The Apple Industry in Japan[1]

G. I. Mink
Washington State University,
Irrigated Agriculture Research and Extension Center, Prosser

Officially, 1972 marks the 100th anniversary of the modern apple industry in Japan. Although a small, crab-type apple was grown there for several centuries, the modern cultivated apple was virtually unknown in Japan prior to the Meiji Restoration which reopened the country to foreign trade in 1868. Since their introduction in 1872 apples have become the second leading fruit crop with 149,000 acres currently producing some 90 million boxes (40 lb.) annually.

The rapid development of the apple industry in Japan during the past two decades has gone largely unnoticed by most western countries. On the other hand future developments in the industry will be of interest to many, particularly those looking to Japan as a possible market outlet. To appreciate these future developments and their effect on foreign trade it is not only necessary to understand the current status of the industry but also to recognize some of the factors which affect it.

Because of the increased interest in apples throughout Japan resulting from the 100th anniversary, this year offered a rare opportunity for a foreigner to get some insight into the Japanese apple industry despite the ever present language problem. Between June 1971 and May 1972 I worked with researchers in the Ministry of Agriculture and Forestry Horticulture Research Branch Station located near Morioka City, Iwate Prefecture, in the northern apple growing region. As our work was mainly concerned with virus diseases of apple, we visited orchards in all major apple growing areas throughout the summer where I was able to see most phases of apple production. During the winter months I attended meetings at which growers, horticulturists, and plant pathologists, individually and collectively, discussed both the current problems faced by the industry and some possible future developments. Many persons kindly provided English translations of numerous facts concerning the apple industry, some of which were not previously available in English. The following records some of this general information together with some personal observations made during the year.

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Brief history

The original apple grown in Japan was a small, crab-type variety called 'Waringo' (*Malus asiatica* Nakai) with fruit similar in size and color to Virginia crab apple. Presumably imported from China around the 15th century, this cultivar was cultivated extensively until the 19th century. However, after the introduction of the modern apple with its superior size and taste the popularity of 'Waringo' declined rapidly. A few 'Waringo' trees are still grown but mainly as ornamental trees in parks and gardens.

A few apple trees were reported to have been imported from America and grown in gardens near Tokyo as early as 1865. However, the modern apple industry is generally regarded as having developed from 75 cultivars that were imported principally from America in 1872 by an agency of the newly formed government. These cultivars were planted in a government-owned garden near Tokyo but moved the following year to Hokkaid Island in the north. From here propagants were distributed to private citizens in most of the northern prefectures (states). Also in 1872 some 21 trees of four cultivars ('Maiden Blush', 'Westfield Seek-No-Further', 'Red Astrachan' and 'Fameuse') were taken directly to Iwate Prefecture in northeastern Japan and planted near the city of Morioka. The first apples were harvested from the Red Astrachan trees in 1875.

Between 1878 and 1880 apples were harvested in several prefectures. The first fruit were shipped to Tokyo from Iwate Prefecture in 1879. There was a gradual increase in the number of apple orchards planted from the mid-1870's until World War II when the acreage decreased markedly.

The rapid economic development that marked Japan's recovery after the war was paralleled by a sharp increase in new apple plantings. This rapid increase continued until the mid-1960's. In 1964 a peak of nearly 175,000 acres were devoted to apple production. In recent years this acreage has decreased slightly with stabilizing economic conditions. Nevertheless, apples remain a leading fruit crop (Table 1), second only to mandarin oranges which are grown both for domestic use and for export. Except for a few apples shipped to Hong Kong, Japan does not export apples.

General background

Japan's small size is often emphasized by foreigners and Japanese alike who cite the fact that the 4 main islands have a combined land area about the same as that of California. Although true, this comparison does not clearly illustrate the magnitude of the problem faced by Japanese agriculture. Japan is larger than Great Britain, West Germany or Italy in total land area. However, because of rugged mountain ranges throughout most of the country, more than 70% of the land is unsuitable for any type of agriculture except lumbering. The total area suitable for farming is roughly the size of Washington State. With a present population of well over 100 million, nearly half that of the United States, the ratio of population to cultivated land in Japan is among the world's highest. After World War II some new land was opened to farming in the northern prefectures but these gains have since been offset by land lost to urban developments. In some of the northern areas where urban expansion is not yet a serious problem, and where rice and apples are both grown, the average price of rice land is nearly $7,500 per acre while orchard land sells for about $4,000 per acre.

