crop and needs timely irrigation, almost 70 to 75 times with per annum water intake estimated to be 1800–2000 mm. Irrigation has to be provided every 7 to 8 days during winter, every 4–5 days during summer and as required during the rainy season (NHB). As banana crops have shallow roots, they cannot hold water. Hence, in addition to irrigation, banana crops also need a proper drainage system. If banana is cultivated using drip irrigation technology, it will not only increase productivity by about 52%, but will also save up to 45% water (NHB, 2017). An efficient irrigation system along with sustainable use of fertilizers enables fertigation technique to be used.

Almost entire Jalgaon region is under drip irrigation for banana cultivation. JISL-developed drip irrigation and sprinklers are greatly benefitting banana plants, especially tissue-cultured plants. Jalgaon itself is not a drought prone area as it has many small and major rivers like Tapi. There is also no report of any water table depletion in the area.

For efficient use of water, drip irrigation is a must. If done on a raised bed, it will further help in draining out the excess water and in better utilization of fertilizers.

In case of mango, which can be grown under various climatic conditions, the fruit is well adapted to tropical and subtropical climate. The mango plantation needs adequate quantity of rain during their growth period (June to October) and a dry spell during the flowering period (November). Mango grows well in the region when there is rainfall of 750–2500 mm during June to September followed by eight months of dry season. In zones receiving less than 750 mm per year, the orchards must be irrigated (UNCTAD 2016). In India, majority of mango plantation is rain fed with conventional spacing of 10 m × 10 m (Gunjate 2006). However, High Density Planting (HDP) is being adopted for new plantings with use of drip irrigation. HDP is a method of mango cultivation which involves planting of tree densely, allowing small or dwarf trees with modified canopy for better light interception and distribution and ease of mechanized field operations. HDP gives higher yield as well as better financial returns.

Under conventional irrigation systems, weekly irrigation is essential (Table 4.8). With micro irrigation, the requirement is restricted to one-third of the water required for conventional method. Fertigation (application of fertilizers with drip irrigation)

Table 4.8 Irrigation requirement for mango plant

Age of the plant (in years)	Irrigation
1	Interval of 2–3 days during dry season
2–5	Interval of 4–5 days
5–8/Fruit set to maturity	Every 10–15 days
Full bearing stage	2–3 irrigations after fruiting

Source NHB

in mango is being promoted to get higher nutrient and irrigation use efficiency. The number of irrigation varies according to soil, age of mango tree and climatic factors such as rainfall and its distribution. During monsoon months, no irrigation is needed.

Mango plants are irrigated using basin irrigation. Use of drip technology, however, reduces considerable water and also helps in fertigation of root zones of the plants.

Fertilizers and Pesticides Usage

Few decades back, banana was the only fruit which did not require any pesticide. Banana is still one of the safest fruits for consumption. However, according to Banana Link, since Cavendish is the single most traded variety in the world, it has become prone to pests, fungi and diseases. Due to this, large quantities of insecticides and pesticides have to be sprayed on the plants. Given that Cavendish bananas are thick-skinned, higher number of sprays are required. There is a great danger when the pests and disease become resistant to chemicals requiring stronger and more harmful pesticides.

High dosage of fertilizers and pesticides has adverse impact on the environment affecting the soil, water, animals and human all at the same time. Farmers should avoid using banned pesticides and only use permitted pesticides that too in a time-bound manner and as per the dosage recommended. Pesticides are usually applied a month after harvesting is done.

Mango, since last many decades has been grown as a crop with least management efforts and without inputs like irrigation, fertigation, etc., resulting in low productivity. As it is a seasonal fruit, farmers' focus has been other crops like pulses and oilseeds. There are several insects which also impact the mango plants such as shoot borer, stem borer, stone weevil, leaf webber, etc. As stated earlier, because of inter-cropping system, mango trees are not hugely impacted by pest attack. Farmers in Maharashtra use fungicides (only twice in a season) prior to fruit bearing stage, if required.

Organic Waste Management for Banana Pseudostem

There is a very high potential for converting waste material of bananapseudo stem into value-added products. The amount of waste produced by banana cultivation is very high compared to other fruit crops, as the stems of banana plant have to be removed before next or alternate year planting. Approximately, 70–80 MT per hectare of waste is generated from this stem removal. Farmers usually throw away these wastes and burn them when dry. This not only pollutes the environment, but also poses additional costs to the farmers without any gain.

If these pseudostems are converted to value-added products, it is not only economically beneficial for the farmer, but also benefits the economy as a whole. A pseudostem has three parts: central core, fibre and waste (Fig. 4.21). Various edible items like candies, pickles, vegetables, soft drinks can be produced from the central core. The juice from the central core is rich in Vitamin A and Vitamin B6. Waste part

