

STRAWBERRY GROWING IN JAPAN

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The Horticultural Development Council funded a strawberry study tour, by Malcolm Beech in June 1988, to determine the varieties, growing systems and advances in research which have made Japan one of the leading dessert strawberry producing nations (Table.1.).

Table.1. Worldwide strawberry production (ooo's tonnes)

NATION	PRODUCTION
UNITED STATES	500,000
POLAND	300,000
SPAIN	210,000
<u>JAPAN</u>	<u>200,000</u>
ITALY	191,000
RUSSIA	126,000
FRANCE	92,000
UNITED KINGDOM	60,000
MEXICO	56,000
WEST GERMANY	51,000

Detailed information on the Japanese strawberry industry has been difficult to obtain and research results, produced for farmers in Japanese as bulletins or grower blueprints, expensive to translate.

It was considered worthwhile therefore to visit Japan to see, learn and discuss firsthand their strawberry industry. Knowledge gained could then be taken into account during review of research needs as addressed by the IHR, East Malling, strawberry research programme, thereby negating the need for some potentially expensive experiments, thus speeding up research progress. I visited the Nara Prefecture, near the city of Osaka, as available information identified this region as a foremost area for strawberry research and culture.

The Japanese horticultural industry consists of both temperate and tropical crops. Planted areas are small with an average farm size of less than one hectare. Diseases, pests and weeds are prevalent and difficult to control because of high summer rainfall and temperature. Successful growing is dependent, therefore, on pesticides, protective coverings and resistant varieties. To meet these requirements and to increase production, labour growth has been inevitable. However, due to labour shortage, farmers have had to resort to mechanisation suitable for small scale land use e.g. most farmers own or share hand operated rotovators, bed-formers and mini-tractors.

In 1927 there was about 350 hectares of small-scale open field strawberry cultivation. Now the Japanese strawberry industry comprises 11,000 hectares producing 200,000 tonnes of dessert quality strawberry fruit (Table.2.). Acreage has declined, however, and a further decrease is anticipated.

Table.2. Strawberry production in Japan since 1975.

	1975	1980	1988
YIELD (tonnes)	165,000	193,000	200,000
CROPPED AREA (Ha)	11,900	11,900	11,000
TONNES/HECTARE	13.9	16.2	18.2

Processing companies purchase direct from the grower so statistics on area occupied and tonnage produced are not readily available. Fruit for processing are used mainly for cake decoration; there are no canning outlets.

STRAWBERRY BREEDING

There are about 17 Government and several privately funded strawberry breeders in Japan. It should be noted, however, that breeders are not crop specific and that they may also be responsible for breeding other plant species e.g. edible chrysanthemum, eggplant or pepper or involved with agronomic studies and the production of strawberry mother plants certified free of virus, pest and disease for release to the industry.

Indicative of how difficult it is to breed a new strawberry is their main variety "Hokowase" which has been the mainstay of the industry for some 20 years (the Japanese "Cambridge Favourite"!). Only recently have new varieties been introduced able to compete with "Hokowase" and grower pressure for the release of new varieties is strong and increasing.

Advanced breeding selections are tested at Prefectural (similar to our Counties) Agricultural Research Stations for yield, fruit quality, disease resistance and marketability. If a selection passes these tests then it is registered and patented. It usually takes 6-7 years from the initial cross to application for a patent.

GROWING SYSTEMS

Until the 1960's a growing system known as stone-wall strawberry culture predominated. This consisted of growing strawberries in soil enclosed by stone or cement block fences on south facing hillside slopes. Thus heat, captured during the day, was retained at night thereby forcing the strawberry into early growth. This system is now only used for a small PYO industry.

The Japanese currently use eight different growing systems to extend the strawberry cropping season and increase yield (Table.3.). These systems are essentially designed to force the strawberry into production in time for Christmas when traditionally the price of fruit is high. Conventional "open field" growing only accounts for 4% of the industry with cropping in May/June at an average of 15-20 tonnes/ha.

Table.3. Acreage and popularity of growing systems used in Japan.

GROWING SYSTEM	ACREAGE		TREND
	Hectares	% of total	
FORCING	7590	69	+
SEMI-FORCING	2310	21	-
OPEN FIELD	440	4	=
COLD-STORED	440	4	=
LOW-TUNNEL	220	2	=

(+) increasing; (-) decreasing; (=) stable.

The unique point about Japan therefore is that approximately 92% of the land used for growing strawberries is under protected culture. Protected cropping was introduced in the 1960's and, apart from July to September, allows year round production. The main system of "forcing" predominates with the other systems being a variation on this theme.

Forcing system

Prior to plant establishment the nursery bed is fumigated, in the winter or spring, by use of methyl bromide:chloropicrin (98:2). Fresh dug runners are then planted in mid-July.

The fruiting field is renovated by growing and cultivating in sorghum to provide a green manure and, additionally, by incorporating 10-20 tonnes/ha of chopped rice straw to improve soil texture. Following cultivation, ridges, 60-70cm wide, are formed to increase available soil surface area.

The site is then covered, from mid-July to mid-August, with a high polythene tunnel. At the same time the ridges are covered with a floating polythene mulch to help increase soil temperatures to 50 C at the soil surface and to 40 C at a depth of 15cm. This technique known as "solar soil sterilisation" is used to alleviate problems with Fusarium wilt which is killed by subjection to temperatures of 60 C for 10 minutes; temperatures of 40-50 C over longer periods are also sufficient. Following soil sterilisation the land is re-cultivated and raised beds, 1.2m wide, formed.

