

Local and Introduced Food Legumes in the Sub-tropical Zone on Japan

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Abstract

In Japan, only Okinawa, is situated in the sub-tropics where high temperature and drought in summer as well as the frequent occurrence of plant diseases and insect damage are serious constraints on crop production. It was considered that germplasm of crops tolerant to these conditions should be present on the island and explorations for the collection of germplasm were organized three times from 1990 to 1992 on the Yaeyama islands in Okinawa. However, the cultivation of most of the local varieties of soybean and groundnut (temperate zone legumes) and mungbean (a tropical legume) was discontinued thirty years ago due to their replacement with sugarcane that is the main cash crop of Okinawa. As for vegetable legumes, although hyacinth bean and yard long bean could be occasionally detected, pigeon pea was no longer cultivated. Therefore the TARC Okinawa Branch attempted to introduce vegetable legumes suitable for the taste of the Japanese people, in order to alleviate the shortage of temperate zone vegetables in summer in Okinawa. The first variety of winged bean introduced from Malaysia was released in Japan in 1991 after breeding. Germplasm of drought-tolerant bambarra groundnut which has been recently introduced from Indonesia, Zambia and Nigeria and of heat-tolerant snap bean from Malaysia and Thailand is currently being evaluated.

Introduction

Within Japanese archipelago, there are several sub-tropical islands in the Pacific Ocean called Nansei shoto. They are situated at latitudes 24° to 32° N (Fig. 1). The islands in the southern part belong to Okinawa prefecture. There is no frost and the mean monthly temperature exceeds 20°C throughout a year there. Main crops are sugarcane, pineapple and tropical grasses for animal husbandry in Okinawa. However, subsistence agriculture had been practiced by farmers in these islands for many years. Food legumes played an important role in subsistence agriculture. As these crops were cultivated in many small isolated islands, it was anticipated that genetically different local varieties would be distributed on each island.

However, due to urbanization and the development of seaside resorts in many islands, the farm land area has decreased and local varieties of the legume crops are coming extinct. Therefore, plans were made to collect and conserve the local varieties in this area. In this paper, the utilization of food legumes and distribution of local varieties in the sub-tropical islands are reported (Hanada *et al.* 1991, Katsuta and Takeya 1992, Terauchi *et al.* 1993). Further germplasm introduction of new kinds of food legumes from tropical countries to this area by the Tropical Agriculture Research Center, Japan (TARC) is also reviewed.

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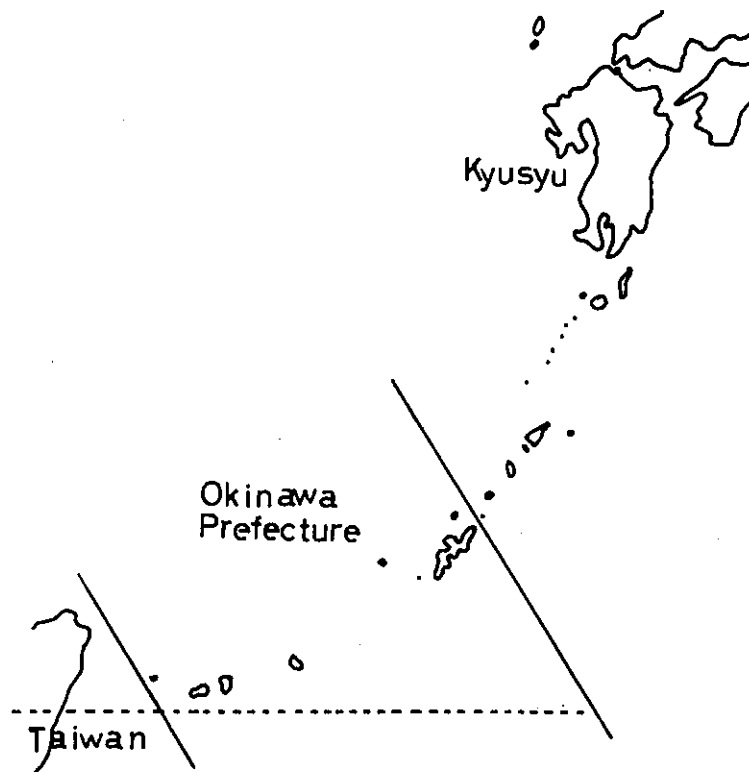


