Importance of Under-utilized Indigenous Legumes in Asia-Pacific Region

C.L.L. Gowda, H.D. Upadhyaya and M.A. Ghaffar
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru
Andhra Pradesh 502324
India

Keywords: Indigenous legumes, human nutrition, value-addition, commercialization

Abstract

Food legumes constitute a major crop group in the Asia-Pacific region because of their unique features including their role in human and animal nutrition, nitrogen fixation, adaptation to stress conditions, suitability to various cropping systems, and for overall sustainability of agricultural production systems. Most countries in the region have attained self-sufficiency in staple cereal crops production. However, the availability of legumes is low, and many countries are importing legumes costing huge amounts in foreign exchange. Dependence on a few legumes in production and market chain, and high demand has lead to increased price for legumes, and thus the poor rural and urban families cannot afford to eat legumes to the desired level (to meet protein needs). Only a handful of legumes are grown on large areas and enter commercial markets. There are many indigenous food legumes whose potential is under exploited and untapped. Many of these indigenous food legumes play a vital role in protein nutrition to poor farm families, especially to women and children, in the region. Looking at the total area cultivated and production, legumes such as soybean, groundnut, chickpea, lentil, common bean, field peas, chickpea, and pigeonpea can be considered as major legume crops. Other legumes that are indigenous and under-exploited are: Adzuki bean, bambara groundnut, blackgram, broadbean (faba bean), horsegram, lablab bean, lathyrus, moth bean, rice bean, and winged bean. Not all of them are indigenous (in the sense of origin), but have been cultivated in the region for more than 200-300 years. Hence, all these are considered indigenous for the purpose of this paper and their potential for expanding the food basket and commercialization in Asia-Pacific region is discussed.

INTRODUCTION

Legumes together form an important group of crops that are important as food, feed, fodder, and for maintaining soil health. Among the 80,000 plant species listed as edible, only about 3000 are used as food, but only around 150 are cultivated. Among the legumes, about 30 species are cultivated, but only a few are widely grown across the continents (soybean, groundnut and peas). There are many other legumes that are cultivated locally or regionally, and their potential is under-exploited. Many of these under-utilized legumes are indigenous, either originating in these areas or have been cultivated in the area for more than 200-300 years.

UNDER-UTILIZED FOOD LEGUMES

As indicated earlier, we present the under-utilized legumes that originated in the region or have been cultivated for more than 200 years, and hence can be considered indigenous for the purpose of this paper. We have not included some of the major legumes such as chickpea, lentil and pigeonpea (in addition to soybean, groundnut, and peas) as these are also cultivated widely. The under-utilized legumes are: Adzuki bean (*Vigna angularis*), Bambara groundnut (*Vigna subterranea*), Broadbean/Faba bean (*Vicia faba*), Cowpea (*Vigna unguiculata*), common bean (*Phaseolus vulgaris*), Horsegram (*Macrotyloma uniflorum*), Lablab bean (*Lablab purpureus*), Lathyrus/Grasspea (*Lathyrus sativus*), Moth bean (*Vigna aconitifolia*), Mungbean (*V. radiata*), Rice bean (*V.*

umbellata), Urd bean/blackgram (*V. mungo*) and winged bean (*Psophocarpus telragenolobus*).

1. Adzuki Bean [*Vigna angularis* (Willd) Ohwi and Ohashi]. It is cultivated mainly in Southeast Asia, including China, Japan, Korea, Thailand, and Vietnam. Being a short-duration crop, it fits well in double cropping system. Seeds are cooked whole and in making soups, and also used in specialty cakes and confections. Adzuki bean is also used in oriental medicines. Crop improvement is minimal and there is potential to increase yield and make the crop amenable to mechanized cultivation.

2. Bambara Groundnut [*Vigna subterranea* (L.) Verde.]. It originated and is cultivated in the drier areas of Africa, and also in Latin America, Australia and Asia. In Asia it is cultivated in India, Indonesia, Malaysia, Philippines and Thailand. Bambara groundnut is a short-day plant, and grows well in 600-750mm regions. The immature seeds are boiled or roasted and eaten as snacks. Mature dry seeds are used in various food preparations. Current landraces are of long-duration and low-yielding. Hence there is need for short-duration, high yielding varieties that can be grown in different farming systems profitably.