Rice, of course, is the main crop grown, but annual surpluses in recent years have resulted in strict government controls. Rice is grown under a subsidy program similar in many respects to that used for wheat in the United States. Despite these controls, farmers still grow more than 8 million acres of rice annually. The price support level is high enough that rice is grown not only

Table 1. Leading fruit crops in Japan (1970 data).

Crop	Acres
Mandarin orange	407,500
Apple	149,000
Chestnut	97,500
Japanese persimmon	87,750
Grape	57,500

because it is a basic food, but also because it gives farmers an exceptionally stable income in this period of rapid economic and cultural change. Farmers with suitable land prefer to grow rice to those crops subject to free market fluctuations. Nearly all farmers who grow fruit or any of the numerous specialty crops also grow rice.

Some efforts are being made to deemphasize rice production and increase production of other crops, but such changes usually occur slowly in any country. In Japan, labor problems are further slowing these changes. Despite its large population, Japan is currently facing a critical shortage of labor, especially in agriculture. A prolonged period with one of the world's lowest birth rates combined with a rapid migration of the remaining labor force into the urban areas is resulting in an increasing shortage of farm labor and a corresponding rise in labor costs. Generally, labor requirements for rice farming are 1/3 to 1/2 that of fruit production. Consequently, even though the gross returns from apples are usually higher than those from rice, the profits are not always greater – a fact not overlooked by farmers.

Industry location

Commercial apple production is limited to Hokkaido Island, the Tohoku District of northern Honchu and Nagano Prefecture in the central highlands (Fig. 1). Overall this region extends north to south for some 600 miles between latitudes 44 and 36. The average length of the growing season increases from 136 days on Hokkaido Island to 178 days in Yamagata Prefecture (Table 2). During this period skies are usually overcast and rain falls at least once during 105 to 130 of these days. Japan has few of the hot sunny periods characteristic of the apple growing areas of the American Pacific Northwest. Annual precipitation ranges from 39 to 72 inches, much of this as snow in Aomori and Akita Prefectures along the Japan Sea. Although snowfall is lighter along the Pacific Ocean, winter temperatures are generally lower there than in other areas. Relative humidities remain between 59 and 80% in summer and between 30 and 50% in winter.

In the Tohoku District apples are grown mainly in Aomori, Akita, Iwate and Yamagata Prefectures with Aomori the leading producer with approximately 60,000 acres (Table 3). Aomori is also a leading rice production area. Consequently, apples are grown mainly on the hillsides or in locations otherwise not suitable for rice.

The northern apple growing prefectures are among the least industrialized areas in Japan. These rural prefectures, with their strong dependence upon agriculture are highly conservative and preserve what little seems to remain of the traditional Japan described in geography books only a few years ago. In these areas the old style farm house with its high, steeply sloped, grass roof remains a common sight (Fig. 2). However, these traditional homes are rapidly being remodeled or replaced with contemporary housing (Fig. 3).

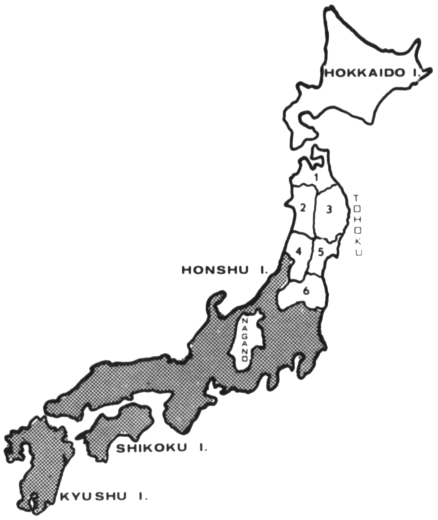

Fig. 1. The white areas represent the major apple producing prefectures in Japan. The 6 prefectures of the Tohoku District are; 1) Aomori, 2) Akita, 3) Iwate, 4) Yamagata, 5) Miyaki, and 6) Fukushima.

Cultivars

Western cultivars currently make up the major part of the apple industry. 'Jonathan', 'McIntosh', 'American Summer Pearmain' and 'Ralls Janet', among the first introduced, were planted extensively during the early years and remain the predominant cultivars in all areas. Collectively, they account for about 70% of the total acreage.

'Jonathan' and 'McIntosh' are familiar old cultivars, but 'American Summer Pearmain' and 'Ralls Janet' are not well known outside of Japan, despite the fact that both were introduced from the United States.

'American Summer Pearmain' is the most important early cultivar in Japan

Table 2. Climatic conditions in the major apple growing prefectures.

