



DIVERSITY OF UNDEREXPLOITED PULSES IN BAHRAICH (UTTAR PRADESH) INDIA

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ABSTRACT

Crop species which are adapted to hot and dry climates will become increasingly important as the world warms. The Krikhouse Trust supporting research and education in the biological Sciences is devoted to agricultural crop improvement for the alleviation of poverty, with a focus on legumes. The trust has supported research on legumes because of their importance in providing high quality protein in the diets of resource-poor farmers. Among these crops are many stress tolerant legume species found in India and Africa, which are relatively minor and neglected crops. A new programme called "Stress Tolerant Orphan Legumes" (STOL) for KT aims to support systematic studies of their potential to address the loss of agricultural productivity in the areas of the globe that are suffering from the grave climate stresses.

There are obvious signs that climate change is already having severe effects on the agriculture where several crops are failing because of the changed climate. In addition to direct effects of heat and drought on crops, the country is suffering soil loss due to increase in desert area per year. Over grazing, intensive cultivation, removal of tree cover, poor water management have all been reasons for this loss which cannot be compensated by any means. One more versatile fact remains that large tracts of land are being taken out of production for diverse types of constructions by the governments for the people as well as by the people for their settlements in urban areas. There are three possible ways to mitigate this looming disaster.

First one is the adoption of stress tolerant legume species which may help farmers to fight the ravages of climate stress: production of grain to feed the family and provide income; fodder and forage to livestock; ground cover as remedy for soil degradation. For this reason, there should be a diversity of species where some crops may prove to be multipurpose, providing grain and fodder, forage and other crops may be specialized for other function such as soil remediation.

In this presentation, we are undertaking twelve orphan legumes viz., *Cajanus cajan*, *Lablab purpureus*, *Macrotyloma uniflorum*, *Phaseolus acutifolius*, *Phaseolus lunatus*, *Phaseolus vulgaris*, *Tylosema esculentum*, *Vigna aconitifolia*, *Vigna radiate*, *Vigna subterranean*, *Vigna umbellata* and *Vigna unguiculata* for their potential of climate stress mitigation, ethno-botanical and ethno-medicinal uses.

KEYWORDS: Underexploited, Pulses, Bahraich

The knowledge of utilizing wild plants was pains takingly passed on from generation to generation database of valuable information of the plants around him. It is natural to assume that certain members of the tribe were gradually entrusted with such knowledge. These were variously known as shamans, bomohs, healers or witchdoctors. As communications between settlements was then poor, it is likely that such knowledge developed independently in different locations (Chin, 2005). The primitive man, through his trial and error, has selected many wild fruits which are

areas still use them extensively as a supplementary to their basic food requirement. A scientific study of wild fruits is important for the potential sources which are protective foods. The nutrients/pigments present in the fruits prevent different degradative/ageing process in our body and thus via restoring health offer longevity (Singh, 2011). These wild fruits would be utilized at the time of scarcity or cultivated as a source of food material for ever increasing population (Rashid et al., 2008). Biological resources are being viewed as national capital, waiting to be tapped for their potential utility, but at the

same time demanding to be conserved for posterity. India being a tropical subcontinent has always supported a wonderful diversity of plants. Indian culture made use of its plant resources to maintain the health of the society, people and pets alike. Several traditions, rituals, taboos, totems, similes and beliefs related with plants, also got associated with the life of the Indian people. Plants also became intricate part in various spheres of the human society. The knowledge of use of plants got transferred from one to another generation since time immemorial. A respectable number of plants are being used curing various ailments and also for edible purposes. Many species used during emergency and famine are not known to urban people but frequently used by tribes. Due to several natural and manmade factors a sizable number of such plants are passing through serious threat.

