

SOYBEAN PRODUCTION IN JAPAN

S. KONNO*

Abstract

In Japan soybean is an important crop next to rice and wheat since it is one of the sources of traditional Japanese foods and an important crop in cropping systems, even though it accounts for only 2.5% of the total cultivated area.

Recently, the importance of soybean cultivation in Japan has increased because in 1978 the government decided to restrict the cultivation of rice and to promote the cultivation of wheat, forage crops as well as soybeans.

In 1982 the area planted to soybeans covered 147.1 thousand hectares, of which 68% was cultivated in converted paddy fields and production amounted to 226.3 thousand tons with an average yield of 1.54 ton/ha. The rate of self-sufficiency was only 5%. About 800 thousand tons were consumed for foods.

Since the increase in soybean cultivation is being promoted by allocation of government subsidies, it is essential to develop a new technology of cultivation enabling to achieve high yields at a low cost in order to firmly establish soybean cultivation before the discontinuance of the subsidies. Therefore, comprehensive research and field trials are being promoted at various institutes as well as national and prefectural agricultural experiment stations throughout the country.

According to the government projections, by the year 1990, it is anticipated that 210 thousand hectares will be planted to soybeans and that the production will amount to 420 thousand tons with an average yield of 2.2 ton/ha.

To achieve this objective efforts on extension aspects should be made to enlarge the scale of farm operations through farmers' cooperation so as to increase yields by the adoption of advanced technology ; save labor by promoting mechanization ; enhance and unify the quality of the products; etc.

The following aspects of research are particularly needed : breeding varieties adaptable to late planting after wheat cultivation, resistant to pod shattering for mechanization, having wide adaptability to produce uniform seed quality ; control of fusarium blight-like disease and seed coat breaking which tend to occur when soybeans are cultivated in converted paddy fields ; identifying ideal growth patterns to achieve high yields ; etc.

Trend in soybean production

In Japan the area planted to soybeans accounts for only 2.5% of the total cultivation area which amounts to 5.6 million hectares. However soybean is an important crop in Japan next to rice and wheat since it is one of the traditional sources of protein for the Japanese people and due to the beneficial role it plays in cropping systems as a legume.

The cultivation of soybeans gradually decreased since the liberalization of soybean trade which took place in 1956 led to the increase in the importation of soybeans whose cost was lower than that of the domestically produced soybeans and also due to the fact that soybean cultivation was deemed less profitable than that of other crops. As a result, in 1977, the area planted to soybeans totalled only 79,000 hectares. However in 1978 the government decided to restrict the cultivation of rice and to promote the cultivation of wheat, forage crops as well as soybeans by allocating subsidies. From then on the area planted to soybeans increased steadily. In 1982, from the 147.1

*Tropical Agriculture Research Center, Yatabe, Tsukuba, Ibaraki, 305 Japan.

thousand hectares planted to soybeans, the production totalled 226.3 thousand tons with an average yield of 1.54 ton/ha (Table 1).

Table 1 Production and trade of soybeans in Japan

Year	Planted area (1,000 ha)	Yield per ha (ton/ha)	Production (1,000 ton)	Import (1,000 ton)	Export (1,000 ton)
1950—1954	419.3	1.07	449.6	328	—
1967—1971	112.5	1.32	148.4	2,727	—
1977	79.3	1.40	110.8	3,602	—
1978	127.0	1.50	189.9	4,260	—
1979	130.3	1.47	191.7	4,132	20
1980	142.2	1.22	173.9	4,401	30
1981	148.8	1.42	211.7	1,197	40
1982	147.1	1.54	226.3	4,344	13

Statistical yearbook of Ministry of Agriculture, Forestry and Fisheries in Japan,
Data about soybeans, MAFF, 1983, Division Upland Farming Improvement, Agricultural Production Bureau.

In addition to Hokkaido and Tohoku which are the leading producing regions, recently, soybeans are being increasingly cultivated in the converted paddy fields of the southern and central parts of Japan and a large area planted to soybeans is found in Kyushu. Presently Hokkaido, Tohoku and Kyushu account for 13, 27 and 16% of the total area under soybean cultivation in Japan, respectively (Fig.1).