Fig. 1 Map of Nansei shoto in Japan

Local food legumes

In Japan, traditional processed soybean foods are consumed as shoyu (soybean sauce), tofu (soybean curd), miso (soybean paste) and natto (fermented soybean grain) which were introduced 1,200-1,500 years ago from China. These foods are popular also in Okinawa, although they are slightly different from those of the Main Island of Japan. Furthermore, other locally processed legume foods such as tofuyo (fermented soybean curd) and jimamidofu (groundnut curd) have also been prepared only in Okinawa. In order to make these processed foods, local varieties of soybean, groundnut and pigeon pea were cultivated by many farmers in Okinawa.

Exploration for the collection of local varieties of vegetables, cereals and food legumes was carried out three times in the southernmost islands of Okinawa (Ishigaki Jima, Miyako Jima, Yonakuni Jima and other five islands) from 1990 to 1992. Total number of accessions obtained during the exploration amounted to two hundreds fourteen and that of food legumes to fifty two. The collection included 2 accessions of common bean (*Phaseolus vulgaris* L.), 8 accessions of soybean (*Glycine max* Merrill), 27 accessions of yard-long bean or cowpea (*Vigna unguiculata* L. spp. *sesquipedalis* or spp. *unguiculata*). Other tropical legume crops such as mung bean (*Vigna radiata* L.), hyacinth bean (*Dolichos lablab* L.) were also collected (Table 1). On the other hand, explorations for food legumes were carried out nine times in the Main Island of Japan from 1983 to 1990. The collection mainly consisted of three temperate zone crops, soybean (182 accessions), common bean (189 accessions) and adzuki bean (*Vigna angularis* (Willd.) Ohwi & Ohashi) (129 accessions) (Table 2). The collection did not include tropical legume species such as mung bean, hyacinth bean and cowpea except for only one accession of yard-long bean.

The local varieties of tropical legumes in Okinawa may have been introduced from Taiwan, because Yonakuni jima, one of the islands where the exploration was carried out, is separated from Taiwan by only 160 km. People had frequently sailed between these islands and Taiwan for trading since ancient times. Although hyacinth bean and yard-long bean are popular vegetables in Taiwan, these legumes have not been extensively utilized in Okinawa, because their taste was not appreciated by the people of Oki-

Table 1 Food legumes collected in the southernmost islands (Miyako jima and Yaeyama shoto) in Japan

Scientific name	1990	1991	1992	Total
<i>Arachis hypogaea</i>	2			2
<i>Glycine max</i>	4	3	1	8
<i>Lablab purpureus</i>	2	3	1	6
<i>Phaseolus vulgaris</i>	1		1	2
<i>Pisum sativum</i>			1	1
<i>Vicia faba</i>	1			1
<i>Vigna radiata</i>		4	1	5
<i>Vigna unguiculata</i> ssp. <i>unguiculata</i>	10	7	9	26
<i>Vigna unguiculata</i> ssp. <i>sesquipedalis</i>			1	1
Total	20	17	15	52

Table 2 Food legumes collected in Hokkaido and Honshu

Scientific name	1983	1983	1985	1985	1986	1987	1989	1990	1990	Total
<i>Arachis hypogaea</i>			2		1	7	1			11
<i>Glycine max</i>	6	31	9		35	51	26	6	18	182
<i>Phaseolus coccineus</i>					3				1	4
<i>Phaseolus vulgaris</i>	10	39	25	9	55	23	20	3	5	189
<i>Pisum sativum</i>							3			3
<i>Vigna angularis</i>	22		19		33	32	16	6	1	129
<i>Vigna unguiculata</i> *						1			1	2
Total	38	70	55	9	127	114	66	15	26	520

* : *Vigna unguiculata* ssp. *sesquipedalis*

nawa. Due to the high temperature and high solar radiation in summer, vegetables of the temperate zone can not be cultivated in Okinawa. It appeared that hyacinth bean and yard-long bean could be used as substitutes for the temperate zone vegetables such as snap bean (common bean variety with young pod production).