Prefectures	Avg temp (°F) Jan	Avg temp (°F) Avg	Frost free days	Annual precipitation (inches)	Avg full bloom date of Delicious (May)
Hokkaido	20	70	136	42	19
Iwate	26	72	163	48	16
Aomori	27	73	172	56	17
Akita	29	74	178	72	16
Magano	29	76	170	39	6

Table 3. Distribution of apple orchards by prefecture (1970 data).

Prefecture	Orchard acreage Bearing	Nonbearing	Total
Aomori	58,000	1,750	59,750
Nagano	29,700	2,800	32,500
Iwate	10,175	1,975	12,250
Hokkaido	9,700	2,450	12,150
Akita	7,350	1,400	8,750
Yamagata	8,025	700	3,075
Miyagi	1,952	1,117	3,075
32 others	3,420	818	4,050
Total	135,250	13,800	149,000

Fig. 2. Traditional Japanese farm home.

Fig. 3. Contemporary Japanese farm home.

and is grown in all areas. The trees are somewhat small, upright, with bloom dates about the same as 'McIntosh'; May 4th to May 17th from S to N. At tree maturity in late August or early September, the fruit are crimson-striped with a yellow background. However, practically all 'American Summer Pearmain' are harvested from mid-July to mid-August, depending upon the area, and marketed as green apples. In many orchards the fruit are covered individually early in the season with paper bags that are not removed until harvest. The green fruit are crisp, juicy and sweet, but have little flavor. The fact that they are sweet and appear in the stores when few other apples are available makes them popular with Japanese housewives.

'Ralls Janet', the most widely grown cultivar, is late-flowering, late-maturing, blooms 3-7 days after 'Delicious', and harvested in early to late November. During the growing season the fruit are distinctively green with large white lenticels, while mature fruit are purplish-striped with a yellow background. Crisp, firm, white-fleshed and sweet at maturity, this cultivar has little flavor and stores poorly in common storage. Despite its low quality and storage ability, its sweet taste and the ease with which it can be grown have made it popular for many years. However, since the introduction of 'Delicious' and 'Golden Delicious' and the development of several Japanese cultivars of superior quality, the popularity of 'Ralls' has declined.

The standard 'Delicious' was first introduced in 1913; 'Golden Delicious' in 1923. 'Starking' and 'Richared Delicious' were introduced in 1929 and 1932, respectively. These cultivars are now grown widely and are popular because of their size, color and taste. Several spur-type 'Delicious' sports have been introduced in recent years and are currently being tested by horticulturists and growers. Of these 'Wellspur', 'Redspur' and 'Starkrimson' are receiving the most attention. All 'Delicious' fruit are tree ripened before harvest. Consequently, storage life for this cultivar in common storage is short.

'Indo', a cultivar peculiar to Japan, is said to have originated as a seedling grown by Mr. John Ing, an American school teacher in Aomori Prefecture, from seed brought from his native home in Indiana. Although the parents are unknown, 'Indo' fruit resemble 'White Winter Pearmain' somewhat in appearance, but not in taste. Harvested just before 'Ralls' in November, the oblique-shaped fruit are greenish-yellow with a reddish brown blush. The fruit are bland, juiceless, and have a strong sweet taste that can best be described as "seedling." 'Indo' fruit may be kept in common storage until May, but the cultivar is highly susceptible to *Alternaria* leaf blotch on both the leaves and fruit. Like 'Ralls' the popularity of 'Indo' has declined sharply in recent years.

In the past 5 decades more than 30 apple cultivars have been developed and released by Japanese horticulturists. Of these the most popular are 'Mutsu', 'Orei' and 'Fuji'.

'Mutsu', a triploid seedling from a 'Golden Delicious' × 'Indo' cross is known in America as well as in Japan for its large size, clear yellow color and generally russet-free skin. The flesh is yellowish-white, juicy, but slightly course when compared to 'Golden Delicious'. The fruit can be stored reasonably well in common storage. Although fruit are yellow when grown without paper bagging, 'Mutsu' develops a bright pink color when bagged and the bags removed 40-50 days prior to harvest. Because of their large size and attractive color these fruit are used mainly for gifts rather than direct consumption.

'Orei', a small, oblong, yellow-fruited cultivar from a 'Golden Delicious' × 'Delicious' cross has good quality, stores well into March in common storage, but is not very popular because of its small size, susceptibility to *Alternaria* leaf blotch and general lack of promotion.

