Global expansion of high value vegetable soybean

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Abstract

Vegetable soybean is a large-seeded, slightly sweet type of soybean harvested while pods are still green. Japan, China, Korea, and Taiwan have historically been the major producers and consumers of the vegetable. Recently AVRDC has promoted vegetable soybean to nearly 50 countries around the world through 72 cooperators. In many countries such as Mauritius, Bangladesh, Sudan, and Vietnam, vegetable soybean is a new crop and has been accepted by the public. It is a nutritious vegetable with value-added properties that contribute to job opportunities and improved income for the poor. A total of 32 improved vegetable soybean cultivars have been released for farmers and they are commercially produced throughout Asia, Africa and the Americas. Besides generating income for farmers, vegetable soybean is a valuable component to the entire farming system. The total biological yield of vegetable soybean can be as high as 40 t/ha in 75 days, consisting of 10 tons of marketable pods and 30 tons of residue that can enrich the soil or feed animals. The future research of this emerging crop will focus on mechanization of its production and harvest, overcoming seed production and seed storage problems, and improving the quality of its flavor. An aromatic soybean for South Asia and Africa markets is in the pipeline.

Introduction

Vegetable soybean, *Glycine max* (L.) Merrill, is a large-seeded type of soybean harvested at the $R_{6.5}$ growth stage while pods and plants are still green (Fehr et al., 1971). The detached pods and shelled green beans are used as a fresh vegetable in Japan, China, and Korea and to a lesser extent in Thailand and Nepal (Lumpkin and Konovsky, 1991; Shanmugasundaram et al., 1991). The pods and shelled green beans are frozen and marketed (Shanmugasundaram, 2001). Vegetable soybean has a large seed size (>30 g/100 seeds dry weight) and a slightly sweet taste. Vegetable soybean is rich in protein (13%), cholesterol-free fat (5.7%), phosphorus (158 mg/100 g), calcium (78 mg/100 g), vitamin B_1 (0.4 mg/100 g) and B_2 (0.17 mg/100 g). It also contains isoflavone and tocopherol.

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Japan, China, Korea, and Taiwan were the major producers and consumers of vegetable soybean in the past. Annual production in Japan was 110,000 tons from 1988 to 1992, but production has declined to around 70,000 tons today. An additional 70,000 tons is imported from other countries. Until 1992, Taiwan monopolized the export market to Japan, but now 50% of Japan's exports come from China, followed by 34% from Taiwan, 13% from Thailand, and 3% from other countries including Indonesia and Vietnam. Since Taiwanese farmers have expertise in growing vegetable soybean for export, prices for their product is slightly higher than for farmers in other countries.

Lin and Cheng (2001) described the historical perspectives of vegetable soybean in Taiwan. Initially Taiwan had 27 frozen food manufacturing companies capturing 90% of the Japanese frozen edamame export market. But due to rising labor and raw material costs, only 11 frozen edamame processors have survived. Almost all the companies have factories in China. In addition to exporting vegetable soybean to Japan, Taiwan exports 5000 tons of vegetable soybeans to USA and smaller quantities to Canada, Europe, and Australia. Exports to USA from Taiwan, China, and Thailand are on the rise.

Since vegetable soybean is only a minor crop, very little publicly funded research is focused on its genetic improvement. A few universities in the USA have developed large-seeded (> 20 g/100 seeds dry weight) varieties and claimed them to be vegetable soybeans. However, their quality is unacceptable in the discriminating Japanese market. In Japan, private seed companies have developed several vegetable soybean cultivars (Kitamura, 2001). Carter and Shanmugasundaram (1993) have compiled a list of soybean cultivars used for vegetable soybean in Japan and Taiwan.

AVRDC's research focus

AVRDC commenced research to develop improved vegetable soybeans in 1981. AVRDC screened the vegetable soybean and large-seeded soybean germplasm from Japan and USA. From the variety, Taishoshiroge, a single plant selection was made and purified. It was designated as AGS 292 (pure line selection from Taishoshiroge). It has total and graded pod yields of up to 26 t/ha and 10 t/ha, respectively in the spring season. In 1987, AGS 292 was the first vegetable soybean variety officially released for farmers' cultivation in Taiwan. Later, AVRDC found that AGS 292 is relatively less sensitive to photoperiod and temperature. Since 1987, AGS 292 has been officially released for farmers' cultivation in at least six countries around the globe. In total, 12 countries have released a total of 32 vegetable soybean cultivars from AVRDC materials (Table 1, Fig. 1). In many countries such as Mauritius, Bangladesh, Sudan, and Vietnam, vegetable soybean is a new crop and has been accepted by the public. It is popular and available almost year round. Both farmers and consumers have benefited from the crop. Vegetable soybean is a nutritious vegetable with value-added properties that contribute to job opportunities and improved

income for the poor. The total biological yield of vegetable soybean can be as high as 40 t/ha in 75 days. The total pod yield is about 10 t/ha, which farmers can sell at the market. The residue (leaf + stem) contains about 120 kg N, 18 kg P_2O_5 and 150 kg K_2O; this residue can be either returned to the soil or fed to animals.