India has been considered as one of the 17 mega-diversity centers of the world with a wide range of Phyto-geographical variations. It consists of about 64 million hectares forest covers out of which 86% is tropical forest comprising 54% dry deciduous, 37% moist deciduous and 9% wet evergreen & semi-evergreen (Kaul and Sharma, 1971). As a characteristic feature, the tropical forest shows a huge variation in tree species diversity place to place (Pitman *et al.*, 2002). Among the different Phyto diverse regions found in the country, the Tarai region is one of them existing from Uttarakhand to West Bengal. It is the transition zone between two eco-climatic zones, the Gangatic plain towards south and Bhabhar towards north, along with the sub- Himalayan tracts (Tripathi and Singh, 2009). The region has lost majority of its natural forest due to deforestation chiefly for agriculture and lack of sustainable forest management in last many centuries (Bajpai *et al.*, 2012a, b). Now the natural forests of the region have been restricted to the wildlife protected areas only. Katarniaghat Wildlife Sanctuary (KWS) is also one of them.

Medicinal plants were used by people of ancient cultures without knowledge of their active ingredients. There is an ever increasing need to limit toxic clinical drugs. Plants produce a diverse range of bioactive molecules making them a rich source of different types of medicines. About 50% of all modern clinical drugs are of natural product origin and natural products play a vital role in modern drug development in the pharmaceutical Industry.

Traditional medicines are used by about 60 percent of the world's population. These are not only used for primary health care just in rural areas, in developing countries, but also in developed countries, where modern medicines are predominantly used. While the traditional medicines are derived from medicinal plants, minerals, and organic matter, the herbal drugs are prepared from medicinal plants only. Use of plants as a source of medicines has been inherited and is an important component of the health care system in India. There are about 45,000 plant species in India, with high concentration in the region of

Eastern Himalayas, Western Ghats and Andaman Nicobar Island. The officially documented plants with medicinal potential are 3,000 but traditional Practitioners use more than 6,000. India is the largest producer of medicinal herbs and is appropriately called the botanical garden of the world. In rural India, 70 percent of the population is dependent on the traditional system of medicine, the Ayurveda, which is the ancient Indian therapeutic measure renowned as one of the major systems of the alternative and complementary medicine (Bhatia *et al.*, 2013). Pulses are an important source of proteins to the vegetarian and socio-economically weaker section of the population. With rapid increase in population coupled with stagnation in pulses production at around 12 to 14 million tonnes, the capita availability of protein has decreased causing Protein-Energy-Malnutrition (PEM) especially among children below the age of five years in India. This has necessitated exploration of alternate sources of protein to bridge the gap for protein requirement of the various sections of vegetarian population. In this context, alternate sources like untraditional legumes (underexploited/tribal pulses) assume significance. Therefore, it is time to understand their biodiversity with a view to exploit such genetic resources to additional supply of plant protein, so that they can augment the availability of protein from conventional pulse crops in India. Around 40 legumes belonging to the genera, *Abrus*, *Acacia*, *Alysicarpus*, *Atylosia*, *Bauhinia*, *Cassia*, *Dolichos*, *Erythrina*, *Indigofera*, *Mucuna*, *Parkinsonia*, *Phaseolus*, *Pongamia*, *Prosopis*, *Sesbania*, *Tamarindus*, *Vicia*, *Vigna* and *Xylia* are known to be consumed by as many as 550 tribal communities in India who account for 67.76 million of total Indian Population. In addition, there are certain orphan legumes viz., *Cajanus cajan*, *Dolichos lablab*, *Macrotyloma uniflorum*, *Phaseolus aconitifolius*, *Phaseolus lunatus*, *Phaseolus vulgaris*, *Tylosema esculentum*, *Vigna deconitifolia*, *Vigna umbellata*, *Vigna subterreanea*, *Vigna radiata*, and *Vigna unguiculata* found in Bahrach.

Since there is limitation about the number of pages the enumeration of all the plant species is not possible. So, the present presentation is an attempt to summarize the information's available on the twelve orphan legumes found in Bahrach for their potential of climate stress mitigation, ethno-botanical and ethno-medicinal uses which are yet not popular due to one reason or the other despite providing an array of benefits to all components of an ecosystem.

