Utilization of Genetic Resources of Tropical and Subtropical Fruit Trees in Japan

Hiroshi DAITO*

Abstract

Genetic resources of about 20 kinds of fruit trees have been introduced from both the tropics and subtropics to Japan. These plants can be grown in areas extending from 38° to 25° North latitude. Some of them can be commercially cultivated through the application of advanced technology relating to the utilization of genetic resources, as well as breeding methods.

The distribution of these plants in the country varies according to the geographical and socio-ecological conditions. Citrus genetic resources were introduced from China to the temperate region 1900 years ago and thereafter, many species have also been introduced from other countries to Japan. In the coastal areas, a large number of citrus trees are being grown. Citrus fruits have been the most important fruit crops for a long time. Fresh fruits and canned products are now being exported to many countries.

Longan, litchi, banana and guava from China have been cultivated in the southwestern part of Japan for 450 years. Loquat was also introduced from Southern China to the western part of Japan from 1830 to 1847, pineapple has furthermore been cultivated in the subtropical zone for 130 years.

Barbados cherry, avocado, passionfruit, papaya, mango, carambola, wax apple, atemoya and canistel have been recently introduced and are grown in greenhouses or in fields in open air in areas along the coastal belt around the Pacific Ocean and East China sea.

Fruits are consumed locally, while several species are cultivated commercially and are costly fruit crops. In areas of the Seto inland sea and temperate zone, olive, feijoa and cherimoya have been commercially cultivated, recently. Pomegranate and jujube are predominantly grown in cold and temperate regions. Fruits are popular for consumers and there has been a large demand for selected exotic fruits for a long time in Japan.

Citrus

Citrus is the most important fruit crop for both Japanese growers and consumers.

Citrus genetic resources were introduced from China to the temperate regions 1900 years ago and thereafter, many species have also been introduced from other countries to Japan.

Yuzu (*Citrus Junos* SIEB. ex TANAKA) and natsudaidai (*Citrus Natsudaidai* HAYATA) were introduced to Japan 1200 years ago. Satsuma mandarins (*Citrus Unshiu* MARC.) originated in Kyushu 300 years ago. Sweet orange (*Citrus sinensis* OSBECK) and Lemon (*Citrus Limon* BURM.) were introduced from the U.S.A. 100 years ago, respectively.

Some of these fruits can be cultivated commercially through the application of technology relating to the utilization of genetic resources, as well as breeding methods and their acclimation to the ecological conditions prevailing in Japan. Therefore, citrus fruits have been the most important fruit crops for a

Presented at the 1st International Symposium on "Fruit Production in the Tropics and Subtropics —Symposium of the XXIVth International Horticultural Congress—" Kyoto, Japan, 22-23 August 1994, held by Japan International Research Center for Agricultural Sciences (JIRCAS)

* Japan International Research Center for Agricultural Sciences, Coordination Section (Ohwashi 1-2, Tsukuba, Ibaraki, Japan)

long time.

In the coastal areas of the East China sea, Seto inland sea and Pacific Ocean, citrus genetic resources consist of mandarins, sweet oranges, sour oranges, tangors, tangelos, pummelos, grapefuits, miscellaneous varieties, lemons, limes, citron, yuzu and its relatives, kumquats, trifoliate orange and its hybrids (Fig. 1).

A total of about 100 cultivars of citrus have been grown. These areas covered about 114,000 ha in 1993.

Plants were planted on sloping ground for a long time, but many greenhouses with plastic have been constructed in flat areas, recently. Fruits also become fully ripe on the trees in greenhouses and even in fields in open air. Fruits are controlled to promote the quality. Fruit production which amounted to approximately 4.2 million tons, 20 years ago in 1975, decreased by half to less than 2.2 million tons in 1992 (Table 1).

Fresh fruits and canned products are now being exported to many countries.

Loquat

Loquat (*Eriobotrya japonica* LINDLEY) was also introduced from southern China to the western part of Japan (Nagasaki) 150 years ago. Thereafter, it was propagated and distributed to areas at 37° North latitude.