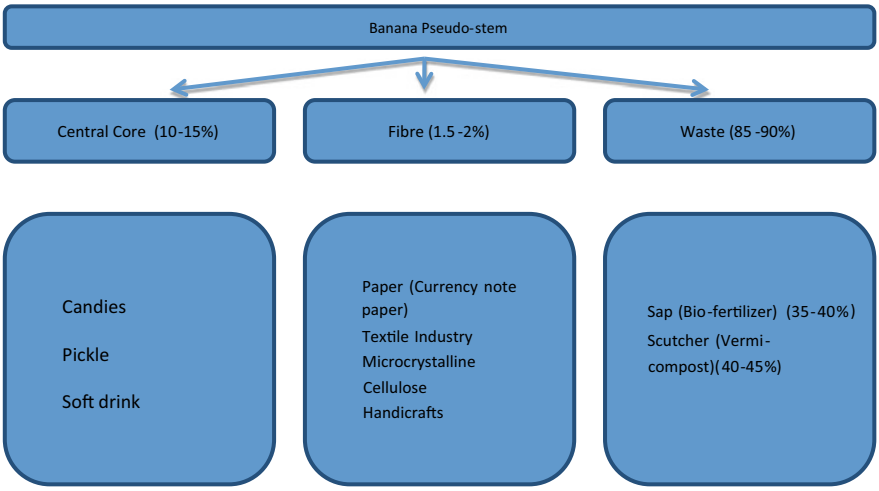

Fig. 4.21 List of value-added products from banana pseudo stem. *Source* Field visit to Tapti Valley Banana Co-operative Society and (RKVY)

which is about 85–90% of the pseudostem can be converted to useful fertilizers and manures. While bio-fertilizers can be prepared from the liquid sap that is extracted from the waste, vermi-compost can be prepared using scutcher. The most important by-product of this waste is fibre which can be used for making paper currency, textile and handicrafts. In fact, textile industry can benefit to a great extent from banana fibre as unlike other natural fibres these are prepared from a complete waste product and can substitute highly water intensive cotton. This way, each and every part of the pseudostem is well utilized.

4.6 Scalability

There has been a tremendous increase in production of horticulture crops in India including fruits. Driven by increase in incomes, a large middle-class population and greater availability of different varieties, fruits demand has risen in India. Responding to this increase in demand, India's fruits production has increased from 29 MMT in 1991–92 to 97 MMT in 2018–19, more than three times. Out of this, banana and mango together accounts for 50% of the total production. In this section, we will evaluate the scalability of banana and mango value chains.

4.6.1 Scalability in Area and Production

Area and Production of Bananas

India is the world leader in the production of bananas. India's banana production quadrupled from 10 MMT during TE 1993–94 to more than 30.6 MMT during TE 2018–19 (Fig. 4.22). Even though the overall increase is positive, there have been instances when the production declined due to decrease in area cultivated. For example, banana production declined in 2000–01, then again in 2011–12 and the following years. As farmers are free to choose what they want to cultivate, they tend to decrease their acreage due to many external factors, like previous year's profit or, peer farmers' cropping decisions, etc. There is no real-time acreage data available which can predict supply in the following season, which could have helped farmers take better farming decisions.

As bananas have proved to be a profitable crop for farmers over the years, they have shown keen interest in newer technologies that have a positive effect on banana yield. There appears to be a structural break in the production of bananas in 2003–04, after which the trajectory of production increase changed its course. Introduction of tissue culture cultivars especially Grand Nain variety of Cavendish bananas resulted in the increase in production. Grand Nain is an Israeli variety, introduced by Jain Irrigation (JISL). They developed a Hi-tech model for banana cultivation with proper pre- and post-harvest management for export variety of bananas. They used poly-house instead of shade net for nursery raising with mulching to protect the roots. This resulted in disease free saplings, as there is no scope of disease in a controlled environment of a nursery. The model took years to be developed and was ready for adoption in early 2000s. According to our interactions with JISL scientists, banana yields in India increased from 35 tn/ha in 1994 to almost 110 tn/ha in 2017–18, for hi-tech model in Jalgaon, and for normal model, it is 70 tn/ha. Price also increased

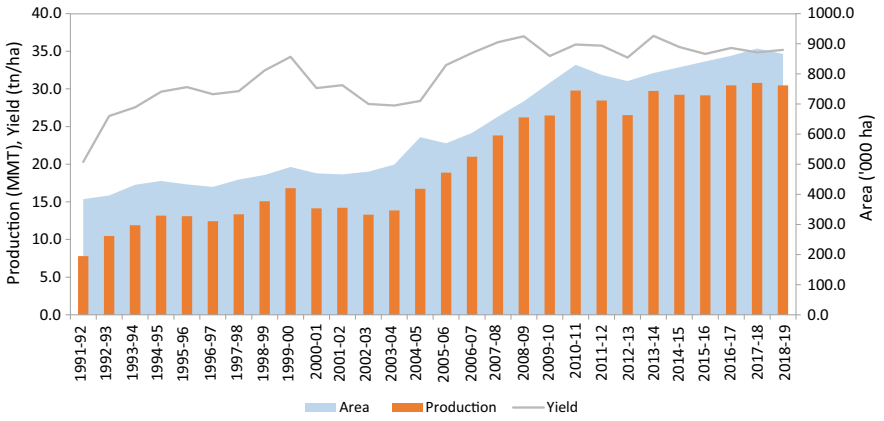

Fig. 4.22 Banana area, production and yield—All India. *Source* DoAC&FW, NHB

during this time; twice for normal variety and 4 times for hi-tech variety. Hence, there has been prosperity among banana growers in Jalgaon during these two decades.

Other reasons that triggered this quantum jump in banana production were adoption of drip irrigation technology, precision farming and high density planting. Precision farming ensures maximum output with minimum resource use, and this technology has been used for banana cultivation in many parts of the country. It was adopted by farmers in Theni district of Tamil Nadu way back in 2007–08, where (80–85)% of the area is covered under Grand Nain variety (Balaganesh et al. 2016).

