



## Development Status of Chinese Mango Industry in 2018

Aiping Gao<sup>1\*</sup>, Yeyuan Chen<sup>1</sup>, Ruixiong Luo<sup>1</sup>, Jianfeng Huang<sup>1</sup>, Zhichang Zhao<sup>1</sup>, Wenjing Wang<sup>1,2</sup>,  
Yingying Wang<sup>1,2</sup>, Zhiguo Dang<sup>1</sup>

<sup>1</sup>Tropical Crops Genetic Resources Institute, Chinese Academy of Tropical Agriculture Science, Haikou, Hainan, 571101, China

<sup>2</sup>College of Horticulture, Hainan University, Haikou, Hainan, 570228, China

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**\*Corresponding author:** Aiping Gao, Tropical Crops Genetic Resources Institute, Chinese Academy of Tropical Agriculture Science, Haikou, Hainan, 571101, China. Email: [aipinggao@126.com](mailto:aipinggao@126.com)

### Abstract

China is the third largest mango cultivation country in the world in 2018. Mango has become the main source of income for mango farmers in eight provinces and regions such as Guangxi, Yunnan, Hainan, Sichuan. At present, there are more than 20 varieties with different maturity, which are mainly produced by moving the harvest forward or postponing harvest and other comprehensive technical measures, China has become the only country in the world that can produce mango annually. At the same time, China has adopted a series of technical measures, such as top working, bagging, integrated disease and pest control and so on, which has significantly improved the quality of mango fruit, increased its market competitiveness which can not only meet the domestic market, but also export to foreign countries. China has a bright future for developing mango.

**Keywords:** Annual production; China; Mango; Production; Technology; Quality; Varieties; Trade

Mango (*Mangifera indica* Linn. 2n=40) is known as the king of tropical fruit [1]. There are about 110 countries and

regions which produce mangoes. It has a production of 241.48×10,000 metric tons in 2018 in China [2]. China is the third largest mango production country according to its area and production from information of China. This paper will mainly summarize the present situation of Chinese mango industry from the aspects of production, variety, technology, processing and trade market. At the same time, it also puts forward some directions for the development of mango industry in the future.

### Current Production Situation in China

China has a long history over 1300 years to cultivate mango. It is said that mango was introduced from India to Mainland China in 645 A.D. by Tang Xuanzang (Tang Dynasty). Commercial cultivation was started in Taiwan in 1960s and in the mainland in 1980s. If according to FAO data, China has become the second mango cultivation country in the world [3]. (Table 1) In fact, according to the data of the Ministry of Agriculture and Rural Affairs of China, China is the third. China grow 294326 hectares of mango and harvest 2414800 tones.

Polity	India	China	Thailand	Indonesia	Philippines	Mexico	Pakistan	Bangladesh	Nigeria	Egypt
Hectares	2 212 000	604647	446728	202547	194367	188644	169234	159042	134468	121604
Productions in tones	19506000	4941830	3824279	2566046	748957	1958491	1685304	1517691	935954	1351316
Footnote		F	F				F	F	F	F

No symbol = official figure F = FAO estimate

Source Food And Agricultural Organization of United Nations: Economic And Social Department: The Statistical Division

**Table 1:** The Main Production Countries in the World (2017).

Commercial cultivation mainly lies in south China, including Guangxi, Yunnan, Hainan, Sichuan, Taiwan, Guangdong, Guizhou and Fujian (Table 2). Among these provinces and Regions, they are divided into three different harvest zones, Generally, Hainan ,Taiwan and Guangdong belong to the earliest harvest zones, Sichuan ,Fujian and Guizhou belong to the latest harvest zones, Guangxi is a

medium mature region .There are early, medium and late maturing mango production areas in Yunnan. Guangxi, Yunnan and Hainan are the largest production areas, accounting for 78.66% of the total area and 78.33% of the total output respectively (Table 2). China has become one of the main mango production country [3].