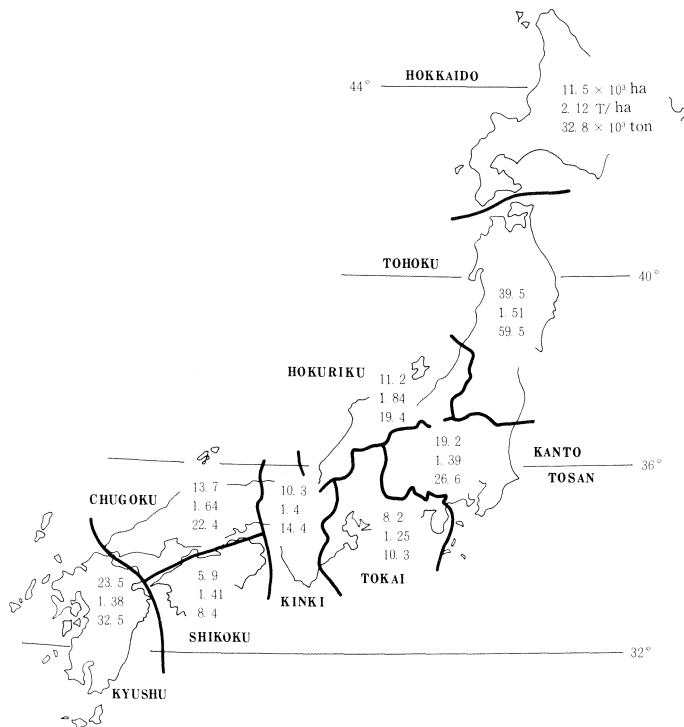


Fig. 1 Soybean production by region in Japan (1983).

Trends in supply and consumption of soybeans

The demand for soybeans is likely to continue to increase in Japan. In 1982 the importation totalled 4,344 million tons while the rate of self-sufficiency was only 5%. Among the imported soybeans, 83% is for the extraction of edible oil while the by-products are used as animal feeds. The consumption of soybean foods including tofu, natto, miso, etc. amounts to 800 thousand tons. Besides, about 50 thousand tons of soybeans are kept by farmers for their own use (Table 2).

The increase in consumption of soybeans is due mainly to the strong demand for soybean cakes as animal feeds as well as edible oil. Also the consumption of tofu, natto and soybean milk is increasing.

Table 2 Soybean consumption in Japan

(1,000 ton)

Year	Oil	Feed	Tofu	Frozen tofu	Natto	Miso	Shoyu	Soybean milk	Boiled beans and others	Sub - Total	Total
1975	2,620	30	414.3	30	68	186.1	11	—	16	725.4	3,375.4
76	2,701	30	416.5	29	69	190.5	10	—	16	731	3,462
77	2,878	30	427	30	70	185	8.5	—	16	736.5	3,644.5
78	3,297	40	445	29.8	71	182	6	—	16	749.8	4,086.8
79	3,401	55	452	29	73	181	7	1	16	759	4,215
80	3,453	55	460.3	28	75	185	6.6	2	16	772.9	4,280.9
81	3,495	55	470	28	77	183	6.5	5	15	784.5	4,334.5
82	3,591	55	480	28	80	180	6.5	12	13	799.5	4,445.5

Statistical yearbook of Ministry of Agriculture, Forestry and Fisheries in Japan.

Data about soybeans, Division Upland Farming Improvement, Agricultural Production Bureau, MAFF, 1983.

Methods of cultivation currently applied in Japan

The growing season of soybeans in Japan starts earlier in the northern part of the country than in the southern part. In Hokkaido and in the northern Tohoku region soybeans are sown in late May and harvested in October. In the central and western parts of Japan they are sown in June and harvested in October and November while in the southern part of Japan or in the Shikoku and Kyushu regions they are sown in June and harvested in November. In Shikoku and Kyushu, farmers grow also a very early-maturing variety as short-season crop which is sown in April to May and harvested in July to August (Fig.2).

For soybean growing, plowing is performed mostly by tractors. However, in smaller fields, power tillers are being used. Then the fields are harrowed once or twice to improve the soil.

About 10 ton/ha of compost and 1 to 2 ton/ha of dolomite or limestone are plowed in the soil. In most cases compound fertilizer is used. About 30 kg of N, 100 kg of P₂O₅, and 100 kg of K₂O are applied per hectare under the row at the time of sowing.

Seeds are placed in hills (2 to 3 seeds/hill) on the rows. The spacing between rows is 50 to 75 cm. The seeding rate ranges between 50 and 70 kg/ha or 100 to 200 thousand plants/ha. Recently mechanization of seeding and fertilizer application are making steady progress and about 1/3 of the soybean area is planted by powered machines.

