Soybean Cultivation in Japan

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Demand and production

Soybeans have high nutritive value and the soybean plant is advantageous in that cultivation does not require so much labor and soil fertility does not deteriorate. For these reasons it has been cultivated in Japan for a long time as an important crop and it is still widely cultivated throughout the country, following rice, wheat, white and sweet potatoes and naked barley among the ordinary crops.

The consumption of soybeans in Japan (domestic production & import) was about 700,000 tons during the 1910's and about a million tons in the 1930's. From the 1960's consumption has rapidly increased, witnessing over 2.7 million tons in 1969 and the increasing trend in demand is not slackening (Table 1).

About 70% is used for oil crushing and the remainder is used for 'Tofu'*, 'Miso'*, 'Natto'*, other foodstuffs and feed. The soybean meal from the oil crushing is used mostly for feed (79%). Major portion of the increased demand is due to the augmentation of oil consumption.

Table 1. Production and consumption of soybeans in Japan

Year	Planted area 1,000 ha	Production 1,000 t	Imports 1,000 t	Consumption* 1,000 t	Self supplying rate %
1915	462.9	488.2	248.0	736.2	66
1920	468.1	547.6	340.6	888.2	62
1925	389.3	451.9	557.2	1,010.1	45
1930	342.5	388.6	612.6	1,001.2	39
1935	328.1	288.6	649.5	958.1	31
1940	319.8	314.2	561.5	876.7	36
1945	257.6	170.4	800.0	970.4	18
1950	413.1	445.9	197.4	643.3	69
1955	385.2	507.1	808.2	1,315.3	39
1960	306.9	417.6	1,128.3	1,545.9	27
1965	184.1	229.7	1,847.5	2,077.2	11
1968	122.4	167.5	2,420.8	2,588.3	6
1969	102.6	135.7	2,590.6	2,726.3	5

* Production & Imports.

* 'Tofu', 'Miso' and 'Natto' are soybean curd, soybean paste and fermented soybean respectively, which are necessities in the Japanese diet.

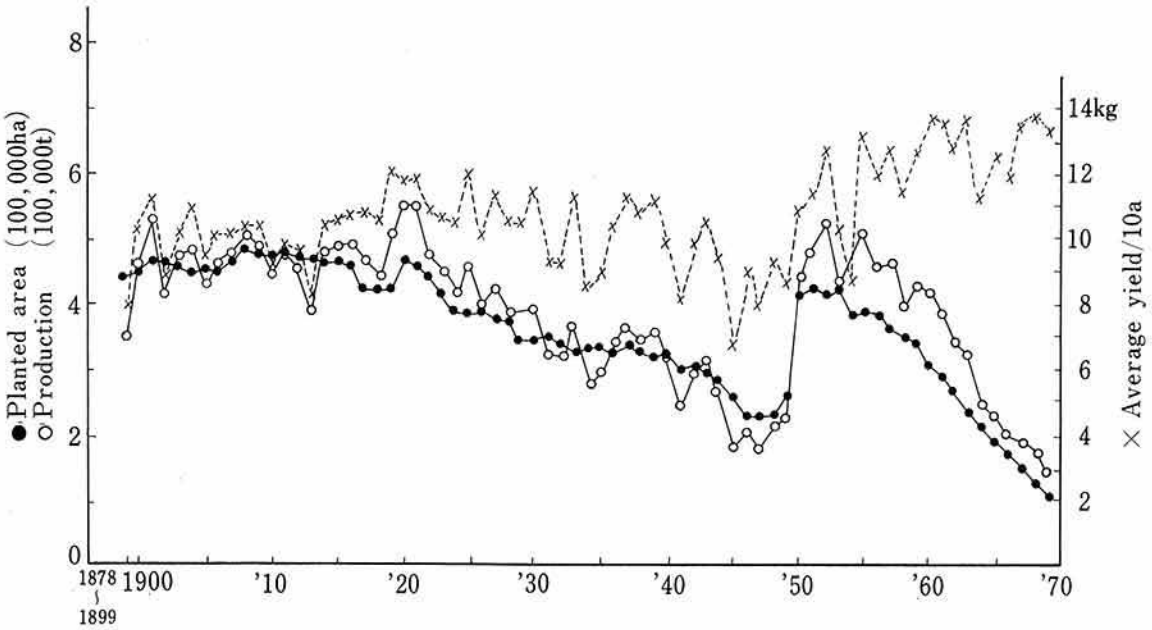

Fig. 1. Soybean production in Japan.

On the other hand, against such a consumption increase the planted acreage and production of soybeans in Japan have decreased as shown in Fig. 1 on account of the import of Manchurian soybeans up to 1945. Although the production had once increased since then the hike in import from the United States accelerated the decline. The self-supplying rate of soybeans in the 1920's and the 1950's was over 60%, but in 1969 it was only 5 per cent.