Although pigeon pea was not collected during the exploration, it used to be designated as "Ryukyu mame" which means "bean of Okinawa" and it was also an important grain legume. The grains of pigeon pea were used for home cooking and were prepared for pigeon pea curd. However the cultivation of pigeon pea was discontinued 30 years ago in Okinawa as pigeon pea is no longer a popular food.

On the other hand, in the case of grain legumes, though fava bean and groundnut were extensively cultivated in Okinawa, they have almost disappeared due to the competition with cheap imported products. Eight accessions of local varieties of soybean were collected during the exploration. At lower latitudes, late maturing varieties of soybean are distributed. However, two maturing types of soybeans were observed in the Nansei shoto. The differentiation into the two types occurred in order to avoid serious pod damage caused by insects in summer. The early maturing varieties consist of soybeans for grain production which are harvested before summer. Actual cultivation of these varieties for grain production has been discontinued due to competition with cheap imported soybeans. Most of the local varieties and many breeding lines of this type in an agricultural experimental station had been lost. The varieties for grain production collected during the exploration were the last two which remained in Okinawa. On the other hand, the late maturing varieties have small seeds which are used mainly for green manure and forage in addition to grain production. They make pods after summer. They are called "Gedaizu" which means low quality soybean. Presently the cultivation of "Gedaizu" for green manure is hardly carried out.

Furthermore, in the case of grain legumes, only cowpeas are still being cultivated in home gardens of farmers. Varieties of cowpeas cultivated in Okinawa are red with a similar seed size to that of adzuki bean. Cowpeas are used as a substitute for adzuki bean in some kinds of foods based on adzuki bean. As import of adzuki bean from foreign countries is not so much and the price is higher than that of other legume grains in Japan, cowpeas are still being cultivated in Okinawa in place of heat susceptible adzuki bean.

Introductions of food legumes

During twenty two years from 1969 to 1990 TARC Okinawa sent abroad nineteen expedition teams for germplasm collection. The teams collected mainly forage crops, tuber crops and rice plants. However, the types of vegetables available on the markets are very limited in summer in Okinawa, because few vegetables of the temperate zone can be produced under the hot summer conditions of Okinawa and few tropical vegetables are cultured. Therefore TARC Okinawa promoted the introduction of new kinds of vegetables from tropical and sub-tropical countries. Germplasm of vegetables was introduced during the explorations organized by TARC, mainly in 1985 and 1986.

The new vegetables introduced should display the following characteristics :

- 1) tolerant to high temperature and drought stress
- 2) resistant to strong wind of typhoon
- 3) free from serious insect damage and plant diseases

TARC Okinawa eventually selected winged bean (*Psophocarpus tetragonolobus*) which is cultivated in South Asia and Southeast Asia as a candidate for introduction to Okinawa. Germplasm of winged bean was introduced from Southeast Asia, the collection of IITA (Institute of International Tropical Agriculture in Nigeria) and Ministry of Agriculture of Australia. Since 1982, line selection was initiated with the collection of 49 accessions (Fig. 2). Though most of the lines were late maturing, an early maturing line could be found among the progenies of the introduced materials (Fig. 3). It was selected and after local adaptability tests it was registered under the name of "Urizun" in 1986 (Noguchi *et al.* 1988). It was the first variety of tropical vegetables bred in Japan. The cultivation of winged bean will be extended to Okinawa and other warm areas of southern Japan.