Herbicides are applied immediately after sowing. Intertillage and hilling up are performed two to three times at 20 to 40 days after sowing and 10 to 14 days thereafter with the use of a cultivator, so as to control weeds at the same time.

Soybean pod borers (*Leguminivora glycinovorella*), soybean pod gall midges (*Asphondyla* sp.), bugs, viruses and purple seed stain (*Cercospora kikuchii*) are important insect pests and diseases which severely limit grain yield and adversely affect quality.

Soybeans are harvested by uprooting the whole plant or cutting the stalks with a sickle in the fields on a small scale while machines are used for harvesting in operations on a large scale. At

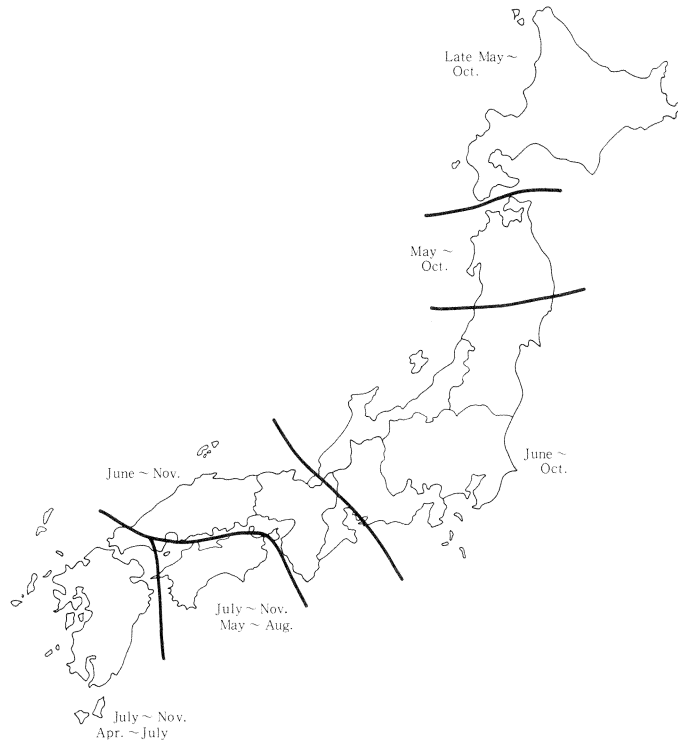


Fig. 2 Planting and harvesting time of soybeans in Japan.

present, soybeans that are harvested with the use of a mechanical bean harvester account for about half of the soybean area.

Harvested soybeans are mostly dried in the fields before threshing. Moreover, some are dried in the sun after threshing and others are dried at a low temperature with the use of a mechanical drier.

After threshing, usually soybeans are grouped by seed size and also imperfect grains are removed with the use of a grain sorter. Thereafter they are sold to users through agricultural cooperatives or local brokers.

Most of the seeds sown by the farmers are those collected from preceding year's harvest. Most of the prefectures have seed multiplication farms and supply certified seeds of suitable varieties, by which farmers rejuvenate their seed stocks at several year intervals.

Since the Japanese islands stretch over a long distance from north to south, in some areas there is only one cropping season during the year and in others a 4- to 5-crop rotation for a 2-year period. In Hokkaido the 4- to 5-year crop rotation consists of soybeans-maize-kidney bean-wheat-potato. In other regions soybeans are grown in combination with tobacco, potato, wheat, vegetables, etc. In addition, in converted paddy fields, soybeans are mostly grown under the following cropping pattern : rice-soybeans-wheat-soybeans-wheat-rice.

Generally, the crops grown in the same season as soybeans such as adzuki bean, kidney bean, beet, wheat, tobacco, vegetables, maize, forage crops, etc. are of the same or of a higher economic importance and compete with soybeans.

