

THE RATIONAL USE OF WINGED BEAN IN CROPPING SYSTEMS, TO IMPROVE THE NUTRITION OF THE SMALL FARMERS IN THE HUMID TROPICS

Introduction

This report was prepared by Dr. Gustavo Enríquez, Head of the Perennial Plants Program at CATIE, after attending the Conference on the Winged Bean in the Philippines in January, 1978. Even though intensive research on the winged bean is not being done at Turrialba, CATIE has a large winged bean germplasm collection*. This plant could be very important for the humid tropics and this report hopes to focus attention on it and on its potential.

The winged bean has been cultivated for many years and is part of the history of Asian and African countries. In Asia, it is grown predominantly in the high-altitude zones of the southeast in countries such as Papua New Guinea, the Philippines and others.

The winged bean has been cultivated in these countries primarily for home consumption. Recently, however, it has become a semi-commercial crop and its green beans (pods), roots, dried beans (seeds) and vines can be found in some market places, although in limited quantities. This is similar to the marketing practice for vegetables and local root crops in other places.

There are two very similar species of the winged bean. They are *Psophocarpus tetragonolobus* (L) DC. and *P. palustris* Desvaux. The first species has the most widespread use.

Place of Origin

The place of origin is not known with certainty. Some authors (6) think it is West Africa, while others (4, 8) think it is India. According to Khan (4) the winged bean could have originated in Madagascar, Mauritius or in Papua New Guinea. Africa seems to be the most important center of dispersion for the winged bean since the majority of the closely-related species are found there and the greatest diversity of plant characteristics are seen.

* Included in the collection are the following entries:

Indonesia 1	UPS - 31
Indonesia 2	UPS - 32
Kade 6/16	UPS - 45
S 684-799-2B	UPS - 47
S 685-993	UPS - 53
Thai - Selc.	UPS - 62
S - 207	UPS - 102
TPT - 1	UPS - 121
Turrialba 6304	UPS - 122
Turrialba 6305	18 - 02
Turrialba 6306	26 - 01
Turrialba 6307	26 - 03
UPS - 29	28 - 01

General Characteristics of the Plant

At the present time, the winged bean is being recognized as an important plant because of its distinctive characteristics.

Protein content of all parts of the bean plant is very high. The root (a tuber) has a protein content higher than that of any other known root crop. The percentage of protein in the dried bean is among the highest in the legume group, besides being highly digestible. The young pods are considered very appetizing by those who regularly eat them, and also contain a high percentage of protein. The protein content is comparable to that of other vegetables with edible young fruits, but the others do not compare in flavor to the winged bean. The flowers are eaten in some parts of Papua New Guinea. These also have a high percentage of protein, but their use has not spread to other areas where the plant is cultivated. Another characteristic worthy of attention is the nodular capacity of the plant. It has been shown that the symbiosis of the plant and the *Rhizobium* is highly promiscuous while in other legumes it is highly specific. This advantage allows it to adapt very well to many environments where it was not previously cultivated. Also, a special affinity has been detected with many strains of the cowpea (*Vigna unguiculata*) (1).

These characteristics give the winged bean an advantage over other legumes as a crop which can be used in many ways. It is a logical and suitable crop for the farm systems of farmers with little resources, in a great diversity of environments. It can be grown in relatively dry areas, and in very wet areas. It can be used as a food crop, as an animal food supplement, as a cover crop and as green manure.

It can be grown in relatively dry areas even during the driest periods by planting it near the house where water would be easily available for some irrigation until the plant is well established. It can be used as a cover in plantations of perennial crops such as African Oil Palm, Peach Palm, Rubber and others, where weeds can be a problem, with the following advantages: 1) more nitrogen fixation from the air to the soil, 2) a good cover, 3) recirculation of elements by means of the dry leaves covering the soil, and 4) a permanent food source for people and animals, with all the advantages noted above.

Another advantage of this plant is its high potential yield, both of the dry grain and of the green pods or tuberous roots. These yields are comparable to the best yields of similar types of crops.

The potential yield of the grain has been shown to be more than 4,500 kg/ha in northern Australia and Malaysia. Very few, if any, legumes have obtained yields this high under farm conditions.