Condition of location

Soybean cultivation is widely practiced throughout the country between about 30°N and about 45°N, particularly, in Hokkaidō, every prefecture of the Tōhoku region and in Nagano, Niigata and Kumamoto Prefectures. Soybean heretofore was planted in an important part of the upland, but in recent years it has been replaced by other crops and is being transferred from level to slope lands nearly to poor condition land.

Even the general practice of planting soybeans at the ridge of paddy field is also decreasing in recent years. However, in spite of the poor condition of location, the reason for no decline in the average yield per acreage is attributed to the result of breeding and the progress in cultivation technique.

The major cultivating districts stated above are characterized by daylength (sunrise-sunset); minimum 9~10 hours and maximum 14~16 hours, and for the greater part of the growth period, over 12 hours.

The average monthly temperature of those districts is maximum 20°~27°C in August, and minimum −10°~−5°C during December to January.

The precipitation is about 1,000 to 2,500 mm a year and those between November and February are the lowest, being about 50 mm each month. However, in Niigata and Akita Prefectures on the Japan Sea side a large precipitation of 150 to 300 mm is sometimes witnessed during this period due to heavy snowfall. In general 100 to 150 mm is the monthly average in June to September and in Kyushu it is larger exceeding 300 mm in June and July.

The monthly sum of the sunlight duration is about 150 to 200 hours for each month

Fig. 2. Soybean field in Japan, flowering stage.

Fig. 3. Soybean field in Japan, pod filling stage.

Fig. 4. Soybean field in Japan, mature stage.

throughout the year. Under such a climatic condition soybean is planted between April and July and harvested between August and November.

Cropping system

Generally, after the harvest of leguminous crops weeds are few and as the soil is soft and swollen it is suited to root crops. Because the land is fertile after the root crops it is beneficial for gramineous crops. Thus, the crop rotation in the order of root crops→ gramineous crops→leguminous crop is adapted as a rule. However, in recent years, because emphasis has been placed on the cultivation which increases farm income various types of short-term rotation have been adapted, resulting in diversification of the cropping system. Moreover, in the Tōhoku region and southward where the soybean is cultivated after wheat or barley, there are many cases where the catchcropping is pratcticed between those crops.

Cultivation method

Varieties

As the history of soybean cultivation is long it has undergone a great differentiation and

many varieties have been bred under natural and artificial conditions. At present, many types of soybean suitable to respective regions from the torrid zone to the sub-frigid zone are being cultivated. In Japan there are as many as 400 varieties that can be grown by farmers, and besides these indigenous varieties 53 varieties have been bred at several breeding centers and are registered with the Ministry of Agriculture and Forestry. Each of these varieties has its own superior character with respect to maturity, resistance to diseases and insects, high yield, white hilum, large grain and high protein content.

The maturity of varieties is classified in I~V and a~c by the number of days to flowering and by the number of days from flowering to ripening respectively; namely, the earliest varieties of Ia to late varieties of Vc. Of those varieties, Ia and Ib are being cultivated in Hokkaidō, IIb, IIc and IIIc in the Tōhoku, Tōsan and Hokuriku regions, IIa and IIb in Kantō, and IIIc~Vc, Ia and IIa in Western Japan. Furthermore, the varieties are sometimes classified into summer soybean, fall soybean and intermediate soybean from the relation between the planting time and the flowering and maturity.

Each prefecture selects and recommends varieties suitable to its own district. The recommended varieties of major producing prefectures are listed in Table 2.

Fertilizer

The absorption of nutrition by soybean plant continues up to the later growth period and this influences the yield. N and P are the elements which are accumulated mainly in grain and are taken in from the field in a large quantity together with Ca and Mg in a pod-shell. Although the N is supplied by nodulating bacteria (Bacillus radicicola) to a certain extent, to ensure a good yield it is inadequate and large amounts of fertilizer elements are necessary. Thus, in recent years, intensive fertilizer application is being recommended.

The amount of fertilizer to be applied differs with soil, climate and other cultivating conditions but generally, an optimum application per are is N: 0.2 kg, P_2O_5: 1.0 kg, K_2O: 0.5 kg, dolomitic limestone: 6 kg and compost: 100~200 kg.