Several varieties of soybeans have been recommended for commercial production to farmers by the authorities of each prefecture. At present about 80 soybean varieties in total are recommended in Japan. Among them, Enrei, Akiyoshi, Shirosennari, Tamahomare, Kitamusume, and Toyosuzu

varieties are widely distributed in the country. Kitamusume and Toyosuzu are the leading varieties in the Hokkaido region and the latter variety is moderately resistant to the cyst nematode (*Heterodera glycines*). Shirosennari which is a variety adapted to the Tohoku region is resistant to lodging as well as to purple seed stain and fusarium blight-like disease. Enrei variety is planted over a wide area from the Kanto to the Chugoku regions and is covering the largest area in the entire country. This variety is high-yielding and has a good quality even in the case of late sowing. Tamahomare which is a variety suited to the Kinki and Chugoku regions is moderately resistant to purple seed stain (*Cercospora kikuchii*). Akiyoshi which is a high-yielding variety in the Kyushu region accounts for the second largest area planted to soybeans in the country.

Among the soybean diseases the most destructive ones are those caused by viruses, mainly soybean mosaic, cucumber mosaic (soybean stunt), and soybean dwarf viruses. Purple seed stain (*Cercospora kikuchii*) and fusarium blight (*Fusarium oxysporum*)-like disease are likely to occur where soil contains a high moisture level such as in the case of converted paddy fields.

Insect pests that attack the soybean crop are numerous and cause serious damage, particularly in the warm areas. Soybean cyst nematode (*Heterodera glycines*), soybean pod borer (*Leguminivora glyconovorella*), soybean pod gall midge (*Asphondylia* sp.), lima bean pod borer (*Etiella zinckenella*) and bugs (bean bug (*Riptortus clavatus*), green stink bug (*Nezara antennata*), one-banded stink bug (*Piezodorus hybneri*)) are the major harmful insect pests that limit grain yield.

The farmers who are growing soybeans on a small scale only for their own use do not usually proceed to weeding, intertillage, hilling up, and pest control after sowing up to the harvesting period because they cultivate other crops more important than soybeans. Thus soybean yield in those fields remains at a very low level, which reduces the average yield in the country.

Although, growing of soybeans after wheat is a desirable cropping pattern, soybean seeds must be sown later than the normal time which results in low soybean yields. Moreover, the farmers in some regions are confronted with the difficulty of sowing the soybean seeds in their fields due to continuous rainfall and unfavorable field conditions since the time coincides with the rainy season (bai-u) in Japan.

Seed coat breaking in mature grain is frequently observed when soybeans are cultivated in converted paddy fields and the quality of these grains is low when estimated by standard inspection.

Soybean research and extension

In Japan, soybean breeding is conducted at the Hokkaido Tokachi Agricultural Experiment Station, Hokkaido Central Agricultural Experiment Station, National Tohoku Agricultural Experiment Station, Nagano Prefectural Chushin Agricultural Experiment Station and National Kyushu Agricultural Experiment Station (Fig.3).

The major breeding objective in these stations is focussed on varieties whose maturity is adapted to the respective areas so as to achieve high yields and good seed quality.

In addition each station pursues specific objectives. The Hokkaido Tokachi Agricultural Experiment Station places emphasis on the breeding of varieties that are resistant to cool weather damage and soybean cyst nematode and are highly adaptable to mechanized cultivation ; at the Hokkaido Central Agricultural Experiment Station, breeding of varieties with large grain that are resistant to soybean dwarf virus is given priority ; at the National Tohoku Agricultural Experiment Station emphasis is placed on the breeding of varieties resistant to soybean cyst nematode, viruses and purple seed stain and with a high protein content ; at the Nagano Prefectural Chushin Agricultural Experiment Station priority is given to breeding for resistance to soybean cyst nematode and fusarium blight-like disease as well as lodging and adaptability to late planting ; at the National Kyushu Agricultural Experiment Station emphasis is placed on the breeding for resistance to diseases, insects (soybean stem miner and bugs) and lodging. Also mutation breeding is carried out at the Institute of Radiation Breeding which is affiliated to the National Institute of Agricultural Sciences.