2. Broadbean or Faba Bean (*Vicia faba* L.). Broadbean originated in the Mediterranean region, but is now widely cultivated in the temperate zones of Mediterranean area, and in highlands of Asia, Central and South America. Faba bean is used as human food and is a major protein source in animal feeds. Both green and dry seeds are used as food. Being a high protein crop (around 32%), it is used to replace meat in human diet. However, presence of anti-nutritional factors [tannins, lectin, protease inhibitor, and glucoside vicine that induces favism (a haemolytic anemia) in susceptible individuals] in seed has limited its wide-spread use. However, selection can reduce the contents of these anti-nutritional factors. The green plants are used as cattle feed and in green manuring. Modern breeding efforts have provided high yielding varieties with reduced anti-nutritional factors.

3. Cowpea [*Vigna unguiculata* (L.) Walp.]. It is an important legume crop in Africa, but is also cultivated in Asia and Latin America. Leaves, green pods and seeds are used as vegetable, and dry seeds are cooked and eaten to serve as protein supplement (23-30% protein). Plants are used as fodder, hay, pasture and green manuring. It is adapted to marginal soils, and fits in various intercropping and multiple cropping systems. There are both photoperiod sensitive and day-neutral varieties that are used in specific farming systems. Availability of short duration (60 days) varieties has expanded the scope for large scale cultivation. Yardlongbean (*V. unguiculata* cv. Sesquipedalis) is grown for green pods that are used as vegetable in Southeast Asia.

4. Horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.]. Horsegram is widely cultivated in India, eastern and southern Africa, Myanmar, Malaysia, West Indies and Australia. It is a tropical crop and grows well under low rainfall and is drought tolerant. Plants are used as fodder, Lay and green manure. Seeds are used as human food as well as cattle feed. Although considerable genetic variability exists, crop improvement efforts are needed to exploit the crop fully.

5. Lablab Bean [*Lablab purpureus* (L.) Sweet]. It is cultivated as sole or intercrop in home gardens, and as a rainfed crop in the tropics in Asia, Africa, Central and South America. Young pods and seeds are used as food; leaves and plants (fresh and dry) are used as fodder and for green manuring. It is a drought tolerant crop, and therefore grown in semi-arid and areas of limited rainfall. In Asia, it is grown in Bangladesh, China, India, Indonesia, Malaysia, Philippines, Papua New Guinea, and Thailand. Further research is needed to enhance yield, make the plant bushy, and to reduce trypsin inhibitor and glucosides in the dry seed.

6. Lathyrus (*Lathyrus sativus* L.). Lathyrus (grass pea) is a hardy and drought tolerant crop, grown under residual moisture conditions in many countries of Asia (Bangladesh, China, India, Nepal, Pakistan), Africa, Central Europe, and the Middle East. In many countries lathyrus is grown for fodder, but dry seeds are also used as human food. A major limitation in use of dry lathyrus seeds as food is the presence of a neurotoxin (ß-N-Oxalyl-diamino propionic acid), that causes lathyrism, if there is continuous consumption

of lathyrus in large quantities (>50% of total diet in take of uncooked seed or flour per day). Soaking overnight or cooking (or any other heat treatment) reduces the level of toxin. However, there are lines with low neurotoxin content.

7. Moth Bean [*Vigna aconitifolia* (Jacq.) Marechal]. Moth bean is native to India, and is grown in arid and semi-arid tropical areas due to its hardiness and drought tolerance. It is used as both food and fodder. It has a good potential as a food crop in arid areas with harsh climate. It is used as a living mulch to reduce soil erosion. Crop improvement efforts are needed to make the crop high yielding, with desired seed size and amenable to mechanization.

8. Mungbean [*Vigna radiata* (L.) Wilezek] and Urd Bean [*V. mungo* (L.) Hepper]. Both mungbean (green gram) and urdbean (blackgram) are related species, grown for their seeds that are used as food in various forms (green seed, dry seed, split (dhal), sprouts, etc). Both originated in Asia, but have spread to a limited extent in middle-east Africa and the USA. In Asia, they are cultivated in Bangladesh, China, Bhutan, Malaysia, Myanmar, Nepal, Philippines, Pakistan, Thailand and Vietnam. Amongst the two, most of the research work has been done on mungbean for the development of improved short-duration varieties that can fit into varied cropping systems. Blackgram is also popular as a catch crop, especially in paddy fallows.