Zone	Total area (10,000 ha)	Harvested area (10,000 ha)	Production (10,000 metric tons)	Average yield per ha(tons)
Guangxi	10.07	3.94	73.47	18.64
Yunnan	7.41	3.67	47.39	12.90
Hainan	5.67	5.21	68.29	13.10
Sichuan	2.74	1.26	14.03	11.11
Taiwan	1.61	1.59	14.67	9.22
Guangdong	1.33	1.20	21.60	18.00
Guizhou	0.56	0.17	1.04	6.12
Fujian	0.05	0.04	0.99	22.87
Total	29.43	17.08	241.48	14.14

Source: Statistics of the Ministry of Agriculture and Rural Areas of China,2018

**Table 2:** Mango Area and Production of China (2018).

## Main Varieties

China may be one of the origins of *Mangifera*. It is said *Mangifera hiemalis* J.Y. Liang as an endemic species of China .The world recognize *Mangifera Indica* L. origins in India [4]. Therefore, most of China's commercial varieties were initially imported from abroad. With the progress of breeding technology in China, more and more researchers have created new varieties and extended them all over the country. China has also selected a number of local varieties from wild and semi-wild resources. According to available data, China has collected over 1100 accessions of mango and preserved in scientific research units, most genetic resources introduced from abroad .The main conservation units are as follows: ①Tropical Crops Genetic Resources Institute, Chinese Academy of Tropical Agriculture Science, Haikou, Hainan ; ②South Subtropical Crops Research Institute, Chinese Academy of Tropical Agriculture Sciences, Zhanjiang, Guangdong; ③Subtropical Crops Research Institute of Guangxi; ④Xishuangbanna Tropical Botanical Garden,

Chinese Academy of Sciences; ⑤Tropical and Subtropical Economical Crops Institute, Yunnan. Academy of Agricultural Sciences; ⑥Sichuan Panzhihua Academy of Agricultural and Forestry Sciences ⑦Fruit Research Institute of Fujian Academy of Agricultural Sciences..

Now there are eight provinces and regions producing mango, mainly commercial varieties are no more than 30 (Table 3), but they contribute over 95 percent of all the products, the other produced varieties are no more than 5 percent of all the area. such as Sannian, Kensintgon, Nam Doc Mai, Yuexi No.1, et al, Other accessions of mango are conserved such as Longmang, Baihua, Huangpi, Putao, Danmang, Langra, Chaosa, Alphonso, Bangalora, Harumanis, Golek, Pope, Ahping, Earlygold, Lippens, Taomang, Guixiang, Chuanmang and some wild germplasm resources such as *Mangifera hiemalis* J.Y. Liang, *Mangifera .sylvatica* Roxb,et al..

Province and Region	Main County and District	Main varieties
Guangxi	Tianyang, Tiandong, Baise Youjiang District	Tainoung No.1, Guire No.82, Red Ivory, Guifei, Jinhwang, Guire No.10, Renong No.1,
Yunnan	Huaping, Baoshan, Honghe, Simao, Yuanjiang,	Keitt, Guifei, Sannian, Nang Klangwan, JinHwang,
Hainan	Sanya, Ledong, Dongfang, Chanjiang, Lingshui	Guifei, Jinhwang, Tainoung No.1, Nang Klangwan, Taiya, Sensation
Sichuan	Panzhihua	Keitt, Sensation, Renong No.1
Taiwan	Tainan, Kaohsiung and Pingtung	Irwin, Local Mango, Jinhwang, Tainoung No.1
Guangdong	Zhanjiang, Maoming	Tainoung No.1, Dashehari, Jinhwang
Guizhou	Wangmo, Luodian, Xingyi	Guire No.82, Keitt, Red Ivory, Guifei, Jinhwang, Hongyu, Sensation
Fujian	Anqi, Putian, Fuzhou, Zhangzhou	Jinhwang, Honghua, Irwin

**Table 3:** Main Counties and Districts Producing Mango and Main varieties in China.

## Main Production Technology

### Moving the Harvest forward

The key technology of early maturing production area was developed, which significantly improved the rate of flower and fruit setting, solved the problem of fruit setting, and the harvest time was 4 months ahead of schedule.