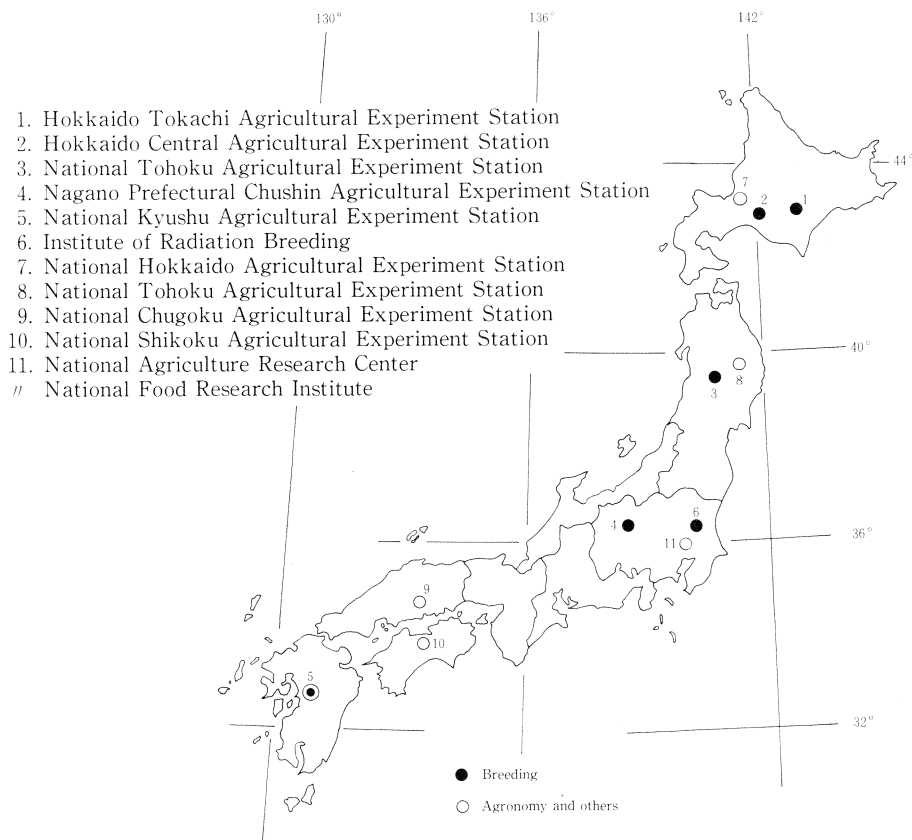


Fig. 3 Centers for breeding and research on soybeans affiliated to the Ministry of Agriculture, Forestry and Fisheries in Japan.

The progenies bred at these stations are tested for their resistance to the following pests and diseases in six locations : soybean pod borer (Hokkaido Central Agricultural Experiment Station) ; sphaceloma scab (Iwate) ; viruses (Yamagata and Ehime) ; purple seed stain (Aizu, Fukushima) ; soybean cyst nematode (Kuroiso, Tochigi) ; and root knot nematode (Oosumi, Kagoshima).

During the last decade 18 varieties were released and registered by the Ministry of Agriculture, Forestry and Fisheries (Table 3). Among these varieties, Tamahomare is a high-yielding variety with good seed quality and wide regional adaptability. It is thus being grown in 15 prefectures from the central to the western part of Japan and covers more than 10 thousand hectares of soybean area.

Suzuyutaka is a variety resistant to soybean cyst nematode, viruses and to lodging. It is grown in Tohoku and in the northern part of the Kanto region as a stable and high-yielding variety.

Miyagioojiro and Yuuhime are large-seeded varieties (about 40 g/100 seed) grown in Tohoku and the northern Kanto region, and in Hokkaido, respectively.

Komamusume and Fukuyutaka are highly adaptable varieties which can be grown in the converted paddy fields of Hokkaido, and the Kyushu and Shikoku regions, respectively.

Suzuhime is a small-seeded variety (13-15 g/100 seed) suited to natto making and cultivated in Hokkaido.

Dewamusume is a resistant variety to most races of soybean mosaic and cucumber mosaic viruses as well as to cyst nematode.

Table 3 Varieties registered during the last decade

Year of release	Variety and station where released	
1976	Himeyutaka (Tokachi)	
1977	Nanbushirome (Tohoku)	Dewamusume (Tohoku)
1978	Kitakomachi (Tokachi)	Tanrei (Chushin, Nagano)
	Nakasennari (Chushin)	Miyagiooijiro (Chushin)
1979	Yuuhome (Hokkaido Central)	Akishirome (Kyushu)
1980	Kitahomare (Tokachi)	Suzuhime (Tokachi)
	Tamahomare (Chushin)	Fukuyutaka (Kyushu)
	Fukunagaha (Hokkaido Central)	
1982	Komamusume (Hokkaido Central)	Suzuyutaka (Tohoku)
1983	Tachikogane (Tohoku)	Wasesuzunari (Tohoku)

Research on soybean physiology, ecology, cultural methods, protection, mechanized cultivation and processing is carried out at the National Agriculture Research Center, National Institute of Agricultural Sciences, and at the National Agricultural Experiment Stations in Hokkaido, Tohoku, Chugoku, Shikoku and Kyushu, at the National Food Research Institute and Institute of Agricultural Machinery.