Actually bambarra groundnut is the next vegetable as candidate for introduction to Okinawa. Bambarra groundnut which originated in the Sahara in Africa is cultivated and utilized in Thailand, Indonesia and the Philippines in Southeast Asia. It is a drought-tolerant and heat-tolerant crop. As it is a plant of the prostrate type, it is resistant to strong wind of typhoon. The taste of the grains of bambarra ground-

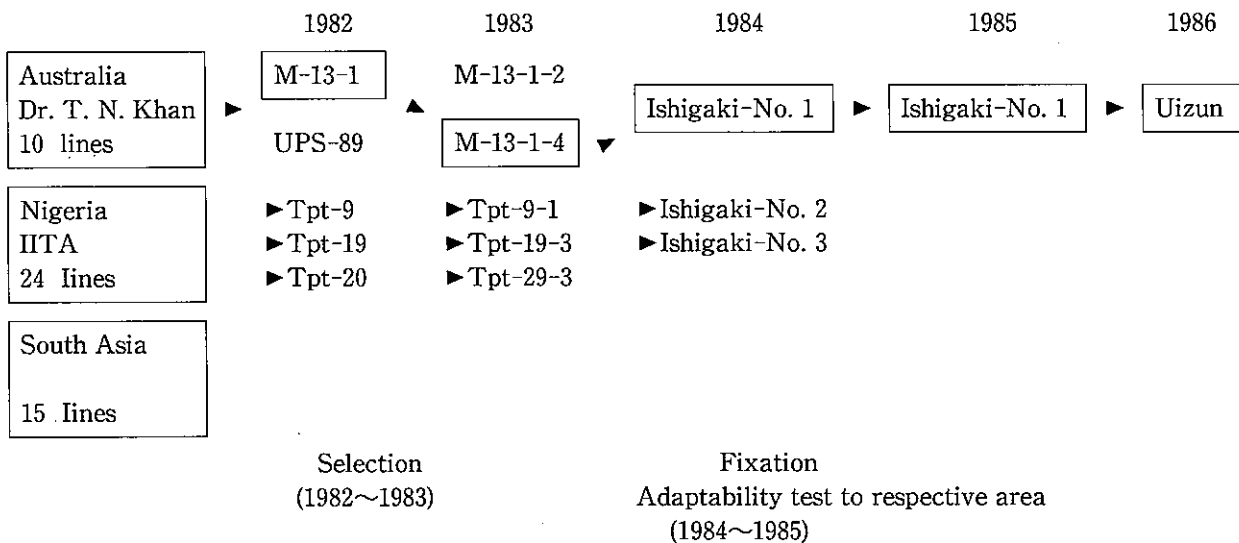


Fig. 2 Breeding process of the first winged bean variety "Urizun" at TARC Okinawa

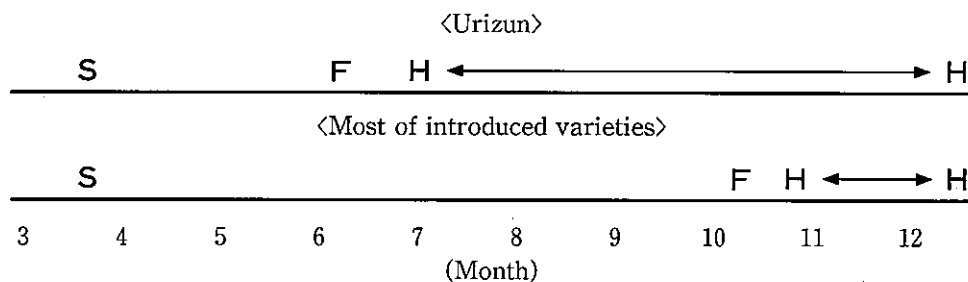


Fig. 3 Harvesting period of winged bean varieties in Okinawa

S: Sowing, F: Flowering, H-H: Harvesting period

nut which is similar to that of fava bean, is familiar to many Japanese who like it. The germplasm was introduced from Zambia and Indonesia and early maturing varieties was introduced from the collection of IITA. From more than thousand seeds of market samples and ten varieties from IITA, line selection was started. All the introduced materials were so late maturing that they matured only in late October in Okinawa, because they originated from countries at low latitude. Lines with high yield and large seeds were obtained from the population, though they are late maturing, too.

In order to propagate bambarra groundnut, a weeding system and a harvesting system are being developed. As we have no traditional method of cooking bambarra groundnut, family cooking and food processing should be promoted to suit the Japanese taste.