'Fuji', a selection from a 'Ralls' × 'Delicious' cross, is currently one of the most popular of the new Japanese cultivars. Introduced for trial in 1958, this cultivar is now being widely planted. Harvested in early November, the fruit are round-oblate or oblong, weigh up to 1/2 lb., have a thick, smooth skin and a color that resembles lightly colored 'Delicious'. The flesh is very firm, slightly course and very juicy. The fruit have a pleasant, aromatic, subacid taste that resembles slightly that of high quality 'Delicious', yet is distinct. The fruit store exceptionally well in common storage until April or longer.

Already several color sports of 'Fuji' have been found; some with deep red stripes, others solid shades of red. More recently at least 2 spur-types have been found, one a solid red sport. The color sports are more attractive than the original selection but usually do not taste as good. The large number of 'Fuji' sports being found and propagated in various areas have presented Japanese pomologists with a new and difficult problem. Patent laws in Japan do not apply to agricultural plants. Consequently, should new names be used for each sport or should 'Fuji' be used as part of the name is a question that has not yet been resolved.

Other Japanese cultivars currently of interest to growers are 'Kinsei' (originally named 'Kinrei', but recently renamed), 'Sekai-ichi', 'Toko', 'Aori #2' and 'Akane. Kinsei', from a 'Golden Delicious' × 'Ralls' cross, is a sweet, yellow apple with a reddish blush and a taste somewhat resembling 'Golden Delicious'. With up to 18% sugar when tree ripe and very little russet, this cultivar can withstand storage until May. Some growers expect 'Kinsei' to compete strongly with 'Golden Delicious'. However, this cultivar is not yet widely grown so many of its cultural problems are not yet known.

'Sekai-ichi', a very large, red-striped apple with average flavor is not highly recommended by horticulturists because of its extreme size and tendency to become soft quickly in storage. However, with 'Sekai-ichi' fruit selling for as much as $3.00 each on the Tokyo market grower interest in this cultivar is high.

Rootstocks

Very few, if any, common apple seedlings are used commercially for rootstocks in Japan. Essentially all orchard trees are propagated on 1 of 4 *Malus* species: *M. prunifolia* var. *ringo*, *M. sieboldii*, *M. sieboldii* var. *arborescens* or *M. bacatta* var. *manchurica* (Table 4). About equal numbers of the existing trees are on either *M. prunifolia* var. *ringo* or *M. sieboldii*. However, in recent years more than 80% of the trees have been propagated on *M. prunifolia* var. *ringo*, preferred by most nurserymen because it can be propagated easily by cuttings whereas the other stocks are grown from seed. In addition, trees on *M. prunifolia* var. *ringo* stocks are smaller and more precocious than trees on the other stocks. However, the widespread use of *Malus* species and *M. prunifolia* var. *ringo* in particular is largely responsible for the increased importance of "top working" disease, a virus-induced disorder. This disease, characterized by a general decline of trees 1 to 3 years after top working, results from the extreme sensitivity of the rootstock to viruses that are present in scion varieties used for topworking. In many respects this disease is similar to the decline problem experienced by American and Canadian orchardists who used 'Virginia Crab' rootstocks a few years ago.

Some of the dwarf and semi-dwarf type rootstocks are being tested, but only on an experimental basis. Very few

Table 4. Percentage of commercial orchard trees propagated on various rootstocks (1958 data).

Rootstock	% propagated
M. sieboldii Rehd.	45
M. prunifolia Borkh. var. *ringo* Asaml	43
M. sieboldii Rehd. var. *arborescens* Rehd.	10
M. bacatta Borkh. var. *mancurica* Schn.	1.5
Apple seedling	<0.5

trees in commercial orchards are on dwarf stocks.

Orchard practices

By western standards most of the privately-owned orchards in Japan are exceptionally small; over 90% are under 3 acres, nearly 70% are under 1½ acres. Tree spacing varies from 40 to 80 trees per acre, with 72 the general recommendation. With the relatively small number of trees on each farm and limited land available for expansion, management practices are intense. Most trees are kept in production for a long time. Many orchards are between 30 and 50 years old, some with scattered trees as much as 60 years old.

Practically all bearing trees are grown with open-center-type pruning. Young trees are pruned with central-leader-type pruning until they are between 5 and 10 years old. At this time the main trunk is cut back to 4-5 ft above ground level and 2 or 3 branches trained horizontally, often for a distance of 10-15 ft (Fig. 4). Upright branches are brought up at various distances from the trunk and the entire tree pruned between 15-20 ft with most fruiting wood kept below 15 ft.

Except for chain saws, power pruning tools are not generally used in most orchards. However, trade schools specializing in teaching orchard management practices to high school graduates are now demonstrating the use of power tools including tractor mounted tree hedgers.

