Indian Farming **67**(11): 21–24; November 2017

Ricebean

A nutritious and resilient crop under present scenario

Kuldeep Tripathi[1] and Padmavati G. Gore[2]

National Bureau of Plant Genetic Resources, New Delhi 110 012

*Ricebean (*Vigna umbellata*) belongs to genus* Vigna *and subgenus* Ceratotropis *exhibiting wider adaptability and has potential to grow well in humid tropical and sub-tropical to sub-temperate climate across different eco-geographical regions of Asia including India. The inherent adaptive attributes has made this crop more tolerant towards diverse biotic stresses that commonly restrain yield enhancement of other* Vigna *species and legumes. Therefore, ricebean exhibits consistent phenotypic expression during adverse climatic conditions and emerges as one of the highest grain yielding potential legume. Ricebean is well-known for its high nutritional quality which is primarily attributed to abundance of high-quality protein contents, and essential amino acids, vitamins and minerals. The lower fat content and a relatively high proportion of healthy and unsaturated fatty acids and digestible protein make this legume crop a nutritious health package. Ricebean, therefore, seems to have a potential to constitute one of the feasible target for eliminating protein malnutrition in the developing countries.*

Key words: Genetic resource, Nutrition, Orphan legume, Ricebean

The majority of germplasm accessions and domesticated varieties of ricebean suffer from many undesirable attributes, including asynchronous and late maturity, indeterminate growth habit, wide range of seed colours, high pod dehiscence, seed shattering habit and enhanced level of few anti-nutritional components despite being a high-yielding legume crop. It is being called as orphan legumes, the crops that are largely grown and used locally by communities. They are not part of the main crops that are traded internationally. They are an important component of diets in many countries and can help provide balanced nutrition and support resilience and sustainable agricultural practices. They can also be grown as feed for animals, fibre for clothing, a fuel source, or even for medicinal use. Ricebean has yet been very little researched and exploited, and not been subjected to systematic genetics, breeding and genomics research especially targeting the aforesaid undesirable traits essential to modulate for fast-paced genetic improvement, popularization and accelerated domestication of this legume crop.

Origin, Taxonomy and distribution

Ricebean is considered to have been domesticated in South-east Asia. Its progenitor is wild form *V. umbellata* var *gracilis*, with which it is cross-fertile and is distributed in North-eastern India, Burma, Thailand, Laos and Vietnam. It is diploid (2n = 22) species. It is an annual legume with erect to semi-erect habit and produces profuse branching. Leaves are tri-foliate and leaflets are broad and hairy. Flowers are borne in clusters with bright yellow in colour. It produces seeds of variable size and colour with predominant hilum and shape of the seed is elongated, slightly curved and beaked. Though this crop shows high adaptive polymorphism with adaptability in humid tropical and sub-tropical to sub-temperate climate across areas, its cultivation is restricted to specialized geographical pockets in different agro-ecological regions of hilly areas and cultivated mainly by poor farming communities for subsistence. It has a rich genetic variability having high yield potential in its ability to



Ricebean growing in field



RIcebean intercrop with maize at Ranichauri, Uttarakhand

survive in marginalized areas in adverse climatic condition and tolerance to storage pests and serious diseases.

Cultivation practices

Ricebean requires hot and humid climate and can be grown well during *kharif* on relatively well-drained fertile and loamy to sandy loam soils. It grows profusely with many lateral inter-twining branches, so can benefit from being sown between rows of a tall cereal such as maize or sorghum for climbing.

Soaking of the seeds overnight (10 to 12 hr) before sowing is essential to facilitate better seed germination. Sowing is done either by broadcasting or dibbling method. 9 to 12 kg/ha seed required in broadcasting method while 5 to 7 kg/ha in dibbling method. Weeds are not a major constraint, however, 2 to 3 weeding could be beneficial at about six weeks after sowing seeds and before flowering. Ricebean matures in 120 to 150 days after sowing. The higher the altitude, the longer is the crop duration. Harvesting is carried out when approximately 75% of the pods turn brown. To tackle the problem of pod shattering, it is good to collect pods during the morning and late afternoon. It is common practise to harvest the whole plant when majority of the pods are dry and then sun-dry the plants on the threshing floor for 3 to 4 days and then plants are beaten with sticks to collect seeds. To obtain a good yield, it is advisable to harvest the pods in 2 to 3 or more pickings as per need. Average grain yield is about 6 quintals per acre. If dried properly, ricebean can be stored for longer period compared to any other grain legumes in ambient conditions. The grains are resistant to pulse beetle and may be stored after sun drying without any seed treatment in dry bins or in gunny bags kept on wooden racks.