These areas covered about 2.8 thousand ha and the production amounted to 8.9 thousand tons, respectively in 1992 (Table 1).

The loquat fruit growers also construct greenhouses to accelerate the maturity and to increase the quality and quantity of fruits.

Pineapple

Pineapple (*Ananas comosus* MERR.) has also been cultivated in the subtropical zone for 130 years. In 1992, 29.3 thousand tons of pineapple fruits were produced covering an area of 1.4 thousand ha (Table 1).

The farmers also construct greenhouses to produce fruits with a good quality.

Pineapple cultivar N-67-10 is the most delicious cultivar bred by Okinawa Agri. Exp. Stan. Creampine was also selected by that station.

Fully ripened fruits are harvested and shipped to the market, while some of them are processed for canning, juice and syrup.

Recently, ornamental pineapple varieties have become popular in Japan for the decoration of houses, restaurants, hotels, banks and offices as IKEBANA materials. One plant can fetch a price of 2,000–5,000 yen.

Table 1 Production of citrus, loquat and pineapple fruits in Japan

Year	Citrus	Loquat	Pineapple
1960	1,114,600 t	23,900 t	27,500 t
1975	4,254,600	14,400	64,500
1987	3,296,000	10,900	38,900
1990	2,212,800	13,000	31,900
1992	2,217,300	8,940	29,300

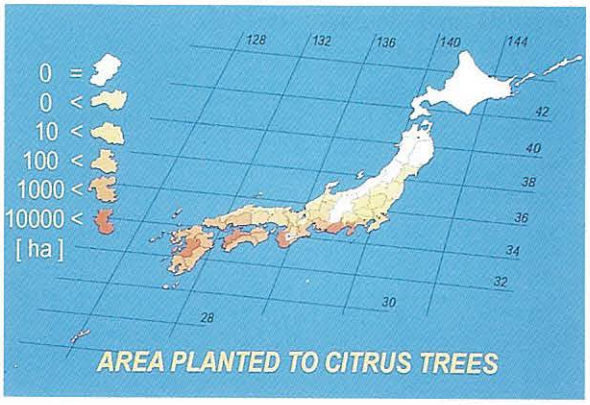

Fig. 1 Citrus genetic resources are utilized in the coastal areas of East China sea, Seto inland sea and Pacific Ocean

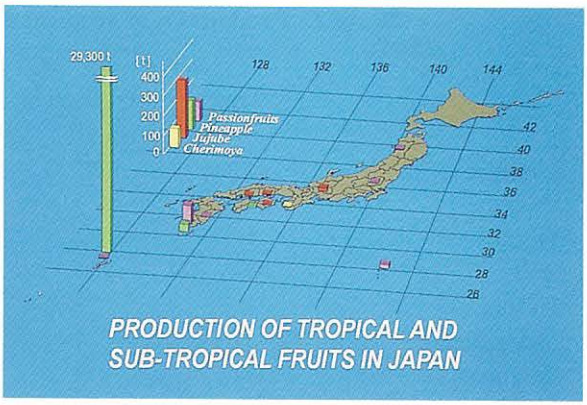

Fig. 2 Production of tropical and sub-tropical fruits in Japan

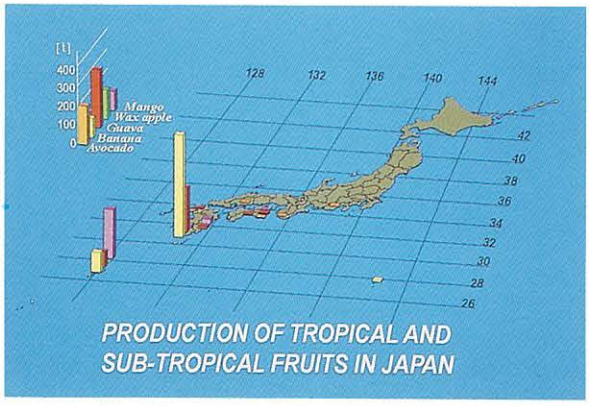

Fig. 3 Production of tropical and sub-tropical fruits in Japan

Fig. 4 The maturity of mango is promoted by direct exposure to sunshine

Fig. 5 Bending system of papaya cultivation in vinyl houses

Fig. 6 Carambola fruit production in greenhouse in temperate zone

Table 2 Production of tropical and subtropical fruits in Japan in 1993.