Hand pollination is sometimes used to improve fruit set, although this practice is not as common now as in the past. However, hand thinning is still done in all orchards. Thinning begins about 10 days after full bloom and may continue until early July in years of heavy set. Paper bagging of certain cultivars begins as soon as thinning is finished. With 'Golden Delicious' thinning and bagging is done at the same time, usually within 10 days of petal fall.

Paper bagging, developed in Japan and limited to a few Asian countries, was initially used to prevent fruit injury by diseases and insects, but now is used mainly to produce fruit with a fine finish and a somewhat different color. Small bags made of newspaper are used to cover the young fruit individually at an early stage. In mid- to late-July these small bags are removed and replaced by larger bags that are left on until shortly before or during harvest, depending upon the variety. Bagging is used primarily for 'American Summer Pearmain', 'Golden Delicious', 'Indo' and 'Mutsu', although some farmers also bag 'Orei', 'Fuji' and 'Ralls'.

Paper bagging greatly improves the appearance of all cultivars by reducing lenticel size and reducing the amount of russet on yellow cultivars. However, this practice greatly decreases both fruit flavor and storage ability. This effect is especially noticeable with bagged 'Golden Delicious' which have little of the aromatic flavor characteristic of the unbagged fruit.

Fig. 4. Open-center-type tree common in most Japanese apple orchards.

Some farmers use double bags or bags of black paper to enhance color formation and to remove ground color. Fruit treated in this manner usually develop unique coloration. 'Mutsu' and 'Golden Delicious', both yellow, develop a distinctive, bright pink color if bags are removed 40-50 days prior to harvest. To obtain uniform color these fruit are rotated periodically by hand. If bags are left on until harvest the fruit develop a pale whitish-yellow appearance. 'Fuji', normally red, becomes bright yellow if black bags are left on until harvest. Although an attractive novelty, such fruit have little flavor.

Currently, bagged fruit of most cultivars sell for premium prices because of their appearance. However, many people, horticulturists and growers alike, feel this practice should be discontinued not only because it produces generally poor quality fruit, but also because of the labor cost involved. An average worker can bag about 3,000 fruit per day and is now paid between $3.00 and $4.00 for the day. Growers estimate that bagging alone accounts for nearly 20% of the total production costs and requires about one-third more labor than when bagging is not done. Faced with increasing costs and with a difficulty in finding sufficient labor, some farmers have already substantially reduced the numbers of fruit bagged.

Although paper bagging was first developed to reduce fruit injury by diseases and insects, chemical control methods are now used routinely in all orchards. As many as 12-15 sprays are applied each season. In orchards located on steep hillsides sprays are applied from stationary tanks or by hand sprayers. In level or terraced orchards application is by tractor drawn speed sprayers of the same make and models as those used in American orchards. The first speed sprayers were introduced into Japan from America in 1923 and were in common use by 1926. This equipment, which is too expensive for individual growers, is owned and operated by grower cooperatives organized solely for this purpose. Spray schedules are determined at annual meetings. Growers furnish the chemicals; the cooperative supplies the equipment, an operator and an assistant to prepare the chemicals. Growers are charged a fee based one-half on acreage and one-half on operation time.

Another hand practice common in Japanese orchards is leaf thinning prior to harvest to improve the color of red cultivars. Leaves that shade individual fruit are removed by hand in 2 stages about one week apart in late Sept. and Oct. Two thinnings are used to prevent sun scald by the sudden exposure of shaded fruit to direct sunlight. When leaves are removed each fruit is rotated slightly to expose those areas shaded by branches or spurs. Although this practice requires considerable hand labor, growers contend that it increases the overall price of fruit about 2-fold by increasing the number of top grade fruit from a given tree. 'Jonathan' and 'Ralls' are leaf-thinned chemically by applying 2000 ppm 2,3,5-triiodobenzoic acid (TIBA) to trees around Oct. 1st and 10th, respectively.

In Aomori Prefecture a late Bourdeaux spray is applied shortly before harvest to aid the coloration of red varieties.

Disease and insects

At least 30 disorders of apples caused by fungi, viruses or physiological conditions occur in Japanese orchards along with numerous insect pests. The high rainfall and humidity conditions make fungal diseases particularly important. However, except for crown gall, which occurs but which is not a serious problem, bacterial diseases of apple do not occur. Fireblight, an important disease of both apple and pear in North America, has not been reported in Japan.