Varietal Diversity of Ricebean

Cultivars differ in period of maturity and seed coat colour. It is classified in to four different types based on the seed coat colour (Table 1).

Economic Importance

Ricebean has been tagged as tribal pulse of eastern India due to its multiple uses. All parts of the ricebean plant are edible and used in culinary preparations. Boiled dry seeds can be eaten with rice or it can be used as good substitute for rice in soups. Nutritive flour is prepared with powdered grain which is included in the children food supplement. Fibrous mucilage present in ricebean, prevents hulling and separation of the cotyledons which limits it preference as *dal*. Young pods, leaves and sprouted seeds are boiled and eaten as vegetables. Young pods are sometimes eaten raw. Ricebean is useful for livestock feeding. The vegetative parts can be fed fresh or made into hay and the seeds are used as fodder. Ricebean straw is the crop residue of the seed harvest, includes the stems, leafy portions, empty pods, and some seeds. Before feeding, the woody portions and soiled or mildewed parts of the straw should be removed. In the marginal hills of Nepal, farmers consider ricebean both as a grain and fodder legume and look for dual-purpose landraces. Along with these useful characteristics, it also contains many genes to tackle with many stress condition and for highest grain yield.

Nutritional quality component traits

Ricebean is multipurpose, highly nutritious legume. It is mainly used for human dietary uptake, with a smaller proportion used for fodder and green manuring. It forms an important part of cereal-based diet as the dried grains are rich in protein, minerals and vitamins. The dried mature seeds of ricebean are usually

Table 1. Landraces showing different traits

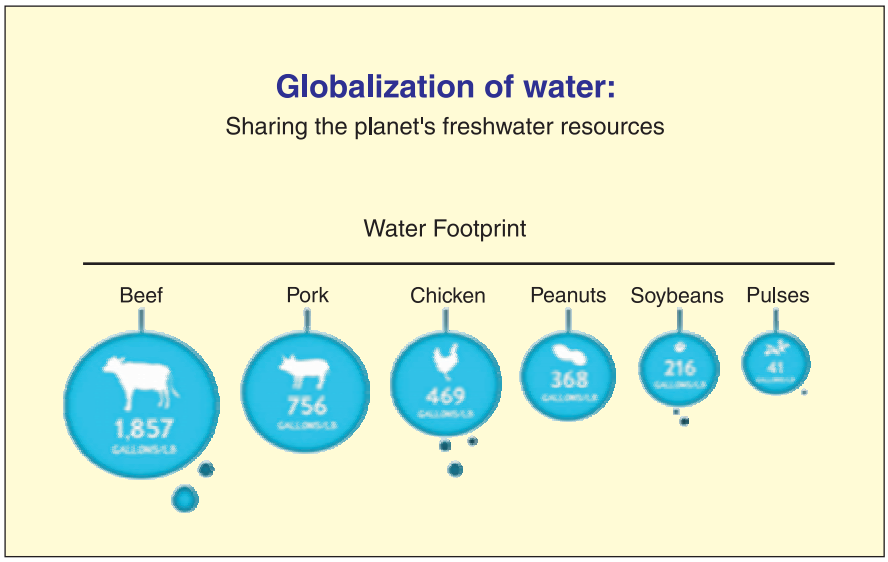
Landrace	Distinguishing Traits	Positive Traits	Negative Traits
Red coarse	Red colour, small to medium-sized grains, medium in maturity	Least affected by rainfall, medium in maturity (third-fourth week of October)	Not very tasty, grain, low grain yield
Brown big	Brown striped colour, bigsized grains, late in maturity	Better taste compare to Rato, better grain yield, good fodder yield	Late in maturity (third week of November)
White big	White to yellowish, big-sized grains, late in maturity	Taste is better, better cooking quality, high grain yield, high fodder yield	Late in maturity (third (week of November)
Early small grained	Greenish to yellowish, small-sized grains, early in maturity	Early maturing (third week of September)	Low grain yield, low fodder yield