	Area	Production	No. of growers	Shipped	Use	
					Table fruits	Processing
Barbados cherry	3 ha	21 t	32	14 t	t	14 t
Atemoya	0	1	7	1	1	
Avocado	1	1	20	1	1	
Olive	47	39	55	39	39	
Canistel	1	3	6	3	3	
Pomegranate	1	1	103	1	1	
Cherimoya	17	21	85	20	20	1
Jujube	1	12	518	12	12	
Passionfruit	53	175	674	131	81	510
Banana	111	696	1,299	567	567	
Papaya	47	584	857	442	250	192
Guava	24	124	602	52	15	37
Feijoa	6	4	85	3	3	
Macadamia nut tree	1	1	62	1	1	
Mango	164	587	1,538	485	484	1
Strawberry trees	118	141	1,312	127	83	44
Litchi	12	17	249	13	13	1
Wax apple	0	3	8	1	1	

Other fruits (Fig. 5. 2-6, Table 2)

1. Mango (*Mangifera indica* LINN.)

1 Mango cultivation in the temperate zone

Minimum air temperature in Kyushu district ranges from 1.8°C to 6.0°C during December to March in the winter season and snow can sometimes reach a 30 cm depth in this season. Growers have to control the air temperature to initiate flower buds at 18°C during December to late January by artificial heating in greenhouses, which is costly. Flower bud initiation in the mango cultivar Irwin occurs in late January and blooming occurs until late February. Minimum air temperature should be maintained at 23°C during the full bloom to ripening periods in mango. Fruit growers are thinning the fruits and keep 1 to 2 fruits per twig with 30 leaves in the upper position of the canopy to promote maturity by direct exposure to sunshine (Fig. 4). Fruits in the lower part of the trees are also irradiated by reflected light from the silver film mulched under the trees. Whole fruits on the trees are therefore fully ripe by exposure to sunlight from both the top and underside of canopy. Fruits are moreover free of diseases and pests in greenhouses. The yield is 2.0 to 3.0 tons per 10 a (0.247 acre). The price of mango ranges from 2,000 to 3,000¥ per kg.

2) Mango cultivation in the subtropical zone

Minimum air temperature in this zone ranges from 15°C to 18°C during December to March in the winter season. As the flowering of Irwin cultivar occurs during the cloudy, rainy and cold season, the occurrence of diseases is promoted. Moreover, pollination is affected due to the absence of honey bees.

Fruits growers have constructed vinyl houses with nets for protection against pests, but without heating systems. Since the greenhouses are open in both sides, the air temperature is almost the same as that outdoors. The plants come into bloom from early February to mid-March, but since there are no bees in this season, growers use flies.

Fruit setting is usually completed by mid-March, and harvesting season takes place from late June to mid-August.

In Okinawa the production reached 1.5 to 2.0 tons of fruits per 10 a (0.247 acre) for the Irwin variety.

Fruits are usually covered with a white paper bag until the maturing stage on the trees to avoid injury by diseases and pests.

Growers supply fully ripe fruits to the consumers by air cargo. Irwin variety of mango fetches 1,500 to 2,500 ¥ per kg.

2. Papaya (*Carica papaya* LINN.)

1) Papaya cultivation under the bending system

As strong typhoons affect the papaya-growing areas in Japan, although high quality papaya can be obtained in open fields, growers cultivate papaya under vinyl houses. However, papaya plants are fast-growing and rapidly reach the roof of the vinyl house. Therefore, a bending system of cultivation under vinyl house was developed which can be easily managed for cultural practices including the spraying of chemicals and harvest of the fruits (Fig. 5). Maximum yield reaches 6.5 tons at densities of 130 plants per 10 a (0.247 acre) under the bending system in greenhouses.