Several fungus diseases are economically important because they occur in many areas and cause extensive damage unless expensive control measures are used. Most important of these are *Monilia* blossom blight, *Alernaria* leaf blotch and powdery mildew. Apple scab, first found in 1955, is considered a serious potential problem, but until 1972 this disease was restricted to Hokkaido Island and to a few local areas in northernmost Honchu. During 1972 apple scab occurred throughout much of the Tohoku District. How this disease will affect the present industry is a source of

general concern to growers.

Early dormant sprays of oil or lime sulfur followed by Dichlone and Thiram during early bloom are the general spray recommendations. Bourdeaux mixture is the general cover spray. However, several new organic fungicides are gradually replacing Bourdeaux in many areas. Polyauxin, an antibiotic, is proving effective against *Alternaria* leaf blotch.

Japanese apple canker (*Valsa mali* Yamada) which does not occur in America deserves special comment because of its destructiveness. This fungus attacks all apple cultivars, apparently through pruning wounds or other types of wounds and spreads rapidly through the bark tissue producing a wrinkled, orangish-pink canker on the bark. If caught at an early stage bark cankers can be removed without serious damage to the tree, especially if the cut surface is painted with a solution containing copper 8-quinolinolate. However, untreated cankers quickly spread deep into the wood and extend in all directions. Limbs are girdled and die in a short time. If not removed, cankers on the main trunks can kill entire trees. In recent years this disease has increased in importance in the northern areas presumably due to the increased use of organic fungicides in place of Bourdeaux mixture and to the increasing number of abandoned orchards near urban developments that serve as a ready source of inoculum.

Physiological disorders such as bitter pit on 'Golden Delicious' and Jonathan spot on 'Jonathan' are chronic problems in some areas. Some recent experimental work seems to connect the increase of these disorders with the decreased use of Bourdeaux mixture as a ready source of calcium. Rough bark, apparently due to an excess of manganese in some soils occurs in some localities. Sun scald is common in most areas, but is especially troublesome on Hokkaido Island where skies are generally overcast except for brief periods of bright sunshine.

Several virus diseases and virus-like diseases have been found in commercial orchards and many of these appear to be increasing in importance in recent years as growers topwork old orchard trees with some of the newer apple cultivars. Viruses causing green crinkle, scar skin, star crack and dapple apple diseases have been transmitted from infected to healthy trees. Symptoms similar to those caused by rubbery wood, flat limb and flat apple viruses have been observed but transmission results are not yet available. Currently the most important virus disease is the so-called top working disease mentioned earlier. This disease occurs in all apple growing areas and affects trees of all cultivars. Trees on sensitive rootstocks decline within 1-3 years after topworking, especially when many of the new color sports imported from America are used for grafting. Although infected trees do not die outright, they become unproductive and are more susceptible to winter damage and attack by root rot fungi. Partial recovery of diseased trees can be obtained by inarch grafting diseased trees with rooted apple seedlings.

The need for some type of virus-free apple certification program is well recognized in Japan and some efforts are being made along these lines. However, few attempts have been made so far to import virus-free cultivars from other countries.

Of the numerous insect pests reported in Japanese orchards, the most important are oriental fruit moth, peach fruit moth, smaller tea tortrix, comstock mealy bug, aphids and European red mite. Several acaricides and organic insecticides are being used effectively.

Harvest

Apple harvest begins in mid- to late-July in Nagano Prefecture and in mid- to late-August in northern prefectures with 'American Summer Pearmain' the first cultivar harvested (Fig. 5). The bulk of the apples are harvested through October and early November, a period which coincides with rice harvest in most areas.

Most cultivars are ripened on the tree before picking. However, there are some exceptions. As was mentioned earlier, 'American Summer Pearmain' are picked and marketed while still green. 'McIntosh', with its tendency for early drop, is often picked early and the final ripening done on mats of rice straw on the ground. Nagano Prefecture is noted for 'McIntosh' ripened on the ground. Fruit are placed on rice straw mats and sprinkled with water 2 or 3 times per day to accelerate ripening. In some locations, 'Golden Delicious' are picked and shipped while still slightly green.

In contrast to the early harvest of some cultivars, many farmers delay picking 'Delicious' until November to increase the number of fruit with watercore. Watercored apples are preferred by many Japanese because of their sweet taste. These fruit often bring a premium price. Aomori Prefecture markets watercored 'Starking' under the name 'Sweet Delicious'.

Because of the pruning methods used in most orchards, nearly all fruit can be reached from 6-8 ft ladders. As in America, Japanese pickers are reluctant to use longer ladders. In contrast to the Pacific Northwest where pickers are paid for fruit picked, all Japanese pickers are paid daily wages. The current daily rate varies between $4.00 and $6.00 per day for men and between $3.00 and $5.00 per day for women.