Source: *LI-BIRD, 2007* (Local Initiatives for Biodiversity, Research and Development)

Biochemical constituents of Ricebean

Constituents	Values (per 100g)
Water	11.20 g
Ash	3.54 g
Protein	19.97 g
Fat	0.74 g
Carbohydrate	51.26 g
Total dietary fibre	13.37 g
Energy	1265 kJ

Source: (Indian Food Composition Table 2017)



consumed with rice or in soups and the leaves, flowers, shoots and young pods are eaten as vegetables in the upland areas of South-east Asia and Southern China. The dry seeds of ricebean are good sources of carbohydrates, proteins, minerals and vitamins. Protein in ricebean is rich in limiting amino acids, viz. methionine and tryptophan. The seeds are also rich in other amino acids including valine, tyrosine and lysine. The seeds contain vitamins such as thiamine, riboflavin, niacin and ascorbic acid. However, the levels of different antinutrients such as phenolic compounds, phytic acids, saponins, oligosaccharides, enzyme inhibitors and lipoxygenase enzyme are observed slightly higher than the other common legumes. These can be eliminated by boiling and germinating seeds before cooking. Thus the abundance of high-quality and digestible protein contents, and essential amino acids, vitamins and minerals with lower fat content make this crop a nutritious health package.

Low carbon footprint crop

Ricebean utilize soil bacteria to draw nitrogen from the air. This natural process replaces the need to add nitrogen fertilizers in pulse crops, which mean it use half the energy inputs of other crops. When soil is fertilized with nitrogen in the form of manure, fertilizer, or crop residue, soil micro-organisms convert some of this nitrogen into nitrous oxide, which is a powerful greenhouse gas. Nitrous oxide is 300-fold more potent than carbon dioxide (CO_2) and represents around 46% of the greenhouse gas emissions from global agriculture. Since greenhouse gas emissions related to crop production are largely driven by nitrogenous fertilizers, nitrogen-fixing pulse crops have a lower carbon footprint compared to other crops. Their tap roots maintain soil structure and provide required nutrients to the plant. It also used to get organic matter by ploughing them in field. Ricebean grown before or after a rice or maize crop is useful to rice and maize.

Water efficient source of protein

Ricebean extract water from a shallower depth, leaving more water deep in the soil for the following year's crop. This increases the water use efficiency the entire crop rotation. It is reported that around 1,857 gallons of water is required to produce one pound (0.404 kg) of beef while only 41 gallons of water is needed produce one pound (0.404 kg) of pulses.

Stress tolerance and yield component traits

A number of wild ricebean accessions are highly tolerant to severe environmental conditions, including high-salinity, acidic or alkaline soil, drought, flooding and pests and diseases. Ricebean contained many useful characteristics viz., bruchid resistance and yellow mosaic virus resistance and bacterial leaf spot resistance and the highest potential of grain yield among *Ceratotropis* species. Ricebean inhibits the larval development of bruchids. Eggs were laid by insect but no emergence was recorded owing to presence of inhibitors.

Varietal improvement

A number of varieties were released in ricebean along with numerous cultivars viz. RBL-1 (1996), RBL-6 (2002). RBL-35 (2003) and RBL-50 (2003). RBL-6 is a photosensitive variety having vigorous spreading growth habit with many lateral intertwining branches having resistance to fungal, bacterial and viral diseases especially yellow mosaic virus. PRR-1 (PRR 8801) and PRR-2 (PRR 8901) were developed by GBPUA&T, Pantnagar in 1995 and 1997 respectively. BRS-1, BRS-2 were released by NBPGR research station, Bhowali, Uttarakhand, for hills region. Regional station of NBPGR, Shimla and VPKAS, Almora released 'Himshkati' (VKB- 3) variety for North-west and North-east hills region of India in 2012. Bidhan Chandra Krishi Viswavidyalaya, Kalyani released Bidhan 1, Bidhan 2 and Bidhan 3, which were suitable to grow in North-Eastern Region, Bengal, Odisha, Jharkhand and Bihar. Konkan Ricebean-1 (KRB-1) was released as fodder type. Naini, Megha Rumbaiza 1(RCRB 1-6) and chaukhamba are popularly grown land races. Ricebean could not get the attention of researchers as it should be due to various constraints like low yield, lack of taste, anti-nutritional factors and its limited use as split pulses. Systematic crop improvement work is need of hour to tap the potential of ricebean and its genetic resources to make it a

sustainable and affordable source of vegetable protein.