Chemical investigations on levels of crude protein and crude lipid also have revealed the existence of genetic diversity not only among different varieties but also among different germplasm of the same species. Several germplasm/Varieties/Species like *Lens esculent* *Mucuna* species, *Pongamia pinnata*, *Phaseolus lunatus*, *Sesbania bispinosa*, *Vicia faba* and *Vigna trilobata* possesses 20-80% more crude protein compare to the conventional pulses. Similarly, several germplasm/varieties/species

like *Bauhinia* species, *Cassia* species, *Mucuna* species, *Pongamia pinnata*, *Tamarandus indica* contain 20-30% elevated levels of crude lipid. Human nutrition requires a valance source of essential amino acids. Generally, seed protein of several legume is deficient in sulfur containing amino acids, cysteine and methionine. The seed protein of *Tamarandus indica* contain sulfur containing amino acids more than FAO/WHO requirement pattern. Similarly seed protein of certain varieties/germplasm of tribal pulses like *Abrus precatorious*, *Acacia nilotica*, *Bauhinia malabarica*, *Mucuna pruriens variety pruriens*, *Phaseolus lunatus*, *Pongamia pinnata* and *Vigna aconitifoliam* etc. contain tryptophan more than FAO/WHO requirement. The germplasm of untraditional pulses like *Mucuna pruriens* have been advocated for large scale cultivation and consumption as an alternate and an additional source of plant protein (Janardhanan et al., 2003). There are fifty-five plant species representing nineteen genera found in Bahraich. The genera *Cassia* is being represented by ten species whereas *Bauhinia* by seven species, *Alysicarpus* by six; *Acacia* and *Vigna* with five; *Indigofera* with four; *Sesbania* and *Vicia* with three; *Erythrina* with two plant species and rest ten genera viz., *Abrus*, *Atylosia*, *Dolichos*, *Lens*, *Mucuna*, *Parkinsonia*, *Phaseolus*, *Pongamia*, *Prosopis* and *Tamarandus*. are represented by single genera only. Family Papilionoideae is being represented by thirteen genera where as Ceasalpinaceae with four genera and Mimosaceae with only two genera.

STUDY AREA

The study area Katarniaghat Wildlife Sanctuary (KWS) is situated in Bahraich district of Uttar Pradesh in India. It lies along Indo-Nepal international boarder and is situated between 27° 41' – 27° 56' N and 81° 48' – 81° 56' E covering an area of 440 km² with 116 to 165 m elevation. The sanctuary comes under the tropical moist deciduous forest of the Himalayan Tarai-Bhabar region (Champion and Seth, 1968; Rodgers and Panwar, 1988). The forest of the sanctuary area has been classified into two major forest types (i) The Sal forest and (ii) The miscellaneous forest (Champion and Seth, 1968). Pedagogically the study area is made up of the alluvial soil of the Kaudiyala and Saryu rivers and its tributaries flowing adjoining to it. Geologically the sanctuary area has been divided into high and low land areas.

CLIMATE

A typical tropical monsoonal climate with three distinct seasons i.e. summer (April to June), winter (November to February) and warm-rainy (July to September) prevails in the study area. March and October are considered as transition months between the seasons. The mean maximum temperature ranges from 22°C in January to 40°C in May and the mean minimum temperature ranges from 8°C in January to 27°C in June. The annual rainfall ranges from 36 to 142 cm in winter, 34 to 662 cm in summer and 1294 to 1689 cm in warm-rainy seasons (Bajpai et al., 2012).

ENUMERATION

Cajanus cajan (Linn.) Millsp.: Pigeon pea, Dhal, Gandul, Red gram, Congo pea, Gungo pea, No eye pea (Fabaceae).

Synonyms: *Cajanus indicus* Spreng. *Cajanus flavus* DC., *Cytisus cajanus* Linn.