Description of the Plant

Winged bean is a perennial plant with indeterminate climbing vines reaching up to several meters in length. The color ranges from green to purple with many intermediate shades and variations. The vines renew themselves annually. A bush bean type with determinate stems has not been found. The underground part is a tuberous root, found close to the surface and is easy to harvest. There is variation within the species in the formation of tubers. Under certain environmental conditions some lines or varieties do not form tubers. Under other environmental conditions, some varieties form tubers almost exclusively, and have a low grain yield. This characteristic of high variability within the species is interesting from the point of view of improvement of the crop and its adaptation to many conditions.

The flowers are clustered at the end of long peduncles. The corolla ranges in color from white to blue to purple and in some cases can be of two or more colors.

The pods show great variability. They can be straight or slightly curved, short (about 10 cm) or long (50 cm), thick or very thin, the width varying from 2 to 4 cm. They characteristically have four prominent longitudinal wings corresponding to the four corners of the pod, with curved indentations of the border of the wings. A cross-section cut shows the basic form. The shape of the wing section ranges from square to a flattened rectangle, giving the impression of a pair of wings almost fused together. In these cases, the line where the two carpels meet is found within or between the pairs of wings. The surface of the pod can be smooth or can range to very rugose (wrinkled). The color ranges from white to green to purple with many combinations and shades of the basic color.

The seeds also vary in their characteristics. Some may be flat, but the majority of the varieties have round seeds. The environment can influence the size of the seed. The color ranges from very deep purple (black) through brown (tan), cream and a greenish

Closeup of winged bean in the CATIE germplasm collection.

color, to almost white. The environment influences seed color, which changes rapidly depending on harvest, drying, and storage conditions. Completely white seeds have not been found.

Ecology of the Crop

Although the absolute rainfall range for winged bean is not known, it is estimated that it can grow well under 152 to 250 mm of annual rainfall (7). This would be considered a fairly dry area under conditions of high temperature.

Pachie and Rober (5) estimate that winged bean grows very well in areas with about 1500 mm of rainfall annually. This is considered a wet area if the rainfall is distributed evenly throughout the year or if there is only a short dry season.

The winged bean also adapts to a wide range of altitudes. As with the common bean, it can be found from sea level to 1,500 m in optimum conditions. It is also found at altitudes of 2,400 m growing in association with other crops. The diversity of altitudes tolerated by the winged bean indicates that it can adapt to a wide range of temperatures, tolerating high temperatures without any major problems (2).

Normally, the winged bean is considered a short-day plant, although there is variation in photoperiod response. The photoperiod response is also influenced by temperature, that is, the response is sensitive to the interaction of temperature and photoperiod (9).

Dr. Gustavo Enríquez, Head of the Perennial Plants Program at CATIE, holding winged bean in the germplasm collection.

It is a plant usually grown in association with other crops and can tolerate a certain amount of shade without harm to its growth and general development.

It is a somewhat demanding plant in respect to soil texture. It adapts well to many conditions but requires a certain richness of nutrients and good drainage.

Cultivation

In general, this crop is grown in a traditional manner. The technology for the crop is not well-developed probably because it has not been grown for large commercial production. It resembles the climbing or indeterminate common bean which requires support for climbing so that the aerial parts of the plant can be harvested. However, the winged bean can also be grown as a creeping vine. These vines climb only when they encounter another plant or some other type of support. Good results have been shown using winged bean in this way as a cover crop.

As mentioned, this plant is basically grown for home consumption. There are some areas in Papua New Guinea where it has been cultivated more extensively but still produced only for the local market and the small towns. Generally, the larger market places are supplied by a few farmers who live near the cities.

It is very common to find winged bean in association with other crops or as part of a farm system. It often occupies a secondary position or is a filler. It is also found as part of a rotation, especially with sweet potato (*Ipomoea batatas*) as the alternating crop. Rice, followed by winged bean, followed by sugar cane is a common rotation in Southeast Asia (Burma). In Papua New Guinea it is very common to find winged bean associated with maize. The maize and the beans are planted at the same time or the beans are planted later and use the dry maize stalks for support. The winged bean is also found in association with *Leucaena leucocephala*. It climbs this plant while it is growing.