Fruit quality is superior with this system as sunlight reaches the fruits uniformly. Brix value is 15° and tartaric acid content is 0.03% in fresh fruits. Fruit price ranges from 800 to 1,000 ¥ per kg. As the papaya plants are not affected with virus diseases, their life span is prolonged.

2) Cultivation of grafted papaya plants

The sex of papaya flowers can not be usually identified in young plants. As the growers must plant 3 seedlings per pit and then remove the male plants after flower emergence, many seedlings are lost.

In this cultivation method, the scions with female or bisexual flowers are grafted on the young root-stock. Grafted plants are planted in the field according to the inclining system in greenhouses, and fruits are borne at a lower position on the young plants. The yield and quality of fruits are almost similar to those of the fruits cultivated by the bending system.

3. Production of other fruits

As passionfruits (*Passiflora edulis* SIMS) are tolerant to cold temperatures, they can be cultivated in cold areas, such as Akita and Tochigi prefectures using hot springs and underground water, respectively.

Jujube (*Zizyphus jujuba* MILL.) which is the most tolerant fruit to cold temperature is cultivated in cold temperature areas.

Cherimoya (*Annona cherimolia* MILL.) was introduced to Wakayama 10 years ago. The production amounts to 30 tons. Cherimoya, longan (*Euphoria longana* LAM.), litchi (*Litchi chinensis* SONNERAT), atemoya (*Annona atemoya* HORT.) and carambola (*Averrhoa carambola* LINN.) (Fig. 6) are cultivated in greenhouses with heating system or under natural conditions in temperate and subtropical areas in Japan.

Banana (*Musa sapientum* LINN.), guava (*Psidium guayava* LINN.), avocado (*Persea americana* MILL.), Barbados cherry (*Malpighia glabra* LINN.), wax apple (*Eugenia javanica* LAM.) and canistel (*Lucuma nervosa* A. DC.) are cultivated in the subtropical areas.

Olive (*Olea europaea* LINN.), feijoa (*Feijoa sellowiana* BERG.) and strawberry trees (*Myrica rubra* SIEB. et ZUCC.) and macadamia nut tree (*Macadamia ternifolia* F. V. MUELL.) are cultivated in temperate regions, and pomegranate (*Punica granatum* LINN.) in the cold zone, respectively.

As fruit yield and quality are high under controlled conditions, growers and consumers aim at increasing the production.

However, the author would like to conclude by stating that although tropical and subtropical fruit trees could be cultivated in areas farther north through the use of advanced techniques including biotechnology and plant domestication, the cost of production would be comparatively high.

References

1) Fruit and Flower Division, Agricultural Production Bureau, Minist. of Agri., Forest. and Fish. (1995): Fruit production year book, 1993, 106–127.
2) Fruit and Flower Division, Agricultural Production Bureau, Minist. of Agri., Forest. and Fish. (1995): Source book about fruit production in Japan, 36–37, 42–43.

Discussion

Galan Sauco, V. (Spain): What kind of rootstock did you use for the cultivation of mango under greenhouse conditions?

Answer: For cultivation in the greenhouse, it is necessary to use the rootstocks of dwarf type. We used *M. indica* cv. Madu (honey in Indonesian language) which was kindly given to us by Dr. Winarno. This cultivar is polyembryonic and originates from West Sumatra.

Sykes, S. (Australia): Are you producing Chinese jujube? What markets are you producing jujubes for? Domestic or export? Are the fruits consumed/produced as fresh, dried or processed? What cultivars are you producing?

Answer: We produce Chinese jujubes mainly for domestic consumption as fresh, dried or processed fruits.

Comment: Arora, R. K. (IPGRI): Truly tropical/subtropical jujube is *Zizyphus/Zizyphus mauritania* which is largely grown in India and South Asia in the arid and semi-arid region. There are many cultivars with small and large fruits. The tree/bush is of multipurpose use (leaves as fodder, twigs for fuel and edible fruits).

Amnon Erez (Israel): What are the temperature and humidity level in the greenhouses where the tropical fruits are grown?

Answer: The temperature is in the range of 15°C–18°C and the relative humidity ranges from 75 to 85%.