Perennial woody shrub, mostly grown as an annual for the legume; strong, woody stems up to 4 m tall, freely branching; root system deep and extensive, to about 2 m, with a taproot. Leaves alternate, pinnately trifoliate, stipulate; stipules small, subulate; leaflets lanceolate to elliptic, entire, acute apically and basally, Penni nerved, resinous on lower surface and pubescent up to 15 cm long and 6 cm wide. Inflorescence in terminal or axillary racemes in the upper branches of the bush. Flowers are multi-colored with yellow being predominant, red, purple, orange occur in streaks or fully cover the dorsal side of the flag, zygomorphic. Pods compressed, 2–9 seeded, not shattering in the field. Seeds lenticular to ovoid, to 8 mm in diameter, about 10 seeds per gram, separated from each other in the pod by slight depressions. Germination crypto cotylar (Duke, 1981).

Cajanus cajan grows in forests in its native range. It can be found in warmer, dryer regions of the tropics and subtropics as well as more temperate regions.

Chemical composition

Analysis of dal (without husk) gave the following values: moisture, 15.2; protein, 22.3; fat (ether extract), 1.7; mineral matter, 3.6; carbohydrate, 57.2; Ca, 9.1; and P, 0.26%; carotene evaluated as vitamin A, 220 IU and vitamin B1, 150 IU per 100 g.

Sun-dried seeds of *Cajanus cajan* are reported to contain (per 100 g) 345 calories, 9.9% moisture, 19.5 g protein, 1.3 g fat, 65.5 g carbohydrate, 1.3 g fiber, 3.8 g ash, 161 mg Ca, 285 mg P, 15.0 mg Fe, 55 g carotene equivalent, 0.72 mg thiamine, 0.14 mg riboflavin, and 2.9 mg niacin.

Immature seeds of *Cajanus cajan* are reported to contain per 100 g, 117 calories, 69.5% moisture, 7.2 g protein, 0.6 g fat, 21.3 g total carbohydrate, 3.3 g fiber, 1.4 g ash, 29 mg Ca, 135 mg P, 1.3 mg Fe, 5 mg Na, 563 mg K, 145 g carotene equivalent, 0.40 mg thiamine, 0.25 mg riboflavin, 2.4 mg niacin, and 26 mg ascorbic acid/100 g.

Among the total amino acids, 6.7% is arginine, 1.2% cystine, 3.4% histidine, 3.8% isoleucine, 7.6% leucine, 7.0% lysine, 1.5% methionine, 8.7% phenylalanine, 3.4% threonine, 2.2% tyrosine, 5.0% valine, 9.8 aspartic acid, 19.2% glutamic acid, 6.4% alanine, 3.6% glycine, 4.4% proline, 5.0% serine with 0 values for canavanine, citrulline and homoserine. Methionine, cystine, and tryptophan are the main limiting amino acids. However, in combination with cereals, as pigeon peas are always eaten, this legume contributes to a nutritionally balanced human food.

The oil of the seeds contains 5.7% linolenic acid, 51.4% linoleic, 6.3% oleic, and 36.6% saturated fatty acids. Seeds are reported to contain trypsin inhibitors and chymotrypsin inhibitors. Fresh green forage contains 70.4% moisture, 7.1 crude proteins, 10.7 crude fibers, 7.9 N-free extract, 1.6 fats, and 2.3 ash. The whole plant, dried and ground contains 1, 1.2% moisture, 14.8 crude protein, 28.9 crude fiber, 39.9 N-free extract, 1.7 fat, and 3.5 ash (Duke, 1981a).

Ethno-botanical Potential

Commercial crop: *Cajanus cajan* is grown as a pulse crop (crop harvested for dry seed) or eaten green as a vegetable. The grain is popularly consumed in India, Asia, and Africa. India is the largest importer and producer, where seed is sold as dal (dry split pea). Unprocessed seed should not be consumed by humans or livestock. The seed contains tannin and trypsin inhibitors (trypsin inhibitors are removed through cooking). The protein content in split seeds is similar to soybean and ranges from 21–28% (Phatak et al., 1993). It is also widely used as a good source of dietary vitamins and minerals.