Over 20 years, AVRDC has made and evaluated 568 crosses in an effort to develop vegetable soybeans that were adapted to the tropics and subtropics. The number of countries requesting AVRDC vegetable soybean germplasm and improved lines has increased from two in 1979 to 41 in 2000. Similarly the number of cooperators from private and public institutions has increased from two in 1979 to 72 in 2000 (Fig. 1). AVRDC has distributed a total of nearly 9,000 seed packets for evaluation around the world.

Prospects for further expansion

Asia – AVRDC vegetable soybeans have been evaluated and produced in countries throughout East, South, and Southeast Asia. Quality soybeans can be grown in these regions but there is a need to promote them in the market and to organize processing facilities. Vietnam and Indonesia are already exporting. Malaysia is marketing domestically and India is moving in that direction.

Africa – AVRDC's Regional Center for Africa (RCA) is evaluating and promoting AVRDC vegetable soybeans in Africa (see paper by M.L. Chadha and Mel Oluoch in this proceedings). They have distributed vegetable soybean seeds to 26 African countries from 1998–2003. Buker (2001) has introduced AGS 292 to Uganda. There is hope that these beans can generate income, increase jobs, improve nutrition, and improve the sustainability of soils.

Americas – Greater awareness on the benefits of healthy diets is driving the demand for vegetable soybeans in the USA. Universities and private seed companies are developing improved varieties. Jim Lothrop's Company in Hawaii has released 12 varieties from AVRDC breeding lines adapted for Hawaii and North America. Another seed company has signed an agreement to produce and market the seeds of AVRDC selections on a non-exclusive basis. In Latin America, results of evaluation of vegetable soybean showed that the potential is there; however, commercial production is yet to begin.

Europe – A company in England is interested in producing vegetable soybean for domestic marketing. Currently the English are importing the crop from Taiwan and Thailand.

Future Research Goals

Machinery for harvesting and shelling the beans have been introduced in Taiwan to reduce production costs; these technologies may serve as models

for farmers in developing countries to modify (Shanmugasundaram and Yan, 2001). Improved seed production and simple seed storage practices are being developed for farmers and industries in developing countries.

Consumers in South Asia and Africa do not like the beany flavor of vegetable soybean. A group of brown-seeded varieties in Japan, called *Dadacha-mame*, have an aroma similar to fragrant rice (Fushimi and Masuda, 2001). AVRDC has studied the inheritance of this flavor and our breeders are transferring these "fragrance genes" to green, yellow and black-seeded vegetable soybeans. Such flavored vegetable soybeans can be marketed as "Basmati" vegetable soybeans for discriminating consumers.

Local name	AVRDC ID #	Year	Country	Remarks
GC 83005-9	GC 83005-9	1995	Bangladesh	HY, suitable for homestead cultivation
AGS 292	AGS 292	1990	China	
MKS 1	AGS 190	1995	Malaysia	HY
VSS 1	AGS 292	1999	Mauritius	
VSS 2	AGS 339	1999	Mauritius	
Rawal-1	AGS 190	1994	Pakistan	HY
PSB-VS 1	AGS 191	1997	Philippines	HY
PSB-VS 2	AGS 190	1997	Philippines	HY
PSB-VS 3	AGS 186	1997	Philippines	HY
	AGS 190	1992	Sri Lanka	HY, suitable for soymilk and ice cream and soynuts, less beany flavor
	AGS 292	2002	Sudan	
Kaohsiung No. 1	AGS 292	1987	Taiwan	HY, MH, DM, EM
Kaohsiung No. 2	Ryokkoh x KS 8	1991	Taiwan	HY, MH
Kaohsiung No. 3	PI 157424 x KS 8	1991	Taiwan	HY, MH
Kaohsiung No.6**	AG S292	2001	Taiwan	
Kaohsiung No.7**	AGS 292	2001	Taiwan	
KPS 292	AGS 292	1992	Thailand	HY
CM 1	AGS 190	1995	Thailand	HY, suitable for domestic consumption
Mana	AGS 292	1999	Hawaii, USA	
Makani	AGS 334	1999	Hawaii, USA	
Momona	AGS 337	1999	Hawaii, USA	
Nui	AGS 346	1999	Hawaii, USA	
Buker's Favorite	AGS 292		USA	
Koapaka	GC97002 F3	2002	Hawaii, USA	HY, adaptation* MKK, Ohio
Hiluhilu	GC97022 F3	2002	Hawaii, USA	HY, adaptation MKK, Ohio, SC
Kanaloa	GC97002 F3	2002	Hawaii, USA	HY, adaptation Ohio
Kila	GC97022 F3	2002	Hawaii, USA	HY, adaptation SC
Onaona	GC97002 F3	2002	Hawaii, USA	HY, adaptation SC
Mimiki	GC97022 F3	2002	Hawaii, USA	HY, adaptation SC
Palanehu	GC97002 F3	2002	Hawaii, USA	HY, adaptation MKK
Akua	GC97029 F3	2002	Hawaii, USA	HY, adaptation MKK
VRQ 46	AGS 346	1999	Vietnam	EM (65–85 days), HY (11–14 t/ha), 3 crops/year
Total	32		12	