It is clear from Table 4.9 that most of the growth in production (5.1%) was due to area growth (2.9%). However, growth in yield (2.1%) was also significant. Banana acreage increased substantially in Kerala, while it declined in Tamil Nadu from 17% in TE 2008–09 to 10% in TE 2018–19 and in Maharashtra from 12% to 9% during the same period. In one decade, the shares of different states in banana production also changed. For example, Andhra Pradesh became the largest producer of bananas from 11% during TE 2008–09 to 16% during TE 2018–19, even though during TE 2018–19 Andhra Pradesh lost Telangana share. It is interesting to note that around 46% of bananas in India were produced in Tamil Nadu and Maharashtra, which has now declined to half, i.e. 23% (Fig. 4.23). This change in cropping pattern is due to expansion of banana production in newer regions and decline in the dominance of Tamil Nadu and Maharashtra.

Table 4.9 Compound annual growth rates for area, production and yield of bananas in India

Variable	Banana CAGR (%)						
	1960s	1970s	1980s	1990s	2000s	2010s	All
Area	2.4	3.5	3.9	2.3	6.7	1.8	2.9
Yield	0.3	1.3	2.2	3.8	3.1	−0.4	2.1
Prod	2.7	4.8	6.2	6.2	10.1	1.4	5.1

Source Authors' calculation using data from D/o A&FW and FAOSTAT

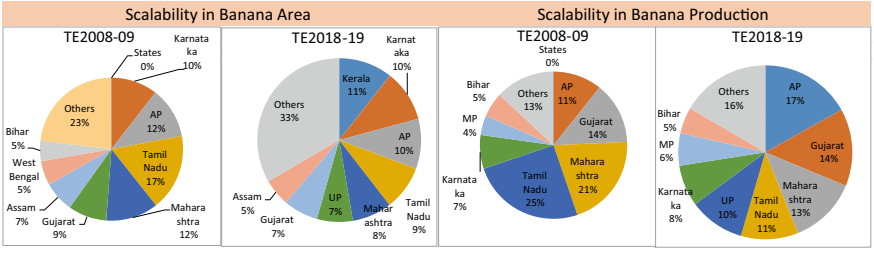

Fig. 4.23 Scalability in area and production of bananas in India. *Source* Authors' calculation using data from D/o A&FW

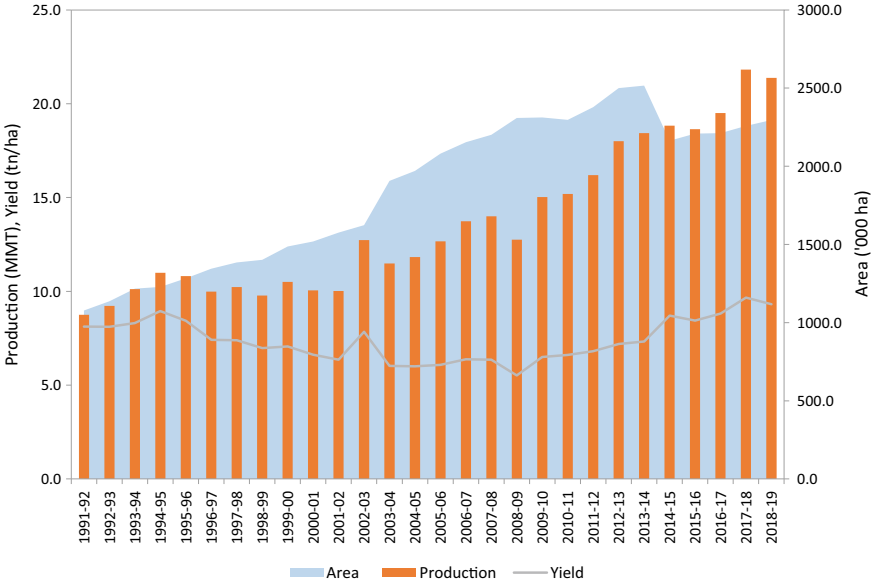

Fig. 4.24 Mango area, production and yield—All India. *Source* DoAC&FW, NHB

Area and Production of Mangoes

Figure 4.24 indicates that the increase in mango productivity since 1990s has been rather slow. Mango production has increased from 9.4 MMT in TE 1993–94 to 20.9 MMT in TE 2018–19, at an annual average growth rate of 3.6%. The area under mango cultivation increased from 1.1 million hectares to 2.3 million hectares during the same period, at an annual average growth rate of 3%. The increase in productivity has been rather slow. There has been not much change in the production pattern in the key producing states.

According to a statement in Lok Sabha, MoAC&FW stated that Indian Council of Agricultural Research (ICAR) institutes like Central Institute for Subtropical Horticulture (CISH), Lucknow and Indian Institute of Horticultural Research (IIHR), Bengaluru, are engaged in development of new technologies and varieties which has resulted in innovative mango cultivation like High Density Plantation (HDP). For enhancing productivity and cost effectiveness of mango cultivation, technologies for canopy management and cultivation of climate tolerance varieties are being promoted under Mission for Integrated Development of Horticulture (MIDH) and Rashtriya Krishi Vikas Yojana (RKVY) (Lok Sabha Questions 2019).

On the new varietal development front, there has not been major breakthrough in the decade starting 2010. The last mango variety developed by CISH was Arunika back in 2008. Without varietal developmental, scalability of mango value chain remains an area of concern. There is a need for development of long shelf life mango varieties without compromising on the taste or flavour. Due to short shelf life of mango, exports are not often viable.