At present two kinds of national research programs involving soybeans have been conducted since 1978 and 1979. One is related to basic research on nitrogen fixation under the comprehensive research program on the "Effective Utilization of Natural Energy Resources". The other is a research project for "Promoting Upland Crop Cultivation in Converted Paddy Fields". These programs which will cover 10 years are carried out by teams of researchers from the above mentioned research institutes/experiment stations and some universities.

Experiments on the selection of varieties, cultivation practices and extension are being conducted at each prefectural agricultural experiment station in the country.

Each prefecture has organized extension services through local agricultural extension offices which are located in several districts grouped according to ecological conditions.

Along the lines of the government policy aiming at the improvement of soybean production, extension services concerned with the guidance on soybean cultivation have recently been strengthened. Also efforts have been made to establish demonstration plots, seed multiplication trials to promote more intensive cultivation with a view to raising the yield level in farmers' fields.

Government participation in and support of soybean production

As mentioned before, since soybean is an important crop as a source of traditional Japanese foods and as a significant component in cropping systems, the Japanese government is intent on promoting soybean production. Moreover, as a result of export limitations imposed by the soybean-producing countries in 1972-1973 followed by the "Oil-Shock" of 1973, the government was forced to reconsider the policy of easy-going dependence of food imports. Thus, in recognizing the importance to increase the level of food self-sufficiency the government is making efforts to promote the production of soybeans.

With a view to alleviating the possible effects of low cost imports on local prices of indigenous soybeans, the government has since 1961 determined the floor price for soybeans (i.e. ¥17,200, US\$70.20/60 kg for 1982 crop). When the average sale price is lower than the floor price, the difference is paid to the producers by the government.

Financial assistance is also provided for the establishment of demonstration plots as well as for

promoting planting of soybeans in converted paddy fields. Also the government subsidizes the cost of the activities of farmers' groups to improve soybean production, such as holding of meetings and seminars, purchase of machinery and equipment or construction of facilities.

Since the recent increase in soybean cultivation is being promoted mainly by the allocation of government subsidies, it is essential to develop a new technology of cultivation enabling to achieve high yields at a low cost in order to firmly establish soybean cultivation before the discontinuance of the subsidies. Therefore, comprehensive research and field trials are being promoted at various institutes as well as national and prefectural agricultural experiment stations throughout the country.

In order to encourage the farmers to cultivate soybeans, national contests have been held since 1972. The prizes are awarded by the minister of Agriculture, Forestry and Fisheries and directors of National Federation of Agricultural Cooperative Associations and several organizations to individual farmers and farmers' groups who have achieved a high level of technology for soybean cultivation.

Future prospects of soybean production and main constraints

It is anticipated that the demand for soybeans in 1990 will reach 5,200-5,430 thousand tons of which only 420 thousand tons will be produced in Japan. The objective is to increase indigenous production to satisfy at least 61% of the soybean requirements for processed foods (excluding oil extraction) by 1990. The projected area to be planted to soybeans for 1990 is 210 thousand hectares and the projected average yield is 2.02 ton/ha.

To achieve these objectives efforts on extension aspects should be made to enlarge the scale of farm operations through farmers' cooperation so as to increase yields by the adoption of advanced technology ; save labor by promoting mechanization ; enhance and unify the quality of the products; etc.

The following aspects of research are particularly needed : breeding of varieties adaptable to late planting after wheat cultivation, resistant to pod shattering for mechanization, having wide adaptability to produce uniform seed quality ; control of fusarium blight-like disease and seed coat breaking which tend to occur when soybeans are cultivated in converted paddy fields ; identifying ideal growth patterns to achieve high yields ; etc.

Discussion

Wang, J.L. (China) : What are the requirements for the quality of soybeans used for food in Japan ?

Answer : Soybeans are classified into three grades by standard inspection. A lot that contains more than 35% of damaged grains, foreign materials or grains affected with purple seed stain or with seed coat breaking is not accepted.

Bhatnagar, P.S. (India) : A considerable amount of soybean is being consumed as human food in Japan. Are there any apprehensions regarding inhibition of iron absorption or adverse effect on the digestion ?

Answer : There are no apprehensions since little soybean is consumed directly and most of it is processed.