The last candidate is a heat-tolerant variety of snap bean. Common bean originated in the highlands of Mexico and is now distributed all over the world. Common bean is very important in China and Japan unlike in the sub-tropical and tropical countries of Southeast Asia, mainly due to the susceptibility of common bean to hot climate. It was reported that the flowers and young pods of the present commercial varieties fall at a high temperature (Iwami, 1950). Due to the lack of heat tolerance, snap bean is not cultivated in the summer in southern Japan.

Very rare varieties of snap bean were able to make pods in summer in Okinawa where the mean day temperature reached 30°C. In the evaluation by open culture in summer, three hundred thirty five lines of "International Bean Nurseries 1990" provided by CIAT, four varieties from the Philippines, seven varieties from Sri Lanka and two varieties from USDA whose high heat tolerance was reported in a previous report (Halterlein *et al.* 1980) could not set pods. However, some local varieties of heat-tolerant snap bean were identified during a TARC expedition in Malaysia in 1986 (Nakano *et al.* 1993). Eight accessions of heat-tolerant cultivars of black-seeded snap bean were collected. They could set many pods in open culture during the period July - August which corresponds to the hottest period in a year in Okinawa (Fig. 4).

However, RAPD analysis of chromosomal DNA showed that they belonged to a genetically related group, suggesting that they may have the same gene set for heat tolerance. The last exploration showed that most of the local varieties of snap bean distributed in Thailand displayed similar characteristics in their morphology and growing habit to those of the eight accessions of snap bean collected in Malaysia (Fig. 5). We plan to collect varieties of heat tolerant snap bean with different genetic backgrounds in order to breed varieties with a higher heat tolerance. Furthermore we plan to improve the quality of the pods by crossing the heat-tolerant varieties with high quality commercial varieties.

With newly introduced germplasm from tropical countries, we plan to extend the cultivation and utilization of legume crops in the sub-tropical zone of Japan.

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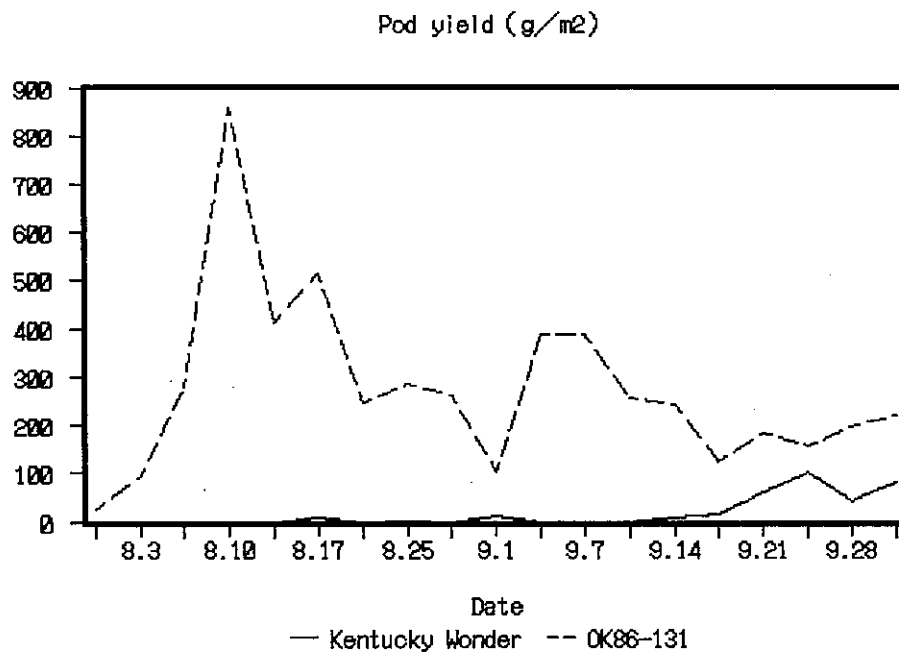


Fig. 4 Fresh pod yield of a variety (OK 86-131) introduced from Malaysia and common commercial variety (Kentucky Wonder) at harvest



Fig. 5 Distribution of snap bean varieties in Thailand and Peninsular Malaysia
 ●: Black-seeded pole bean type, ○: other types.

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