Genetic resources

Genetic resources are the germplasm of actual or potential value which carries heriditary information either in seed or its propagating material. It is being considered as fourth essential element of life after land, water and air. It acts as source of useful traits for crop improvement programmes. Conservation of germplasm is needed for future utilization.

Ricebean germplasm conserved in genebank / institutions around the world

Genebank	Number of accessions
NBPGR, India	1,770
ICGR-CAAS, China	1,415
NIAS, Japan	476
AVRDC, Taiwan	266
CPBBD, Nepal	157
IPB-UPLB, Philippines	150
PGRC, Vietnam	117
LBN, Indonesia	100
Others (18)	364
Total	4,815

Potential for research

Despite having many useful traits, systematic breeding of ricebean has not been carried out to tackle with biotic and abiotic stresses it can be best described as a scientifically neglected crop of great potential. It is a multipurpose crop, so it is necessary to promote ricebean cultivation for food and nutritional security of the people. For this assessment of ricebean diversity, development of high-yielding varieties through plant breeding and dissemination of knowledge among the farmers is necessary. The legume possesses immense capacity of nutrition and production and has a potential for eliminating protein malnutrition in the developing countries but its potential to be a boon in improving the livelihoods of many poor people is yet to be fully tapped. Till date, the commercial importance and market value of this pulse remains unknown to the people. So, the big challenge ahead of us is to make this crop as food legume of 21st century. Ricebean suitable is for inter-species hybridization with other major food legumes to transfer the gene of economic importance.

SUMMARY

Ricebean is a multi-functional crop. It is mainly used for human dietary uptake as the dried grains are rich in protein, minerals and vitamins and also used for fodder. Nitrogen-fixing ability makes ricebean important for green manuring. Besides this, it is a very hardy crop, possesses many useful genes which provide resistance to biotic and abiotic stress. These characteristics of ricebean are very important to tackle the problem of changing climate. Considering its role in food and nutritional security, utilization of ricebean genetic resources is essential in present scenario to make it as food legume of 21st century.

[1]Scientist, Germplasm Evaluation Division, NBPGR, Pusa Campus, New Delhi-110012. Corresponding author e mail: kuldeep.tripathi@icar.gov.in. [2]Scientist, Division of Genomic Resources, NBPGR, Pusa Campus, New Delhi-110012.

Indian Farming
Article Certificate

I.D. No:

Article entitled: .....

It is certified that:

1. The articles has been seen by all the authors (signature given below), who are satisfied with its form and contents.
2. Due credit of authorship has been given to every scientist who has notable contribution to the paper, and we are satisfied with the sequence in which the author's names appear in the by-line (author's name).
3. The by-line of the article does not include any name of a scientist who has not made a notable contribution to the paper.
4. The address of the institute appearing below the by line is that of the institute where the research was conducted and not that of the institute where the first author (for the author who has sent the paper) is currently employed.
5. The results reported in the article have not been simultaneously sent for publication in any other journal.
6. The article has not been rejected for publication in any other journal.
7. If published the copyright of this article would vest in the INDIAN COUNCIL OF AGRICULTURAL RESEACRH, which has the right to enter into any agreement with any organization in India or abroad engaged in reprography, photocopy, storage and dissemination of information contained in it, and neither we nor our legal heirs will have any claims on any royalty.

Signature	Name in Full and designation, Address	Present official address	Subscription with date number

OPTIONAL

The above certificate is correct to the best of my knowledge and I have no objection to the publication of the article cited above in *Indian Farming*.

Signature and address of Head
of the department/head of the institute