Planting time

Sowing is said to be ready any time when soil temperature is over 15°C and there is no fear of late frost. The planting time is determined by considering the crops to be planted before and after as well as variety. When the temperature is low the emergence is delayed, and during that period the plant sustains damage from disease and insect. In the case of catchcropping of wheat or barley, in order to diminish the adverse effect of shade as much as possible the catchcropping period is recom-

Table 2. Recommended soybean varieties in the principal prefectures

Prefecture	Varieties
Hokkaidō	Asamidori, Karikachi, Koganejiro, Kitamijiro, Nakatehikariguro, Wasekogane, Shinsei, Oshimashirome, Yoshiokatairyū, Shirotsurunoko, Okuhara 1, Shirosengoku, Isuzu, Wasemidori, Hokkaihadaka, Sakamotowase, Hōrai, Kitamusume
Aomori	Iwate 2, Tokachinagaha, Mutsumejiro, Raiden, Mutsushiratama
Iwate	Yamashiratama, Shiromenagaha, Tokachinagaha, Kokeshijiro, Raiden, Waseshirome
Miyagi	Shinmejiro, Miyagishirome, Kokeshijiro, Raiden
Akita	Waseshiroge, Raiden, Obakohikari, Raikō, Nemashirazu
Yamagata	Ōu 13, Raiden, Kokeshijiro,
Fukushima	Fukumejiro, Hatsukari, Raikō, Okumejiro, Kairyōkakushin
Nagano	Hatsukari, Fujimijiro, Shiromeyutaka, Misuzudaizu
Niigata	Azeminori, Fusanari, Hatsukogane, Fukusennari,
Kumamoto	Koganedaizu, Shirasaya 1, Asomasari, Asoaogari, Hōgyoku, Asomusume, Higomusume

mended to be less than 15~20 days for early varieties and within 30 days even for late varieties.

The optimum planting time is middle to late May in Hokkaidō, early May to early June in the Tōhoku, Kantō and Tōsan regions and middle to late April for summer soybean and middle July for fall soybean in Kyushu.

Planting rate

The planting rate is determined by soil fertility, variety, the degree of luxuriant growth according to the planting time and row width of the previous crop plant. In most cases 60 cm row width and 2 plants with 20 cm between plants are practiced. Recently dense planting by mechanized cultivation is being recommended with 70 to 75 cm row width and the space between plants 10 cm or sowing in drills for early varieties and 20 to 30 cm for medium or late varieties. The seed rate is 0.5 to 0.7 kg per are.

Land preparation

In an ordinary upland the plowing and land preparation is made by a power cultivator or by a tractor attached with plow or harrow. In the case of catchcropping the plowing is carried out lightly by a cultivator or hoe and sometimes no plowing is made at all.

Intertillage and hilling

Intertillage increases the water-holding capacity of soil and provokes the aeration in soil. Hilling stimulates the development of new roots by covering the lower portion of the stem by soil, promotes the nutrient absorption as well as the resistance to lodging. Moreover, both serve as a means of weeding. Intertillage and hilling are practiced ordinarily 1 to 3 times by a cultivator or hoe.

Control of weed, insect and disease

The use of herbicide has advanced in recent years and the soil treatment immediately after sowing is recommended by the use of trifuralin (1~1.5 g per are) or linuron (0.75~1 g per are). In this case to ensure the effect of weeding and to prevent damage from herbicide it is necessary to determine the kinds and the amount of herbicide to be applied by giving due consideration to the kinds of weed and to the nature of the soil.

Major diseases of soybean in Japan are virus, purple speck (*Cercospora Kikuchii*, MATSUMOTO et TOMOYASU) and fusarium bright (*Fusarium oxysporum f. tracheiphilum*). The control of these diseases is done mainly through the breeding of resistant varieties and there is scarcely by chemicals.

There are many kinds of insects in Japan. Up to the 1950's the insect damage was of such a magnitude that there was some district where soybean cultivation was impossible. Major insects are soybean cyst nematode (*Heterodera glycines* ICHINOHE), soybean pod gall midge (*Asphondyla sp.*), soybean pod borer (*Glycinivorella* MATSUMURA), lima bean pod borer (*Etiella zinckenella* TREITSCHKE), bean bug (*Riptorthus clavatus* TSUNBERG), bean beetle (*Anomala ruforcuprea* MOTSCHULSKY) and seed maggot (*Hylemyia* platura MEIGEN).

Soybean cyst nematode is controlled by the cultivation of resistant varieties such as Raiden and Raikō, soil treatment with such an insecticide as D–D (about 2 *l* per are) or under long term crop rotation. Against the seed maggot ECP or diazinon is dusted at sowing (0.3 kg per are). For the control of other insects from the early period of pod formation after the flowering, fenthion (0.4 kg per are) is dusted 2 to 4 times. In case of a large outbreak of aphis (Aphis glycines MATSUMURA) and bean webworm (Nagia ruralis SCOPOLI) the spraying or dusting of malathion and fenthion is recommended.

Harvesting and threshing

Very early varieties of warm districts reach maturity in July and August and others between September and November. The ripened soybean plants are reaped by sickle or pulled up by hand, and several plants are bound into a bundle and dried on the ground or on rack.

Threshing is carried out by a threshing

machine and after removing the podshells and foreign materials soybeans are dried until the moisture content falls below 15%, and then marketed or stored.