Forage: *Cajanus cajan* makes an excellent, high-protein forage for livestock. Crude protein ranges from 28–36% (Phatak et al., 1993). In Florida, plants yielded 3.1 short tons/acre of biomass (Duke, 1983). Livestock may browse foliage, but damage to the branches may result, so continuous grazing has to be avoided. Palatability has been reported to increase with age of the plant (Cook et al., 2005). *Cajanus cajan* can be grown as a forage intercropped with sorghum and/or millet. The deep taproot of *Cajanus cajan* draws water from deeper soil depths than most legumes, so will not interfere with the water uptake of other crops and grasses. It is not generally seeded as forage with other legumes like cowpea (*Vigna unguiculata*), but mainly with grasses (Cook et al., 2005). A nutritious feed for sheep can be made from the seed pod hulls and threshed waste of harvested plants.

Cover crop/green manure: *Cajanus cajan* competes poorly with weeds and can be slow to establish if soils are not at least 64°F (Mullen et al., 2003). As a green manure it can fix about 62 lb N/acre up to the time when pods are produced (Phatak et al., 1993).

Wildlife: *Cajanus cajan* has been used as a trap crop for *Heliothis* spp. (moth pests), in affected cotton (Mullen et al., 2003). A trap crop is a form of companion planting used to attract pests away from nearby crops. Plantings are also used as live fences and wind breaks in many regions. Woody stems have been used for thatched roofs, baskets, and charcoal (Allen and Allen, 1981).

- Pigeon peas are popular food in developing tropical countries.
- Nutritious and wholesome, the green seeds (and pods) serve as vegetable.

- Ripe seeds are a source of flour, used split (dhal) in soups or eaten with rice.
- Dhal contains as much as 22% protein, depending on cv and location.
- Tender leaves are rarely used as a potherb. Ripe seeds may be germinated and eaten as sprouts. Plants produce forage quickly and can be used as a perennial forage crop or used for green manure.
- Often grown as a shade crop for tree crops or vanilla, a cover crop, or occasionally as a windbreak hedge.
- In Thailand and North Bengal, pigeon pea serves as host for the scale insect which produces lac or sticklac.
- In Malagasy the leaves are used as food for the silkworm.
- Dried stalks serve for fuel, thatch and basketry. (Duke, 1981a).

Ethno-medicinal Potential

- In India and Java, the young leaves are applied to sores.
- Indochinese claim that powdered leaves help expel bladder stones.
- Salted leaf juice is taken for jaundice.
- In Argentina the leaf decoction is prized for genital and other skin irritations, especially in females (Morton, 1976).
- Floral decoctions are used for bronchitis, coughs, and pneumonia.
- Chinese shops sell dried roots as an alexeritic, anthelmintic, expectorant, sedative, and vulnerary.
- Leaves are also used for toothache, mouthwash, sore gums, child-delivery, dysentery. Scorched seed, added to coffee, are said to alleviate headache and vertigo.
- Fresh seeds are said to help incontinence of urine in males, while immature fruits are believed of use in liver and kidney ailments. (Duke, 1981a).
- Decoctions of leaf and stem have been used as a diuretic, laxative, and to treat sore throat (Allen and Allen, 1981).
- *Cajanus cajan* seeds reduces the serum glucose levels (Jeeva and Sheebha, 2014).
- *Cajanus cajan* and *Vigna mungo* (Burm. f.) Walp.: The pulse obtained from the seeds of these plants is cooked and is recommended to diabetics (Ahmad et al., 2009).
- Several cultures have used decoctions for skin irritations and sores. Floral decoctions have been used to treat bronchitis, coughs, and pneumonia. Some Chinese use the dried roots to evacuate intestinal worms, as an expectorant, sedative, and a remedy for wounds (Duke, 1983).
- Commercial crop: *Cajanus cajan* is grown as a pulse crop (crop harvested for dry seed) or eaten green as a vegetable.