Because orchards contain relatively few trees, all fruit are harvested with great care. Most Japanese orchardists seem to feel that paying for the amount of fruit picked would be an impossible system in Japan because of the damage to fruit by careless pickers. However, this attitude may change as labor costs increase.

Pickers use wicker baskets of bamboo that hold 20-30 apples when full. After several baskets are filled, the fruit are transferred to wooden boxes, carried to a sorting room, usually in the home, and hand sorted according to size, color and freedom from blemishes. Fruit for local markets are packed in 40 lb. wooden boxes lined with newspaper packing. Fruit shipped to the Tokyo market are packed with rice hulls or, more recently with polystyrene liners.

In Iwate Prefecture 10 boxes is

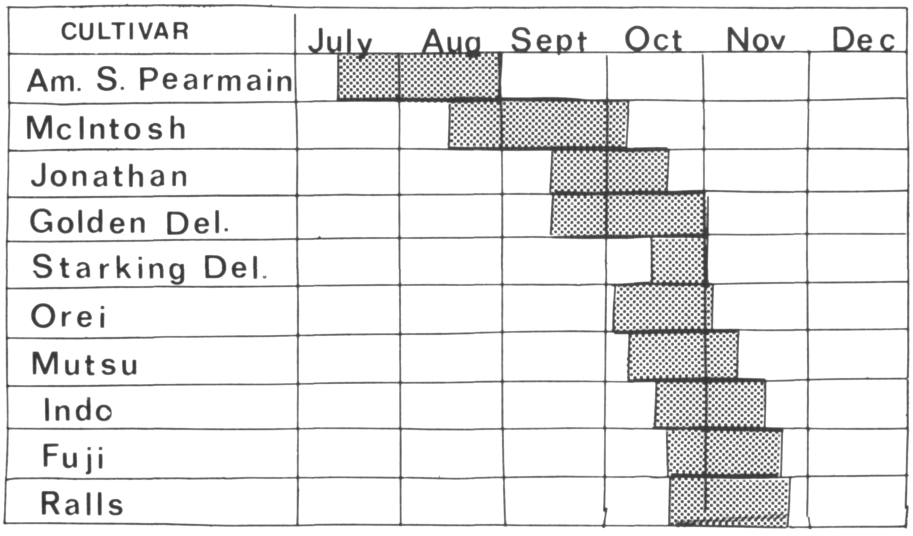

Fig. 5. Range of beginning harvest dates for the major apple cultivars in Japan.

considered ideal production for standard trees. However, the yearly average, according to figures from the prefectural Horticultural Association is closer to 8 boxes with 'Starking' averaging around 7 boxes and 'Ralls' averaging nearly 11 boxes.

After picking, nearly 70% of the apples are taken directly to the market for immediate sale. Farmers that live near the urban areas with large central markets deliver their fruit personally. Those living in the rural areas belong to marketing associations that collect and transport the fruit to market. Less than 20% of the apples are marketed after January.

The relatively small amount of apples that are stored are kept in cold storage facilities mainly on the farm. Cultivars with good keeping qualities such as 'Fuji' and 'Mutsu' may be stored as late as the following May in cold storage.

There are a few controlled atmosphere (CA) storage facilities in Japan but this process is not popular, as most consumers prefer the taste of tree ripened fruit. The largest CA storage building in Iwate Prefecture is now used mainly for cold storage.

Marketing

On the farm apples are graded into four grades; extra fancy, fancy, good and culls. Culls are separated into 2 groups; the better fruit are sold to some local retailers, the remainder used for juice, jam or as a blending material in tomato catsup. Japanese prefer catsup blended with apples to that made entirely from tomatoes. No applesauce or apple butter is made commercially in Japan, and despite the popularity of many American foods, apple pie is made by only a few specialty shops.

Three market grades are based on % color (for red cultivars), size and freedom from blemishes. Premium 'Starking' range between 50 and 60 fruit per box while premium 'Jonathan' run 90 per box.

Most apples are sold through the numerous rural central markets scattered throughout the apple production areas. The largest of these are located in Sendai and Morioka. A large proportion of the fruit from these markets are subsequently shipped to Tokyo and sold to wholesalers through the large central consumers market.

In 1970 the average wholesale prices on the Morioka market ranged from \$2.27 per box for McIntosh to \$4.39 for Starking (Table 5). Extra fancy grade usually sold for 25% above these figures while good grade sold for about 30 percent below. On the same market, 'Fuji' cultivar brought between \$6.00 to \$15.00 per box.