Even though winged bean is usually grown in association with other crops, its expanded production may require that it be grown in monocultures. Very little is known about the extensive production of the bean in monoculture, but it has been observed (2) in the low altitude zone of Ecuador that a high percentage of plants were affected by virus when cultivated in relatively large blocks. Since it has been cultivated successfully in the traditional manner in Africa and other areas, it may be that disease problems are reduced (10) by planting in association with other crops and on small plots.

The use of the harvest is an important factor to consider in cultivating the winged bean. The crop can be very different depending on whether the green pods or the dried beans are to be harvested. In the former case, continual harvesting of the young pods lengthens the period of flowering. The variety used, of course, affects the cultivation and harvest practice.

Some varieties require that the flowers or the young pods be removed for the production of the tuberous roots. Other varieties can produce as many pods as tuberous roots.

Some varieties are sensitive to photoperiod for the formation of tubers. Other varieties respond to treatments such as mulching or harvesting of leaves. Others form tubers when moved to a higher altitude (10).

The vegetative period varies according to variety. Some varieties begin to flower at 45 days after planting and the ripe pods can be harvested at 90 days. The beans (seeds) from another variety can be harvested at 5–6 months after planting. In other varieties the tubers can be harvested at 4–5 months after planting. The photoperiod and the date of planting also affect the vegetative period.

The edible plant parts are highly digestible with the exception of the tubers. They are also poor in sulphurous amino acids. They do have a high protein content (12–15%) and are recommended as a diet supplement, especially in areas where tubers and roots with a low protein content are eaten.

Perhaps the most common use of the bean is as a vegetable. The green pods, especially, can be eaten in many ways. They can be eaten raw, or cooked in different ways. In some places they are infected with a type of rust (False Rust) causing orange-colored sporophores. These pods are considered very desirable by many people. The pods can be cut in small sections and cooked in soups and they make a flavorful addition to vegetable salads.

Not much is known about the consumption of the fresh bean (seed), probably because opening the pods is a difficult chore. However, they are used in the same way as the fresh beans of other legumes. It is possible that it would be economically viable to produce them in a commercial operation.

The young buds are often eaten as a vegetable in the high altitude areas of Papua New Guinea. They are also used as animal feed, but not much is known about their large scale production for this purpose. Nevertheless, an enormous potential exists for the plant, especially in areas where there are dry periods and animal feed is scarce during some months. The leaves are rich in Vitamin A, and are recommended for use in diets poor in this vitamin.

The greatest potential of this plant lies in its high grain yields. In some parts of Malaysia (5) yields of almost 4,600 kg/ha have been reported, although reports from other areas show yields of about 500 kg/ha (10). This indicates that the potential is high, but there is a need for research on the limiting factors of this crop in order to be able to obtain high yields in the areas where it will be introduced in the future.

Pests and Diseases

There have been relatively few pest and disease problems in winged bean cultivated for home use. Nevertheless, some pests and diseases of the winged bean are listed in the literature. It is assumed that when this crop is expanded to other areas and is grown on a larger scale these problems will begin to appear on the farms. Some of the problems must be attended to immediately or they will become limiting factors of the crop in a few generations. Other pests and diseases will probably emerge when the plant is brought to new areas.

A short list of the most important pests follows. Many of these have not been identified yet.

Red Mites

Leaf Miners (various species)

Grasshoppers and Caterpillars which damage the leaves

Caterpillars which damage the young pods

Aphids (*Aphis craccivora*) (4); also attacks cowpea *Maruca testulalis* (4)

Long-horned Grasshopper (*Henosepilacha signatipennis*)

Damage caused by farmyard birds and other birds, who find the beans highly desirable, has been reported.

Among the important diseases are:

False Rust (*Synchytrium psophocarpi*)

Cercospora Leaf Spot (*Cercospora psocarpi*)

Wilt (*Sclerotium* spp.)

Anthrachnose (*Colletotrichum lindemuthianum*),

Powdery Mildew (*Erisiphe* sp.)

A flower blight (not identified)

Some viruses have also been observed. One is a speckled type and another reduces the size of the leaves, giving the appearance of dwarfness.

Finally, nematodes of the genus *Meloidogyne* have been identified in the roots. They provoke a general withering of the young plant and interfere with the proper formation of the tuberous roots.

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