Lablab purpureus (Linn.) Sweet.; Hyacinth-beans, Lablab-bean, Bonavist bean/pea, Dolichos bean, Seim bean, Egyptian kidney bean, Indian bean, Bataw bean, Australian pea, Tonga bean, Papaya bean, Poor man bean, Bounavista pea, and Butter bean.

Synonyms: *Dolichos lablab* Linn., *Dolichos purpureus* Linn., *Dolichos lignosus* Linn., *Lablab niger* Medikus, *Lablab lablab* (Linn.) Lyons, *Lablab vulgaris* (Linn.) Savi, *Dolichos benghalensis* Jacq., *Vigna aristata* Piper.

Lablab purpureus is a species of bean in the family Fabaceae. It is native to Africa and it is cultivated throughout the tropics for food. It is the only species in the monotypic genus *Lablab*. *Lablab purpureus* is an herbaceous, climbing, warm-season annual or short-lived perennial with a vigorous taproot. It has a thick, herbaceous stem that can grow up to 3 feet, and the climbing vines stretching up to 25 ft from the plant (Valenzuela and Smith, 2002). The wild species is perennial. The thick stems can reach six meters in length. It has trifoliate, long-stemmed leaves. Each egg-shaped leaflet widens in the middle and is 3–6 in. (7.5–15 cm) long. The surface of the leaflet is smooth above and short-haired below. The inflorescence is made up of racemes of many flowers. The flowers grow in clusters on an unbranched inflorescence in the angle between the leaf and the main stem. It may have white, blue, or purple flowers depending on its variety. Seedpods are 2 in. (4–5 cm) (Cook et al., 2005) to 4 in. (10 cm) long (Venezuela and Smith, 2002), smooth, flat, pointed, and contain 2 to 4 seeds. Seeds can be white, cream, pale brown, dark brown, red, black, or mottled depending on variety. The seed is about a centimeter long. Wild plants have mottled seeds.

Ethno-botanical Potential

- The hyacinth bean is an old domesticated pulse and multi-purpose crop.
- Due to seed availability of one forage cultivar (cv. Rongai), it is often grown as forage for livestock and as an ornamental plant.
- It is cited both as a medicinal plant and a poisonous plant.
- The fruit and beans are edible if boiled well with several changes of the water. Otherwise, they are toxic due to the presence of cyanogenic glycosides, glycosides that are converted to hydrogen cyanide when consumed. Signs of poisoning include weakness, vomiting, dyspnea, twitching, stupor, and convulsions. It has been shown that there is a wide range of cyanogenic potential among the varieties.
- The leaves are eaten raw or cooked like spinach. The flowers can be eaten raw or steamed.
- The root can be boiled or baked for food.
- The seeds are used to make tofu and tempeh.
- In Maharashtra, dry preparations with green masala is often made out of these green beans mostly found at the end of monsoon during fasting festivals of Shravan month.

- In Karnataka, the hyacinth bean is made into curry, salad, added to upma, and as a flavoring to Akki rotti.
- Sometimes the outer peel of the seed is taken out and the inner soft part is used for a variety of dishes. This form is called which means "pressed hyacinth bean, and a curry known as Hitikida Avarekaalu Saaru is made out of this desk inned beans.
- In Telangana, the bean pods are cut into small pieces and cooked as spicy curry in Pongal festival season, along with bajra bread; it has been a very special delicacy for centuries
- In Huê, Vietnam, hyacinth beans are the main ingredient of the dish Hyacinth Bean Sweet Soup.
- In Kenya, the bean called 'Njahe' is popular among several communities, especially the Kikuyu tribe.
- It is thought to encourage lactation and has historically been the main dish for breast feeding mothers. Beans are boiled and mashed with ripe and/or semi-ripe bananas, giving the dish a sweet taste.
- Today the production is in decline in eastern Africa. This is partly attributed to the fact that under colonial rule in Kenya, farmers were forced to give up their local bean in order to produce common beans (*Phaseolus vulgaris*) for export.
- It is a dual-purpose legume and can be used with cereals in smallholder systems. It can be sown with summer grass crops to provide a mixed forage crop system.
- It has high forage quality.
- As a green manure crop restores soil fertility.
- Drought tolerant once established.
- It has high grain yields.
- It has better root disease resistance than cowpeas
- The most common use of *Lablab purpureus* in the United States is as an ornamental crop in the cut flower industry (Stevens, 2012). It is valued for its late summer flowers and colorful, purple peapods. Depending on the weather in late summer, harvest yields can be up to 55 cut stems per plant (Anderson et al., 1996).