The main technical points are shoot control by Paclobutrazol and flower promotion by potassium nitrate [5]. The main technical points include: ① shoot control: prune and release the shoot 2-3 times after harvest, and spray Paclobutrazol to control the shoot before the last shoot maturing; ② flower promotion: After 60-80 days of shoot control, compound sodium nitrophenolate and potassium nitrate were sprayed on the leaves to promote flower growth, ③ promoting the flowering and fruit setting: cutting inflorescence short in bud stage, exogenous application of "spermine + polyaspartic acid + urea" to promote fruit setting. After the technology was applied in the early maturing area, the flowering rate of branches was increased to more than 80%, and the harvesting period was advanced from May to July to late December of last year to May of this year.

### Postponing Harvest

The technique of delaying the harvest time of mango in late maturing area was developed, which solved the serious problem of "Alternate Bearing" in late maturing area and delayed the harvest time by 2 months.

In view of the serious problem of large temperature difference between day and night in autumn and winter under the natural growth of late maturing production area, the phenomenon of "Alternate Bearing" is easy to appear. The comprehensive technology of "delaying flowering period + pruning branches by rotation" was developed. By picking flowers in batches to avoid the influence of low temperature in

early spring, about 60% of branches were reserved to hang fruit after the second physiological fruit fall, and the rest branches were cut short to promote summer and autumn shoots, which were used for cultivating the fruiting branch of next year. The comprehensive application of the technology ensures high and stable yield, and the production period is extended from October to December [6].

### Annual Harvest and Supply

According to the climatic characteristics, production status and development trend of mango in different production areas of China, the mango production in China can be divided into early maturing area, middle maturing area and late maturing area. The early maturing area includes the south-southwest of Hainan, the Leizhou Peninsula of Guangdong, the Honghe River Basin of Yunnan and the south of Taiwan; the middle maturing area includes the Youjiang river valley of Guangxi, the Nujiang-Lancangjiang River Basin of Yunnan the late maturing area includes Sichuan -Yunnan Jinshajiang River dry hot valley basin, the southwest of Guizhou and the South of Fujian.

The harvest period of mango is from April to September through variety, climate and natural growth before the technology "Moving the Harvest forward" and "Postponing Harvest". After two technical measures of production period adjustment, by the perfect combination of variety, climate and production period adjustment technology, the mango can be produced and supplied from January to December. China has become the only country in the world to realize the annual production of fresh fruits.

Advantage Area	Producing Area	Fruit Harvest Time (Month)												
		1	2	3	4	5	6	7	8	9	10	11	12	
Early Maturing	The south-southwest of Hainan, the Leizhou Peninsula of Guangdong, the Honghe River Basin of Yunnan and the South of Taiwan	█												█
Middle Maturing	The Youjiang River valley of Guangxi, the Nujiang-Lancangjiang River Basin of Yunnan, the Southwest of Guizhou					█								
Late Maturing	Sichuan-Yunnan Jinshajiang River dry hot Valley Basin, and the South of Fujian.								█					

Table 4: Annual Supply System of Mango Fresh Fruit.

### Quality Improvement

#### Fertilization and Irrigation

Soil fertility and water has a direct effect on all aspects of mango growth and development. In some cases, post-harvest disorders can be linked directly to the deficiency of a particular mineral, but often other environmental factors such as water stress are involved.