Table 4.10 Funds allocated to states under MIDH (INR/crore)

Funds allocated to states under MIDH (INR/crore)			
2015–16	2016–17	2017–18	2018–19
1379	1238	1397	1846

Source Lok Sabha, 12 February, 2019

During our interaction with farmers and exporters, it was learnt that lack of standardization of production technology and poor extension of technical knowledge to the farmers resulted in slow adoption of HDP technology in mango plantation in the country. High initial establishment cost has been a deterrent for technology adoption (Table 4.10).

Another key concern regarding mango value chain is that there is hardly any advance production information available, like cereal crops. This puts farmers at the mercy of traders for determining the prices, which has gone against scaling up mango trade in the country. In 2019, IIHR-Bengaluru and Indian Space Research Organisation (ISRO) had commenced work on a pilot project to provide mango production advisory to the Karnataka government. Such advisory services need to be expanded to other key mango-producing states. ISRO advisory can give information ranging from flowering of the crop to the estimated crop size during the season concerned. This would equip the state government in estimating the crop size, and hence provide advance information about prices to the farmers.

Role of ICAR Institutions

Indian Council for Agricultural Research (ICAR) affiliated institutions such as National Research Centre for Banana (NRCB), Trichy, and Central Institute of Subtropical Horticulture (CISH), Lucknow, have made contribution towards varietal development of bananas and mangoes, respectively, over the last decades.

The ICAR-National Research Centre for Banana has significantly contributed towards banana research and development. The centre has developed many new technologies related to production, protection and post-harvest management and value addition in banana. ICAR-NRCB has disseminated its new technologies to the farmers and entrepreneurs, which have been adopted widely by the farming community (NRCB 2015). The centre is one of Asia's largest genebanks with 361 indigenous accessions. The centre has released three high-yielding varieties, namely—Udhayam, Saba and Bangrier, which are known for leaf spot resistance, tolerant to drought and salt stress and short duration, respectively.

The centre has been instrumental in developing high density planting with fertigation, organic cultivation of banana, pre- and post-harvest management techniques and development of various value-added products like juices, figs, bars, jams. Some of the popular banana varieties developed by NRCB includes Namwa Khom, Popoulou, Manoranjitham selection with high yield and a fragrant variant.

Similarly, CISH has developed the High Density Planting (HDP) for improving mango productivity as well as higher economic returns per unit area. This has ensured

maximum utilization of land, water, nutrients and solar energy. The conventional mango plantation was in area of 10 m × 10 m (around 100 trees per hectare), while HDP can accommodate 400 trees per hectare (5 m × 5 m). With the integration of fertigation technology, productivity level as high as 14–15 tonnes could be achieved as against 7–8 tonne under conventional system (CISH).

According to CISH, 40% of mango orchards in northern India are more than 40 years old, over-crowded, reduced productivity and hence turning out to be less remunerative (CISH 2013). It has also noted inadequate supply of genuine and quality planting materials and lack of improved package of practices of mango cultivation being adopted by orchardists. Hence, its production, productivity and fruit quality have remained low. The CISH perspective plan suggested medium–high density planting system to be adopted extensively in view of the shrinking land resources in the country. It also suggested that cool chains need to be made more popular amongst the mango growers. Precision Farming Development Centre of the institute is in the forefront of developing and popularizing micro irrigation modules in different crops.

4.6.2 Scalability in Exports

Bananas have higher production tonnage than all fruits and vegetables (except potatoes). Yet India manages to export just 0.4% of total bananas produced, although it exports a substantial amount of mangoes, grapes and onions. Analysis of NPCs computed in this study reveals how India has been export competitive in bananas. Hence, even though exports share in production is very meagre; there is a potential to increase banana exports further from India, as validated by NPC numbers and also the increasing exports to production shares (Fig. 4.25). Share of export to production increased considerably after 2007–08, and then again after 2013–14.

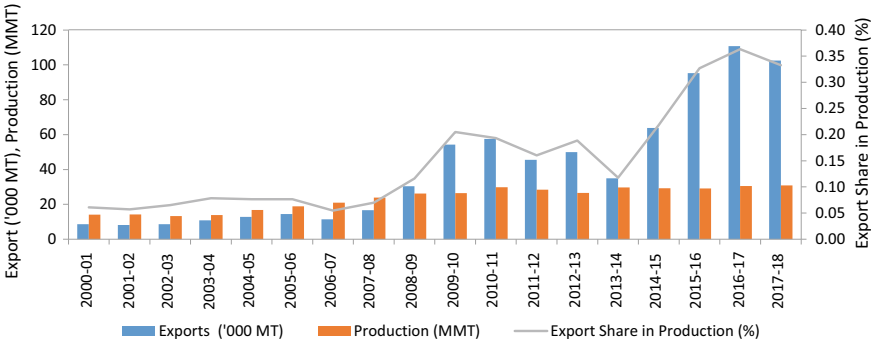

Fig. 4.25 Banana exports as share of production. *Source* DGFT, D/oA&FW

Table 4.11 Mango exports from Maharashtra

Volume in MT. (Value in INR crores in parenthesis)			
	2015–16	2016–17	2017–18
Maharashtra	24,243 (INR 259 cr)	37,180 (INR 368 cr)	33,347 (INR 281 cr)
India	36,329 (INR 317 cr)	53,177 (INR 446 cr)	46,147 (INR 344 cr)