Ethno-medicinal Potential

- *Lablab purpureus* has been used in the Philippines and China as a stimulant.
- To reduce fever, flatulence.
- It stimulates digestion.
- It is also used as an antispasmodic (Stuart, 2011).
- In Namibia, the root has been used to treat heart conditions (Pennacchio et al., 2010).

Macrotyloma uniflorum Lam: Horse gram, Gaheth.
Synonym: *Dolichos uniflorum* Linn.

Macrotyloma uniflorum is an erect, sub-erect or trailing, densely hairy annual herb. Leaves compound, alternate, trifoliate, stipules lanceolate petiole 1-7 cm. long leaflet ovate elliptical apex rounded to acute base

rounded lateral leaflets a symmetric hairy to glabrescent on both surfaces. Flower short only 6-12 mm. long. The flower is cream - yellow with purple spot in auxiliary racemes with 2 appendages at base. Flower zygomorphic, bisexual, Fruit is a linear oblong pod 3-8 cm.x4-8 mm. up curved towards apex acuminate, densely hairy. When young later mar sparsely so margins glabrous smooth or warty dehiscent 5-10 seeds. Seed size ranges 6-8 mm long and 3-4 mm broad smooth of which 100 seed weight is recorded 4 gm. Seed trapezoidal oblong or somewhat rounded. Pale to dark reddish brown speckled or mottled with black and orange brown or all black (Mehra and Upadhyaya, 2013).

Nutritional value (per 100 gm.)

Nutrient Amount Units; Carbohydrates 57.3 gm., Moisture 11.8 gm., Fat 0.5 gm., crude protein 22.0 gm., Calories 321 calorie, Fiber 5.3 gm., Mineral matter 3.1 mg, Iron 7.6 mg, Calcium- 0.28 mg, Nicotinic acid 1.5 mg, Carotene 11.9 IU., Phosphorus 0.39 mg., Vitamin B 0.42 IU. The globulins of Horse gram account for nearly 80% of Nitrogen. They contain arginine (6-7.1%), tryptophan (6.68%), Lysine (7.64%) but are deficient in Cystine and Tryptophan. Fat 10% level of protein intake the biological value and digestibility coefficient are 66 and 73 respectively.

Ethno-botanical Potential

- *Macrotyloma* is a nutritious food legume.
- It is cultivated for its seed and mostly eaten as a dal.
- It is rich in protein iron, calcium and polyphenols. Green plant of horse gram is valuable green manure. Horse gram that fail to meet food grade standards can be used as livestock feed, because of their high protein content and lack of digestive inhibitors.
- Husk, dried leaves, stems and residues can be valuable feed to livestock.
- The fodder being rich in protein; it is widely used as a feed to animals and horses (Prakash et al., 2008).
- Horse gram is a valuable protein supplement.

Ethno-medicinal Potential

- It helps in eliminating kidney stones.
- Horse gram also helps in lowering cholesterol levels.
- Horse gram is famous for its medicinal uses because various parts of the plant are used for the treatment of Asthma, Urinary disorder and kidney stones.
- *Macrotyloma uniflorum* could play a role in antioxidation (Mehra and Upadhyaya, 2013).
- *Macrotyloma* has the greatest potential for further utilization as nutra-ceuticals forage and food for malnourished and drought-prone areas of the world.
- It is famous for its medicinal use because different part of the plants is used for the treatment of heart disease, asthma, bronchitis, urinary disorders and for treatment of kidney stones (Ghani, 2003).