Based on fertilizer, mainly in the following several fertilization ①promoting shoot fertilizer. It is based on nitrogen after harvest, there is balanced ternary compound fertilizer, or compound fertilizer plus urea, but also high-nitrogen fertilizer, generally 0.5kg per tree or so; ②controlling shoot fertilizer: potassium chloride or potassium sulfate 0.5kg / per tree, plus calcium superphosphate 0.5 ~ 1 kg / per tree; ③ promoting flower fertilizer: At the stage of pre-flowering or flowering, mainly compound fertilizer, generally 0.5 ~ 1kg / per tree, mainly for abortion fruit promotion [7].

More and more farmers attach importance to the use of organic fertilizer. In the selection of fertilizer types, 77% of farmers in Hainan of China apply organic fertilizer, and most of the application of organic fertilizer is in the form of base fertilizer after fruit picking. 53% of farmers use less than 2500 kg / hm<sup>2</sup> of organic fertilizer, 38% of farmers use 2500-5000 kg / hm<sup>2</sup> of organic fertilizer. The types of organic fertilizer used by farmers include commercial organic fertilizer, sheep manure, pig manure, chicken manure, etc. 84% of farmers use commercial organic fertilizer, only 16% of farmers use livestock manure. In general, the use of organic fertilizer in mango orchards in China is still low.

Amount and frequency of irrigation depends upon the type of soil, prevailing climatic conditions, especially rainfall to be

given and its distribution and age of trees. Critical periods for irrigation are mainly at flowering and fruit set. The experiment of mango irrigation system from 2014 to 2017 showed that the yield and quality of mango increased significantly compared with no irrigation. The best irrigation amount is 1500 m<sup>3</sup>/ hm<sup>2</sup>, the best irrigation times are 6 times. The best irrigation time is 1 time in autumn shoot, 1 time in flower bud differentiation, 2 times in flowering and fruit setting, and 2 times in fruit expansion. There is no need to irrigate during fruit ripening [8].

#### Pest and Disease Control

At present, the main diseases in China are anthracnose (*colletrotrichum gloeosporioides*), bacterial black spot (*Xanthomonas campestris v. mangiferae indicae robs*), powdery mildew (*Oidium mangiferae Berthet* and the main pests are scitothrips dorsalis (*Scirtothrips dorsalis Hood*) leaf gall Midge (*Erosomyia mangiferae felt*), leaf cutting weevil (*Deporaus marginatus Pascoe*), chilumeta traversa (*Chlunetia transoersa Walker*), etc. In production, pesticides should be used alternately to avoid resistance to diseases and insect pests. The usage and dosage of pesticide shall be in accordance with the instructions of the pesticide. Acid and alkaline pesticides cannot be mixed. At present, chemical control is the main control method; physical control and biological control is the auxiliary.

#### Bagging

Mango bagging has the following advantages: ①to protect fruit surface to make it smooth and delicate; ②to improve the internal quality of fruit; ③to reduce the spraying frequency, to lower pesticide residues and production costs; ④ to improve fruit storability to extend the shelf-life; ⑤to raise the price of fruit. In general, the peel of red mango is generally covered with a single layer of white bag, while the peel of yellow mango is generally covered with a double layer of bag,

the outside is yellow, and the inside is black. The best bagging time is after the second physiological fruit drop [9].

### Storage

Post-harvest fruit must be washed in the detergent within 24 hours, after drying followed by the hydrothermal ( $53 \pm 1$  °C) 50% benomyl or thiabendazole 1000 ~ 2000ppm soaking the fruits of 10 to 15 minutes, to prevent and control anthracnose, stem end rot. Fruit classification should firstly lie in their appearance, and then the size of fruits, and then they should be transported away after packaging. As for storage, Fruits should be stored in low-temperature.

In the controlled atmosphere storage context, Yu Wangqing et al (1998) reported that Deshehari mango can be stored for about 40 to 50 days at  $10 \sim 11$  °C under the conditions of use of 5% to 6% carbon dioxide and 2% to 4% oxygen. The flavor of the fruit is almost the same as that of the natural ripened fruit at room temperature after a certain shelf time [10]. Feng Xuqiao et al (2012) reported that under the condition of cold storage, the fruits treated with  $50 \mu\text{L} / \text{L}$  1-ocp and  $5 \mu\text{L} / \text{L}$  1-MCP maintained good storage quality [11].