Source Maharashtra Economic Survey 2017–18

Department of Commerce prepared an **Agriculture Export Policy (AEP)**[2] and noted that bananas have very high potential for export from India along with several other agricultural commodities. The policy document identified 50 export clusters which are unique product-specific districts that will be promoted for agri exports. For bananas, 2 western states and 3 southern states have been chosen. In Maharashtra, the clusters are Jalgaon, Kolhapur and Sholapur, and in Gujarat, Bharuch, Narmada and Surat. In Kerala, Andhra Pradesh and Tamil Nadu, important banana growing regions have been included. Uttar Pradesh, one of the major suppliers to Delhi and the fifth largest banana-producing state, has been completely left out. For mangoes, AEP has identified 15 districts of Maharashtra (2), Gujarat (4), UP (3), Telangana (3), AP (3) as clusters for mango exports. Maharashtra which has a major share in mango exports has also identified several districts including Aurangabad and Jalna to be developed as export hubs.

Banana value chain does not face any production or price related issues, but face issues related to post-harvest management and export. There is a need to scale up exports as well as processing capacities for banana.

For mango, Maharashtra has taken active role in promoting exports in collaboration with APEDA through Maharashtra State Agricultural Marketing Board. Measures have been taken in promoting exports of Alphonso, Kesar and other varieties of mangoes. Other key mango growing states such as Uttar Pradesh, Andhra Pradesh, Telangana and others must give thrust on promoting mango exports. This would scale up the mango trade in the country (Table 4.11).

4.7 Access to Finance

Key to any successful value chain model is the availability of timely and affordable credit. Typically, small farmers engaged in cultivation of bananas and mangoes find it difficult to access affordable formal credit facilities. In this section, we have studied the existing financing mechanism for key stakeholders—farmers, exporters, and retailers in the mango and banana value chains. Through field visits, interactions with stakeholders and available data in the public domain, this section examines the key financing channels available in the existing value chains and possible areas of intervention to strengthen access to finance.

[2] http://commerce.gov.in/writereaddata/uploadedfile/MOC_636802088572767848_AGRI_EXPORT_POLICY.pdf.

4.7.1 Financing Mechanism for Farmers

The following institutional sources for credit are available for farmers:

- District cooperative banks finance several *Kisan* societies which further finance farmers. In Jalgaon, Jalgaon District Cooperative Society (JDCC) provides credit facilities.
- Central Banks mainly through *Kisan* Credit Cards provide loans to farmers at 7% interest per annum. If the premiums are paid on time, 3% is credited back to farmers in about two years.
- Some successful Farmer Producer Organisation (FPOs) also provide loans to farmers at about 12% per annum. However, a very small number of FPOs are actually helping farmers to avail credit as most of the FPOs are either in dysfunctional state or operating at the mercy of government subsidies.

Among institutional sources, farmers have access to crop loans mainly through Kisan Credit Cards (KCCs) availed through district cooperatives societies, provided there is no default on repayment of loans. While large mango farmers who constitute a small group, have access to credit from the banks, most of the small and marginal farmers depend on self-financing mode for carrying out mango plantation. Most of the small farmers who grow mango as well as banana also grow several other crops. Mango farmers need credit only for few months of a year.

Non-institutional Sources

Despite the presence of banking facilities, small and marginal farmers are heavily dependent on non-institutional sources. This is because either the farmers are defaulters, who have not paid back previously borrowed money from banks or they simply do not want to go through the cumbersome paper work and land ownership certificates that have to be submitted. Besides, the processing time taken by banks for granting loans to farmers are high and farmers prefer known commission agents, *sahukars*, friends or relatives who provide instant credit. However, the interest charged by these entities is as high as (2–2.5)% per month and can go up to even 5%.

4.7.2 Government Schemes for Horticulture Sector Development, and Processing

The public sector banks provide loans for development of fruit orchards like mango, chikoo, grapes, pomegranate, apple, etc., as well as short-term crops like banana, pineapple, flower in open and greenhouses and vegetable crops. However, the credit is available to those farmers who have cultivable lands, thus leaving out those farmers who carry out tenancy farming without any land holdings (Table 4.12).

The loan repayment starts after the completion of the gestation period varying from 4 to 7 years for different crops. Repayment commences from the time the crop gives economic yield and is linked to the income generation of each crop every year and varies between 7 and 12 years.

Table 4.12 Loans for farmers

Loan amount	Loan available	Hypothecation
Up to INR 1 Lakh	100% of the cost of the project	Hypothecation of asset created
Above INR 1 Lakh	75–80% of the cost of the project	Hypothecation of asset along with mortgage of land

Besides this, Government of India's SAMAPDA (Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters) Yojana provides subsidy for setting up of food processing industry and has boosted the food processing sector. Renamed as Pradhan Mantri Kisan SAMPADA Yojana,[3] with an allocation of INR 60 billion for 2016 to 2020, the scheme provides subsidy of 35% of the project cost up to INR 5 crores for setting up of food processing units. This scheme will not only help in setting up of food processing units but will also include food parks, integrated cold chains, creation of backward and forward linkages, food safety and quality and other infrastructures. (MoFPI 2018).