DM = resistant to downy mildew; EM = early maturing; HY = high yielding; MH = suitable for mechanical harvesting; * MKK = Molokai, Hawaii, USA Ohio = Ohio, USA; SC = South Carolina, USA; **Cross between AVRDC line and other cultivar

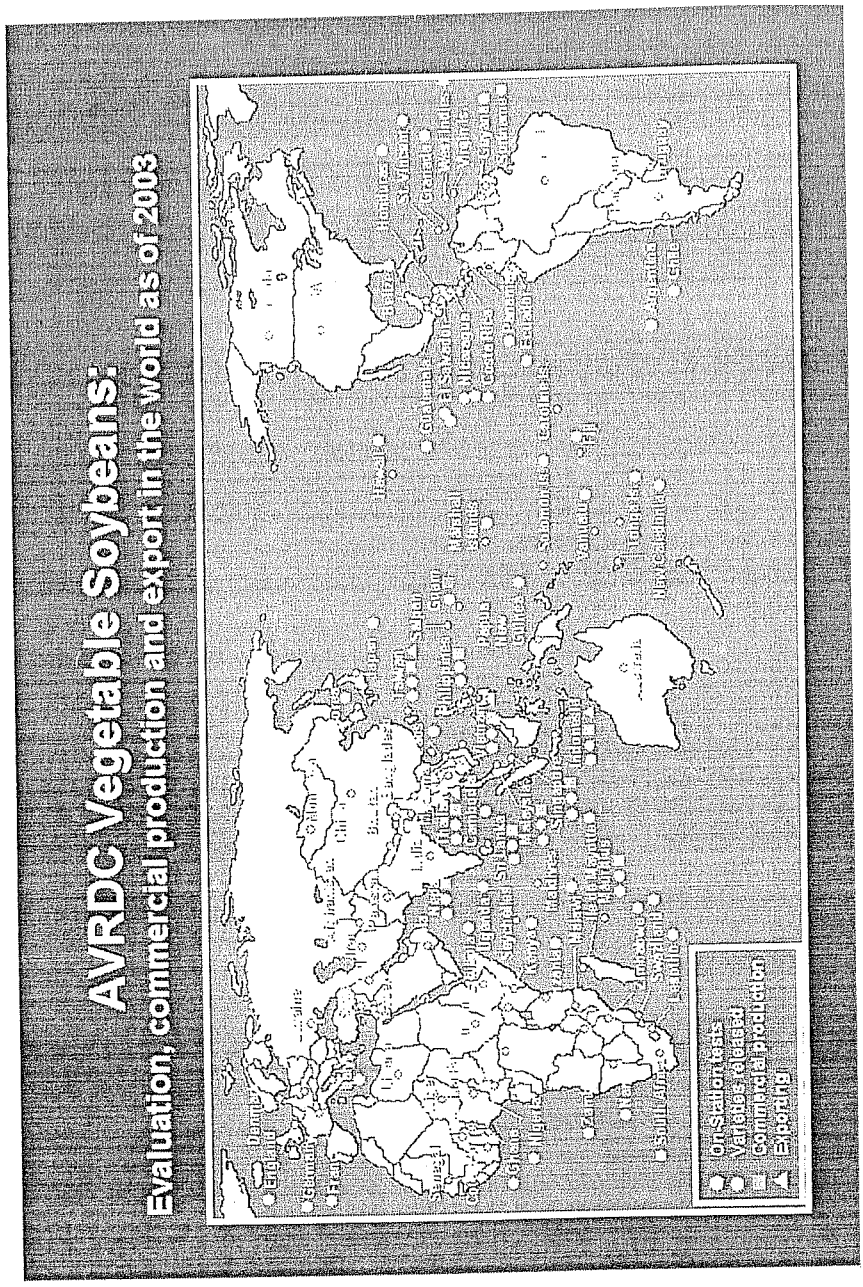

Figure 1. Countries evaluating, commercially producing, and exporting AVRDC vegetable soybeans

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