Plants are lifted from the nursery bed in mid-to-late August, their roots trimmed and immediately planted in the fruiting field. The roots are trimmed to deplete the plants of nitrogen during the short day flower initiation period in September. The Japanese have determined that low plant nitrogen levels at this time results in enhanced and earlier flowering. The runners are planted, 15cm apart in double rows, to give a population of 98,800 plants/ha. During plant establishment mist irrigation is provided, twice daily, to cool the foliage and immediate environment. Mist irrigation is essential as the trimmed roots are not capable of adequately replenishing the water that would normally be lost through transpiration.

Following flower bud initiation the beds are mulched, in October, with black polythene and the high tunnels covered with a 75um gauge polythene film. At the same time dormancy is inhibited by spraying the plants with gibberellic acid at 10ppm (to increase vegetative growth) and provision of a 16-hour day from 100 Watt incandescent lights (ordinary household light bulbs).

Flowering and fruiting begins in November when a second polythene skin is added to the high tunnel and low polythene tunnels erected over the raised beds. The aim of these treatments is to produce as much fruit as possible just before Christmas. Most of the fruit is produced in January, however, with cropping continuing until March with yields averaging 47-62 tonnes/ha.

Most growers grub the tunnel at the end of March and replant with crops giving a higher return at this time of year e.g. tomato, eggplant or cucumber. Other growers rest the strawberry plants during April and, following thinning of crowns to one per plant, continue to pick strawberries until late May/early June. The lights are removed from the tunnels at the end of March but flower initiation still occurs under long days in February and March as cold night temperatures, of just over 5 C, override the normal photoperiodic control mechanism inducing flower initiation. Fruit size is increased at this time by the provision of extra nitrogen; at 34kg/ha through the drip irrigation system in March or by use of 80-100kg/ha slow release fertiliser previously incorporated in the beds.

The system of continuous cropping was developed following the discovery that flower initiation occurs with short day varieties (June bearers) under both short and long days providing that the ambient temperature remains within 6-14 C (Table.4.). At temperatures below 5 C plants enter dormancy and above 15 C they become vegetative under long days. Before entering a variety into a "forcing" system, therefore, the Japanese make a point of determining its physiological responses to daylength and temperature so that cropping potential can be optimised.

Table.4. Effect and interaction of photoperiod/temperature on flower initiation of the June bearing strawberry variety "Hokowase".

		Temperature (C)			
		0-5	6-14	15-24	25+
Daylength					
Short day	Dormancy	Flower initiation	Flower initiation	Vegetative growth	
Long days	Dormancy	Flower initiation	Vegetative growth	Vegetative growth	

HARVESTING

Fruit are harvested, between 3-4am, into a single container and then graded in a fruit store into one of seven grades depending on size e.g. LLL (20-25+g); LL (18-20g); L (15-18g); M(11-14g); S (8-10g); SS (5-7g); and additionally in December and January, a misshapen fruit category. The L and M sizes are the most popular and fetch a premium. The fruit arrives pre-graded at the market by 8 am and reaches the shops by 9 am. This short time interval between harvesting and marketing is essential for the variety "Hokowase" which has a soft skin and consequently a short shelf-life. The Tokyo/Osaka regions produce the most strawberry fruit with 40% being sold locally. The remainder is shipped north, so a firm skinned variety is required to withstand the rigours of transportation. It is estimated that the average consumption of strawberries in Japan is 300g/person/annum.

VARIETIES

Table.5. Strawberry varieties grown in Japan.

VARIETY	% OF ACREAGE	TREND
HOKOWASE	27	-
NYOHO	35	+
TOYONOKA	18	+
REIKO	7	-
DONNER	7	-
OTHERS	6	-

(-) decreasing; (+) increasing.

Hokowase. Until recently the most commonly grown but is now being replaced by new varieties (Table.5.). It has very soft skin and flesh, a medium red skin colour with a sweet, highly aromatic flavour. The plants are vigorous and susceptible to Fusarium wilt, mildew and botrytis.

NYOHO. Vegetatively vigorous making it ideal for the "forcing" system as it does not require long day or gibberellic acid treatment. The fruit are large, very attractive, firm and well flavoured. It is susceptible to anthracnose (black fruit rot).

Toyonoka. A high-yielding, firm, large-fruited variety which suffers from susceptibility to powdery mildew. The flavour is excellent but variable fruit ripening can be a problem.

Aiberry. A recently introduced, privately bred, variety also known as "loveberry". Its fruit are exceptionally large with the primary berries averaging 80g per fruit. The fruit are also sweet and very soft, For these reasons it is marketed as a berry that young couples can share !. The plants are susceptible to botrytis, mildew, anthracnose and Fusarium wilt.

Summerberry. Another recently introduced variety identified as a day-neutral type as it has the ability to initiate flower buds in the long days of July and August. It is high yielding with good fruit size, firmnes and aromatic flavour.

CONCLUSION

The Japanese have made full use of innovative research in the development of their growing systems and varieties. Experimental Agricultural Research Stations provide growers with bulletins on how to grow a given variety along with details of its physiological responses to variation in daylength, temperature and plant growth regulator treatment. Clearly this information has helped to extend the cropping season, to increase yields, improve fruit quality and, thereby enabling Japan to become a leading strawberry producing nation.

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