Government of Maharashtra tied up with World Bank for $300 million project, known as Maharashtra's Agri-business and Rural Transformation Program (SMART) Project (World Bank 2018). The project aimed to develop inclusive and competitive agriculture value chains, focusing on smallholders and agri-entrepreneurs in Maharashtra with active participation from private sector. The scheme includes several agricultural commodities for value chain development including bananas and mangoes.

4.7.3 Development of Export Infrastructure

To facilitate exports of mangoes by refrigerated vans, Agricultural & Processed Food Products Export Development Authority (APEDA), under the Infrastructure Development component of its export promotion scheme, provides financial assistance for purchase of insulated/reefer transport/mobile pre-cooling units up to 40% of the cost subject to ceiling of INR 100 lakhs. Assistance is available for the establishment of post-harvest infrastructure for fresh horticulture produce like integrated pack house, cable handling system for banana, mango and other similar requirements for other crops, purchase of insulated and, reefer transport/mobile pre-cooling units. APEDA provides financial assistance to exporters for setting up post-harvest infrastructure facilities, purchase of laboratory equipment, implementing quality management system and transport assistance for non-traditional markets (Table 4.13).

To meet the quarantine concerns of importing countries, APEDA has extended financial assistance to state government agencies to establish vapour heat treatment

[3] http://mofpi.nic.in/Schemes/pradhan-mantri-kisan-sampada-yojana.

Table 4.13 APEDA assistances for mango and banana exporters

Components	Scope	Assistance
Integrated pack house	Improve compliance of phyto-sanitary requirements	Up to 40% of the total cost subject to a ceiling of INR One crore for each of the activities
Purchasing insulated, reefer transport/mobile pre-cooling units	Cold chain strengthening	
Cable handling system for banana and other crops	Quality improvement	
Processing facilities	Enhancing productivity, efficiency and quality for value-added products	

Source APEDA

facilities in Andhra Pradesh, Uttar Pradesh and Maharashtra and for irradiation facility in Maharashtra and Gujarat.

Assistance for reefer transport vehicles is also available under Mission for Integrated Development of Horticulture (MIDH), a Centrally Sponsored Scheme implemented by Ministry of Agriculture & Farmers' Welfare. Under MIDH, credit linked assistance is provided for establishment of cold storage, ripening chambers and reefer transport vehicles for perishable horticulture crops, including mango. The component is demand and entrepreneur-driven, and funds under MIDH are allocated to states on the basis of Annual Action Plans.

4.8 Conclusion and Policy Recommendations

While India has favourable geographic and climatic factors for growing both banana and mango, the potential it holds for catering to world's demand of fresh fruits has remained untapped. These value chain suffer from improper post-harvest management, fragmented and small farm sizes, and weak linkages to the global markets, especially, in the case of banana. The sustained efforts by APEDA and state governments of Maharashtra and Gujarat helped boost mango exports. Indian mango varieties such as Alphonso, Kesar and others are exported to UAE, USA, UK, and other European countries. There is a significant opportunity to scale up mango exports focusing on the uniqueness of Indian mangoes in terms of appearance, flavour and taste.

Hence, to bring efficiency in the value chain of bananas and mangoes, policy recommendations should address the challenges faced at each stage of the value chain from origin of planting material to the final consumption of the product. The establishment of traceability and certification will help ensure stronger export markets

for Indian bananas, and mangoes. Farmers need good quality inputs such as seeds, fertigation, robust extension services, and affordable credit facilities. Based on our analysis of the value chains on the CISS-F framework, we put forth certain important policy recommendations that will further strengthen these value chains.

4.8.1 Generic Policy Recommendations for Fruit Crops

1. **Alternative markets for perishables**: Despite delisting of fruits and vegetables from APMC by several states, much of the marketing of these commodities is still channeled through APMC markets. Traditional APMC markets are plagued with issues related to high cost of intermediation, opaque price discovery controlled by commission agents and traders, poor infrastructure facilities and services that cannot handle perishable commodities. As a result, farmers suffer from high marketing costs and lower price realization, adversely impacting their income levels. Agricultural marketing reforms are targeted towards streamlining marketing operations, upgrading existing markets as well as broadening the spectrum of markets to include private markets, digital markets, farmers' market, and other direct marketing channels. The Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act enacted by the Parliament in September 2020 will be instrumental in setting up of these kind of alternate markets and lending greater access to the farmers. Incentives for private sector participation in agricultural markets and investments in building advanced value chains will improve both domestic and export marketability of these commodities.
2. **Farmer collectives**: Farmer Producer Organizations (FPOs) can be effective in providing pre and post-harvest infrastructure and services to the farmers. Government schemes aimed at extending financial support towards building these fruit value chains can be leveraged to the benefit of the farmers. FPOs can also facilitate direct market linkages with organized wholesalers, retailers, processors, and exporters, ensuring farmers the remunerative prices, and assured market access. The recent Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services or the FAPAFS Act enacted by the Parliament in September 2020 is an attempt by the government to legalize contract farming. Examples of Mahagrapes (grapes) and Sahyadri Farmer Producer Company Limited (fruits and vegetables) show how farmers can benefit from farmer-market linkages facilitated through such institutions, and important lessons can be drawn.
3. **Value Chain Financing**: Horticulture farmers mostly access finance from informal credit sources comprising of market intermediaries (commission agents/*arhatiyas*), traders and/or self-finance. The rate of interest charged by the intermediaries range between (2–2.5)% and can go up to 5% per month. Banana and mango farmers, especially small and marginal, need affordable and timely access to institutional credit for buying planting material, automated fertigation,

pipelines, tractors, etc. Such credit requirements can be made available through Kisan Credit Cards (KCC) or through FPOs.