Marketing figures for 1970 provided by the Iwate Horticulture Association indicated that the average wholesale price for all apples sold in the prefecture was \$3.22 per box and the average yield was slightly over 600 boxes per acre, making the average gross return from apples in this area nearly \$2,000 per acre. Good growers were able to double this figure.

Table 5. Average price for apples in Iwate Prefecture in 1970.

Variety	\$/box (40 lb.)
McIntosh	2.27
Jonathan	2.33
Ralls	2.39
Indo	3.00
American Summer Pearmain	3.55
Golden Delicious	3.78
Red Delicious	3.78
Starking Delicious	4.39
Fuji	> 6.00

In 1971 early spring frosts and an unusually cool, rainy summer resulted in an excess of low quality apples that substantially decreased the price in the low market grades. However, the price for top grade fruit increased over that of the previous year. In November extra fancy 'Fuji' and 'Mutsu' sold for \$16.00 and \$28.00 per box, respectively.

In western style supermarkets, apples are displayed in clear plastic containers of various design. The fruit are good to fancy quality and most are blemish-free. In small local retail stores, apples are displayed in small piles of 5-8 fruit on fruit counter. These fruit are often unwashed and many are still covered with Bourdeaux spray residue. During display many apples develop a variety of fruit spot disorders but no effort is made to remove the blemished fruit. Most cultivars retail for \$0.30 to \$0.50 per pile. No special advertising techniques are used to promote apple sales.

Extra fancy apples are sold mainly in speciality shops for use as gifts. They are usually attractively packaged individually or in combination with other fruit. Prices for apples sold in these shops are unusually high. In the apple production areas individual 'Fuji' fruit sell for about \$0.50 each. In Tokyo, 'Fuji' and extra fancy pink 'Mutsu' sell for up to \$1.50 per fruit. In 1971, 'Sekaiichi', although not recommended by horticulturists, sold for about \$3.00 per fruit in Tokyo.

Future of the industry

In nearly every meeting with growers or horticulturists the question was invariably asked of me – how do apples grown in Japan compare with those grown in America? The question was difficult to answer in one word; better or worse. Low quality cultivars such as 'Ralls', 'American Summer Pearmain' and 'Indo' obviously cannot be compared with 'Delicious', 'Golden Delicious' or even 'McIntosh' grown in either country. 'Jonathan', 'McIntosh' and 'Golden Delicious', in my opinion, looked and tasted the same in Japan as in America, except for the bagged fruit which were obviously low quality. Because of the differences in harvest and storage methods it was difficult to compare Japanese 'Delicious' with those shipped commercially from Washington State. Tree ripened fruit, in my opinion, are preferable to those stored in CA storage, but the taste of tree ripe 'Starking' in Japan was no better than that produced in most Yakima Valley orchards. The largest negative factor for 'Delicious' under Japanese conditions was its tendency to become soft after rather short storage periods.

Of all the cultivars, American or Japanese, grown in Japan, my personal choice was 'Fuji'. Even though the standard selection lacks the color generally required by American consumers, its fine quality and the fact that it can be stored all winter with little change in texture or quality makes Fuji competitive with anything produced in America. Fuji does, however, have one disadvantage. Many fruit develop an internal crack around the core near the stem end. The cause of this problem hasn't yet been determined.

The extremely high price paid for extra fancy 'Mutsu' and 'Seiki-ichi' was completely unjustified on the basis of taste. This opinion seemed to be shared by many horticulturists who were puzzled by the rapid increase in popularity of 'Seiki-ichi'. However, the traditional Japanese custom of giving gifts of fruit, particularly to convalescents, provides a strong demand for large, attractive fruit. As these fruit are rarely eaten by the purchaser, size and appearance are far more important than quality.

Growers and horticulturists are generally optimistic about the future of the apple industry. A healthy economy and the improvement of markets in the densely populated areas of southern Japan are increasing the demand for apples. These factors, together with a general shift from rice to other crops, should produce a sizable increase in apple acreage over the next decade. On the other hand, there is much concern within the industry that importation of apples from foreign countries, particularly from the U. S., will greatly affect this growth potential and possibly even cause a reduction in the size of the industry. Some of these fears are probably true in view of the large number of low quality cultivars such as 'Ralls' and 'Indo' that are now being grown. However, with the rapid trend underway toward high quality cultivars such as 'Fuji', 'Delicious' and 'Golden Delicious' it seems unlikely that imported apples will seriously threaten the local apple industry so long as Japanese consumers continue to prefer sweet, tree ripened fruit.