8. Rice Bean [*Vigna umbellata* (Thund.) Ohwi and Ohashi]. Rice bean is a low-input crop, providing good fodder and protein rich seeds. It is cultivated in tropical areas of Asia (China, Myanmar, Malaysia, Thailand, Philippines and Vietnam), Africa, America and Australia. In most East Asian countries, rice bean is used as a substitute to adzuki bean in various food preparations. The crop is also used as green and dry fodder. However, research has been limited to develop improved varieties for various agroclimates.

8. Winged Bean (*Psoprocarpus tetragonolobus* D.C.). Winged bean is a backyard crop in many countries, especially in the humid tropics. Young leaves, tender shoots, flowers, tender pods, green seeds, and dry seeds are used as food. Seeds have high protein (>30%). Despite its huge potential as a multi-purpose crop, winged bean cultivation has not been commercialized. Hence much more research is needed to make the crop amendable to large-scale cultivation (bushy plant, day-neutrality, drought tolerance and short-duration).

NEED FOR INCREASED PRODUCTION

These indigenous legumes play a vital role in improving the nutrition and health of rural poor (especially women and children) and also provide a good source of income through sale of excess production. Demand for food legumes too exceeds production, but only a few legumes are traded in the global markets. There is a huge opportunity for value-addition in terms of both ethnic and traditional foods and also for novel food uses. Thus, the under-utilized food legumes provide greater opportunities for increased income to the rural farming communities globally, and Asia-Pacific region particularly.

STRATEGIES FOR INCREASING UFL PRODUCTION

Considering that there is a huge and un-met demand, and need for increasing UFL production, we need to strategize the processes to meet the same. Germplasm of UFL need to be collected/ assembled and evaluated to enable selection of unique accessions (for adaptation, seed quality parameters, and diverse uses). Selected germplasm can then be used in genetic enhancement for yield, resistance to pests and diseases and other associated traits mentioned above. Intercropping of UFL with other cereals and legumes, and their cultivation in new niches and cropping systems will expand the cultivated areas and thus increase production. UFL also need to be made amendable for mechanized cultivation to reduce the need for labor, and cost of cultivation. Most importantly, there is need to enhance post-harvest processing and value-addition to meet the current demand and also to increase production to meet the future demand for processed and value added-foods, such as the ready-to-cook dhal, ready-to-eat dhal, snacks, bakery products, etc. Government policies should encourage trade of UFL grain and value-added products.

However, there are some bottlenecks for UFL improvement:

(i) Limited availability/access to germplasm, including minimal international exchange of germplasm. Many UFL species are not in the Annexure 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). Efforts should be made by member countries of ITPGRFA to include the UFL species in Annexure 1, so that these germplasm are in the multi-lateral system (MLS) for facilitated access and benefit sharing.

(ii) Policy support and funding for research and development of UFL crops in developing countries is negligible and needs to be increased.

GENETIC ENHANCEMENT OF UFL

There is limited genetic enhancement for some of the UFL species. Yield, adaptation and seed quality traits can be significantly improved through genetic enhancement. Many of the UFL species (and their wild relatives) have evolved under harsh agro-climatic conditions, and hence are likely to have adaptation traits (tolerance to drought and salinity, resistance to pests and disease, etc) rather than high yield. Landraces are likely to get extinct (due to competition from dominance of high yielding varieties of other crops). Hence there is an urgent need to collect and conserve the genetic resources for future use in crop improvement. Pure line selection among landraces is likely to get effective in the short-term. However, targeted crop improvement involving hybridization and selection will be needed for medium and long-term, especially to improve seed quality traits unique to each UFL species, and others that may enhance value-addition. Some legume seeds contain anti-nutritional factors (trypsin inhibitor, glucocides, etc), and need to be reduced or eliminated to improve their digestibility and use as food.

COMMERCIALIZATION OF UFL

As indicated earlier, commercialization is likely to drive the future demand for UFL, especially for value-added and easy-to-cook products. Value-chain (production-processing-consumer) for each crop needs to be established. Traditional products (made from UFL) with potential for large scale production and marketing, need to be identified. The next step is to find potential industry partners willing to invest and commercialize these products. Farmers (growing UFL) should be linked with the industry through contract farming so that the latter can get a steady supply of quality grains. It is also possible to establish small-scale value addition at village level, with farmers themselves as stake-holders in processing and marketing. In order to sustain these efforts, research-industry linkages need to be strengthened to develop novel food products and innovative value-addition and packaging to improve shelf-life, and for export to niche markets in country and to other countries.

ACKNOWLEDGEMENTS

The authors wish to thank the Organizing Committee of IVs 2006 for the opportunity to present the paper at the Conference, and for publication in ISHS.

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