### Top Working

The technology of “Top Working” is based on the original mango tree, through heavy pruning, the new varieties are grafted to the old varieties by buds or branches. It can be done the first year and bear fruits the following year. It can shorten the period two years than re-planting.

Top working time is different in China. Generally in April to May, when the tree is vigorous, and it is rarely rainy, suitable in temperature, and therefore it has a high grafting survival rate. A vigorous, healthy mature tree may be cut off 1-2 m above the ground and treated with pruning scissors and saws. 5-30 sprouts will grow out from the trunk, when new shoots get matured, most of them can be grafted into desired variety.

### Processing

Because the price of fresh mango in China is generally better, farmers mainly sell fresh fruits, and few enterprises or farmers sell fresh fruits to processing enterprises. Therefore, the processing enterprises are faced with the current situation of difficulties in purchasing fresh fruits. At present, China's processing enterprises mainly import fresh mango or original fruit juice from Vietnam and other Southeast Asian and South Asian countries. Mango juice and mango flesh are the main processing products of mango. Other mango products include dried mango, jam, canned mango, syrup, etc.

In addition, mango branches, leaves, peel and seeds contain bioactive substances, which can be used for functional production and may be a good source of potential nutrients. For example, mango leaves have been used to produce cough

tablets, and mango leaf extract can enhance the ability of aquatic animals to prevent diseases [12].

### International Sales Market

Although China is a main country of mango industry, the trade volume between China and foreign countries is not large. China's sales are mainly domestic, and foreign countries are auxiliary. In 2018, according to the statistics of China Customs, 21164 tons of mango were exported, accounting for 0.84% of the output, mainly to Vietnam, Russia, the United States, Malaysia, Singapore, Kazakhstan and other countries. 10914 tons of mangos were imported, accounting for 0.4% of China's output, mainly from Thailand, Vietnam, Australia, Peru, and the Philippines, Ecuador, Pakistan and other countries. In addition, there is no statistical border mango trade between China and Vietnam. Due to low price, high quality, gradual expansion of trade volume and close harvest period with Hainan, China's mango precocious market will be impacted. In 2018, China imported 1766 tons of mango juice, mainly from the Philippines, Cyprus and Israel, and exported 233 tons to South Korea, Germany and Thailand [13-15].

### General Remarks

China is the third mango cultivation country and has made a great progress in Mango production in recent years, however, it is not the major Mango exporting and importing countries. Through variety, technology and climate conditions, China has succeeded to realize the annual production and supply. China's mango cultivation technology is increasingly recognized by other countries.

In the future, China will continue to strengthen research and promotion on mango breeding, green control of disease and pest, postharvest preservation and quality improvement, expand international cooperation, and constantly expand domestic and international markets. With mango of China gradually moving to the world, mango industry will be better in the future.

### Breeding technology mainly involved in the following aspects:

- 1) Establish a national mango cooperation group.
- 2) Mango resource sharing mechanism.
- 3) Breeding new varieties of different maturity.
- 4) Breeding new processing mango varieties.
- 5) Breeding new varieties of disease-resistance and pest-resistance.

### Cultivation technical questions mainly involved in the following aspects:

- 1) Biological control of mango pests and diseases.
- 2) Mango orchard's efficient water-saving irrigation and cultivation techniques.
- 3) Annual mango production technology and application
- 4) Key technology of high quality mango production.
- 5) Management technology of mango trees.

6) Study on the application of water and fertilizer together.

#### Techniques of post-harvest are mainly involved in the following aspects:

- 1) How to realize the commercialization of mango post-harvest handling and storage technology in ordinary orchards.
- 2) How to realize the organization of mango industry?

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