Given the widespread retail marketing of fruits and vegetables, in this case bananas and mangoes, access to affordable institutional finance can enable small retailers scale up and upgrade their business models. Being highly perishable, storage facilities at the retail level can help extend the shelf life of the commodities and allow retailers to avoid wastage and earn better incomes.

4.8.2 Banana Value Chain

1. Giving bunch treatment to banana plants before harvesting using bunching bags improves the quality of the fruit. This can be done by covering the banana bunches using bunching bags to avoid the spread of thrift pests, which scrap banana juice, leading to brown spots on banana. The resultant spotless bananas will further expand banana exports to promising markets, like the European union.
2. Indian bananas have negligible presence in the global export market. This is because bananas from India are not of the desired quality, are not homogeneously sized, and there is no standardized protocol for handling bananas during harvest. Development of a sea protocol for banana exports which includes the number of days of maturity, size parameters, and pesticide residue range will enable expansion of banana exports via sea route to distant markets.
3. Mechanization of banana transplanting and harvesting should be explored to reduce production costs and wastages. Scaling up pilot projects on cable system for handling bananas, can be the starting point. Mechanization of banana value chain will help reduce labour costs, undertake better cultivation practices that have a favorable impact on quality, thereby making banana cultivation profitable for the farmers.
4. As bananas are water loving plants and its roots cannot hold water for long, it needs efficient irrigation and drainage facilities. With drip irrigation in place, 45% water can be saved and banana yields can also increase by 52%. While Maharashtra has adopted drip irrigation for banana cultivation to a large extent, other banana growing states should adopt drip irrigation facilities to make banana cultivation environmentally sustainable.
5. Banana fibre is a great alternative to other natural fibres, like cotton as the former is prepared from pseudo banana stem, which is a waste product in the banana value chain. In India, 70–80 tn/ha of banana pseudo stem is wasted, which has the potential to be converted into a number of value-added products including paper, handicrafts, fibre, bio-fertilizer, vermin compost, candies and pickle. Hence, it is not only an environmentally sustainable option, but also financially lucrative for farmers as well as the entire banana economy. While a few pilot projects have been started in Jalgaon and Trichy in India, the operations have to be scaled up in other banana growing regions to acquire the desired scale.

4.8.3 Mango Value Chain

1. As mango cultivation is mostly carried out by small and marginal farmers and it is a seasonal fruit, inter-cropping could be encouraged, keeping in mind the nature of soil as well as availability of water or irrigation. The role of ICAR affiliate institutes is critical in developing a sustainable mango cultivation system which is remunerative for the farmers as well as environmentally sustainable.
2. There has been a slow increase in output, productivity, and area under mango cultivation across states, in the last few decades. The last mango variety was developed by CISH (Arunika) in 2008, and since then mango has not seen any significant breakthrough in varietal development. Development of long shelf life mango varieties without compromising on the taste or flavour, will ensure scalability of mango production in India.
3. There is a large asymmetry in post-harvest and export oriented infrastructure facilities across states. While Maharashtra State Agricultural Marketing Board runs irradiation facilities in Vashi and Lasalgaon and several Vapour Heat Treatment (VHT) facilities are located in mango-growing regions in Maharashtra, other states lack such facilities. In the absence of such facilities, mango exporters from Uttar Pradesh bring in their produce to Vashi or Lasalgaon (Maharashtra) for these treatments, which is a mandatory requirement to cater to export markets in many countries. Setting up such infrastructure in Uttar Pradesh, which is the largest producer of mango, would help farmers in cutting cost of transportation, and ensure quicker shipments. All consignments to EU, South Korea, and Japan have to undergo hot water treatment (HWT) or VHT. Irradiation is mandatory for the mango consignment sent to the USA. Hence, ramping up such facilities in other states, such that exporters can avail them easily will have a positive impact on export.
4. Logistics including cold chains, ripening chambers, reefer trucks, etc for perishable commodities and in this context, mangoes, need to be developed and made accessible to the stakeholders in the value chain. Such logistics support will help improve the shelf life and quality of the fresh produce, reduce wastage, and enhance the marketability of the produce. Farmers can benefit from greater demand for mangoes as a result of robust value chain.

Annexures

Annexure 4.1: Banana Value Chain Markups

Components	INR/q	Share in consumer rupee (%)
1. Price received by farmer (From Agmarknet)	682	35.5
a. *Mandi* fees (INR 300/truck of 15–25 MT capacity)	1.5	
b. Packing and loading charges (INR 15000/truck of 15 MT capacity)	100.0	
c. Transportation cost	400.0	
2. Total traders cost (a to c)	502	26.1
3. Traders margin (4-2-1)	67	3.5
4. Delhi wholesale price	1251	
a. *Mandi* fees (1%)	12.5	
b. Official commission charges (6%)	75.1	
c. Cost for transportation, labour, ripening and wastages	100.0	
5. Semi-wholesaler total cost (a to c)	188	9.8
6. Semi-wholesaler margin (10%)	125	6.5
7. Price to retailer	1564	
8. Retailer cost	50	2.6
9. Retailers margin (10-7-8)	307	16.0
10. Price paid by consumers (Delhi retail price)	1921	100.0