The stems and pod-shells after the threshing are used as compost or fuel.

Mechanized cultivation

On such a large farm as in Hokkaidō, mechanized cultivation of soybeans is being carried out and experimental stations in various districts are conducting studies on a consistent mechanized cultivation. That is, the compost and lime are sprinkled by manure loader, manure spreader and lime sower, land is prepared by plow and harrow, followed by fertilizer application and sowing by seed drill, agricultural chemicals spraying by sprayer, intertillage and weeding by cultivator, harvesting and threshing by combine or bean cutter and thresher, and drying by ventilated dryer.

Soybean production usually requires about 3.4 hours labor per are and this has been reduced to less than 1.3 hours by the promotion of mechanized cultivation. However, on a small-scale farm mechanization has not been extended so much because of the high cost.

Average yield

The average soybean yield in Japan was 13.7 kg/are in 1968, which is not so high when compared with the average yield in other countries.

However, this is the average of many locations including where the productive conditions are poor. There are many instances on good conditioned farms yielding more than 30 kg/are. Maximum yield in Japan is indicated in Table 4.

Table 3. Soybean yield per hectare and production in specified countries

Countries	Yield per ha		Production	
	1967 kg	1968 kg	1967 t	1968 t
Canada	1,876.2	2,057.9	220	246
U.S.A.	1,647.7	1,802.3	26,564	30,023
Mexico	2,017.5	1,987.3	121	270
Brazil	1,170.2	1,277.8	716	703
USSR	638.9	672.5	537	570
China (mainland)	847.4	807.0	6,940	6,480
Indonesia	733.0	558.2	484	333
Japan	1,347.5	1,368.5	190	168
Republic of Korea	643.6	780.1	201	245

Table 4. Records of yield in Japan

Prefecture	Year	Variety	Yield per are kg	No. of hill per are
Miyagi	1960	Miyagi-shirome	78.5	1,333
Iwate	1962	Tokachi-nagaha	76.5	4,000
Miyagi	1963	Hakuhō 1	73.0	2,889

Green soybean

Green soybean is harvested at the pod filling stage, boiled in pod and used as food. Because of the high profitability the green soybean production has gradually increased recently so that the planting acreage of green soybeans reached 7,490 ha in 1968 and 7,860 ha in 1969 accounting for 5.8% and 7.1% of the total soybean planting acreage, respectively. Green soybean cultivation is larger in prefectures near large cities such as Chiba, Niigata, Fukushima and Saitama. The cultivating period for green soybeans is earlier or later than usual aimed to ensure a better price, i.e. sowing is done in January to September and harvesting from April to December.

The vinyl cover and other devises to keep up the temperature are employed whenever necessary. There are many early and late varieties such as Ōfurisode (Yoshiokatairyu), Okuhara 1, Tokyowase, Ōu 5, Usuao, Shirohikari, Shirodaizu and etc..

Several characters are expected from green soybeans, such as tasty, good pod-bearing, green, pod, white and soft pubescence, large grains and green or yellowish green seeds at the maturity.

Problems in soybean cultivation in Japan

As stated above, in spite of a rapid increase in demand of soybeans in Japan, production is drastically declining because of the large import of cheap American soybeans. For instance, on a monthl average, Tokyo price of small grain, second grade of Hokkaidō's Tokachi in 1969 was ¥3,813 per 60 kg whole Chicago price of American soybeans was ¥2,046 and CIF price was ¥2,354.

On account of such a low price and supplying of a uniform grade of the soybeans, domestic production cannot compete with the American soybeans.

The government determined the basic price of domestic soybeans at ¥4,650 per 60 kg and in case the standard sale price falls below the basic price, the government grants a subsidy to protect the farmers and soybean production but even under such a protection, domestic producers are unable to compete with the Americans.

At present, American soybeans are used also for raw materials of protein foodstuffs though they are inferior to domestic soybeans in composition especially in the protein content, and domestic soybeans are used for special purposes such as in confectionery which are transacted more profitably. This problem is not the problem of soybeans alone but it is widely applicable to many domestic agricultural commodities. The problem is closely related to the government policy as to what status is to be rendered to agriculture and its content of that in the over-all national economy.

The increase in domestic production of soybeans is utterly impossible without the full implementation of the following measures; namely, to increase the yield per unit acreage and to produce a good quality, highly nutritious soybean by mobilizing all available techniques, planning the production of a larger and uniform grain and improving the marketing system. Moreover, it is also important to lower the production cost and to ensure the farmer that soybean output is appealing.

To ensure production increase, the control of nematode and virus is necessary. The production of high yielding protein-rich soybean is also an important matter and improvement of that is expected from the research in cultivation technique and breeding. The breeding of varieties adaptable to wider regions not restricted in the cultivating period is also desired.