Annexure 4.2: Mango Value Chain Markups

Components	INR per quintal	Share in consumer rupee (%)
1. Price received by farmer (From Agmarknet)	1778	20.7
a. *Mandi* fees	53.3	
b. Packing and loading charges	250.0	
c. Transportation cost	500.0	
2. Total traders cost (a to c)	803.3	9.4
3. Traders margin (4-2-1)	92.4	1.1
4. Delhi wholesale price	2674	
a. *Mandi* fees (1%)	26.7	
b. Official commission charges (6%)	160.4	
c. Cost for transportation, labour, ripening and wastages	100	
5. Semi-wholesaler total cost (a to c)	287	3.3
6. Semi-wholesaler margin (10%)	267	3.1
7. Price to retailer	3228	
8. Retailer cost	50	0.6
9. Retailers margin (10-7-8)	5298	61.8
10. Price paid by consumers (Delhi retail price)	8577	100.0

References

APEDA (2017) APEDA export strategy: Part II—Focus products. New Delhi

APEDA (2018) AgriExchange. Agricultural & Processed Food Products Export Development Authority, Ministry of Commerce & Industry, Govt. of India, New Delhi. Retrieved from http://agriexchange.apeda.gov.in/new_contactus.aspx

APEDA (n.d.) Banana product profile. Retrieved from APEDA Agriexchange. http://apeda.in/agriexchange/Market%20Profile/one/BANANA.aspx

Balaganesh G, Yash G, Anoop M, Singh H (2016) Economics and rate of adoption of precision farming in banana in Theni District, Tamil Nadu. Int J Agric Sci 2553

CISH (2013) Vision 2050. ICAR—Central Institute for Subtropical Horticulture, Lucknow

DoAC&FW (2019) Area and production of horticulture crops. Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers Welfare, Government of India

DoAC&FW (2020) Agricultural census 2015–16. Department of Agriculture Cooperation and Farmer's Welfare, Ministry of Agriculture, Government of India, New Delhi. Retrieved from http://agcensus.dacnet.nic.in/

FAOSTAT (2019) Food and agriculture data. Retrieved from Food and Agriculture Organisation of the United Nations. http://www.fao.org/faostat/en/#data

Gunjate R (2006) Advances in mango culture in India. In: VIII International mango symposium, pp 69–78

Krishisandesh (n.d.) Cultivation of mango in ultra high density mango plantation. Retrieved from Krishisandesh. https://www.krishisandesh.com/mango-cultivation-ultra-high-density-plantation/

Lok Sabha Questions (2019) Lok Sabha, New Delhi

Maharashtra Economic Survey 2017–18 (n.d.) Economic survey of Maharashtra 2017–18. Directorate of Finance and Statistics, Planning Department, Government of Maharashtra, Mumbai. Retrieved from https://mahades.maharashtra.gov.in/files/publication/ESM_17_18_eng.pdf

MoFPI (2018) Pradhan Mantri Kisan SAMPADA Yojana. Retrieved June 2018, from Ministry of Food Processing Industries. http://mofpi.nic.in/sites/default/files/important_notice-sampada-19.05.2017.pdf

NABARD (2017) Farmer Producers' Organizations (FPOs): status, issues. In: National Paper—PLP 2019–20

NABKISAN (n.d.) Concept of producer organisation. Retrieved from June 2019 Nabkisan Finance Limited. http://www.nabkisan.org/faq.php

NAS (2018) National accounts statistics. Ministry of Statistics and Programme Implementation, Government of India, New Delhi

NHB (2008–2010) Indian horticulture database. National Horticulture Board, Government of India, New Delhi

NHB (2017) Horticultural statistics at a glance 2017. National Horticulture Board, Ministry of Agriculture, New Delhi

NHB (n.d.) Crop profile—Banana. Retrieved March 2019, from National Horticulture Board. http://nhb.gov.in/report_files/banana/BANANA.htm

NHB (n.d.) Mango profile. Retrieved March 2019, from National Horticulture Board: http://nhb.gov.in/report_files/mango/mango.htm

NRCB (2015) Vision 2050. ICAR—National Research Centre for Banana, Trichy, New Delhi

NRCB (n.d.) Success Stories. Retrieved June 2019, from ICAR-National Research Centre for Banana. http://nrcb.res.in/success-stories.php

RKVY (n.d.) Processing of banana pseudo-stem into value added products: attempt for waste to wealth. Retrieved February 2019, from RKVY. https://rkvy.nic.in/Uploads/SucessStory/MAHARASHTRA/2018/20181019311.%20Psuedo%20stem.pdf

Saini S, Gulati A (2017) Price distortions in Indian agriculture. World Bank: New Delhi

Shaikh N, Badgujar C, Rajenimbalkar V (2006) Performance of triploid cultivars of banana (Musa spp.) under Maharashtra conditions. Agric Sci Digest 36(2)

Sudha Mysore BB (2016) An economic crop profile of mango in Karnataka. Indian Institute of Horticultural Research, Bengaluru

UNCTAD (2016) Mango: An INFOCOMM commodity profile. UNCTAD Trust Fund on Market Information on Agricultural Commodities, United Nations Conference on Trade and Development, New York and Geneva. Accessed from https://unctad.org/system/files/official-document/INFOCOMM_cp07_Mango_en.pdf

World Bank (2018) State of Maharashtra's agribusiness and rural transformation project. World Bank

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