Phaseolus acutifolius A Gray., Tepary bean, Pawi, Pavi, Tepari, Escomite, Yori mui, Yorimuni and Yori muni.

Synonyms: *Phaseolus acutifolius* var. *tenuifolius* A.Gray, *Phaseolus tenuifolius* (A. Gray) Wooton & Stand., *Vigna aconitifolia* (Jack.) Marehal.

Phaseolus acutifolius, the Tepary bean, is native to the south-western United States and Mexico and has been grown there by the native peoples since pre-Columbian times. It is more drought-resistant than the common bean (*Phaseolus vulgaris*) and is grown in desert and semi-desert conditions from Arizona through Mexico to Costa Rica. The water requirements are low and the crop grows in areas where annual rainfall is less than 400 mm (16 in).

The tepary bean is an annual and can be climbing, trailing, or erect with stems up to 4 m long. A narrow leafed, variety *tenuifolius*, and a broader leafed, variety *latifolius*, are known. Domestic varieties are derived from *latifolius*. In the Sonora desert, "the flowers appear with the summer rains, first appearing in late August, with the pods ripening early in the fall dry season, most of them in October." The beans can be of nearly any color. There are many local landraces. Beans vary in size but tend to be small. They mature 60 to 120 days after planting.

Ethno-botanical Potential

- North-western Mexico is the primary area of production for tepary beans. The tepary is also cultivated in many countries in Africa, Australia, and Asia. In India, tepary beans are an ingredient in the snacks 'bhujia' and Punjabi Tadka by Haldiram's.
- The tepary bean was a major food staple of natives in the Southwestern United States and northern Mexico.
- In addition to being grown in floodplains, it was often grown alongside squash and corn. Growing these plants together, known as Three Sisters agriculture, both enhances their growth and provides more balanced nutrition.
- The International Center for Tropical Agriculture in Colombia since 2015 is testing crossbreeds of the tepary bean and common bean, in order to impart the tepary's drought and heat resistance. The latter could be especially helpful given climate change's effects on agriculture.

Ethno-medicinal Potential

Research in the United States and Mexico suggest that lectin toxins and other compounds from tepary beans may be useful in chemotherapy for treating cancer.

Phaseolus lunatus Linn., Sem, Lima bean, Butter bean, Burma bean, Rangoon bean, Duffin bean, Madagascar bean.

Synonyms: *Phaseolus inamoenus* L., *Phaseolus limensis* Macfad.

It is native to Tropical America and now widely cultivated throughout the tropics of the world, including

India and Pakistan. Two varieties are found as large-seeded Potato Lima and small-seeded Baby Lima which is half of the size of the large variety.

Lima bean is an annual to perennial climbing plant producing twining stems generally up to 4 meters long, though sometimes as much as eight-meter-long, from a perennial rootstock. The stems scramble over the ground or twine into the surrounding vegetation or any provided supports. Plants generally grow well in lowland tropical areas at elevations up to 1,500 metres. An annual rainfall in the range 900 - 1,500 mm is adequate but once established the crop tolerates as little as 500 - 600 mm of rainfall. Plants are generally tolerant of heavy rainfall during the growing period, though heavy rain when they are flowering can adversely affect fertilization. Lima bean is a very popular food crop, being used mainly for its seeds and immature seedpods. There are many different varieties of the plant, producing a wide range of beans, including the large, white 'butter bean'.

Ethno-botanical Potential

- The raw mature seed is poisonous. The toxic principle is hydrocyanic acid and this is destroyed by thoroughly cooking the seed.
- It is claimed, if the green pods are chewed in one's mouth and applied to any place bitten by a horse, it will help.
- Bean pods are effective in lowering blood sugar levels and can be used (with the concurrence of a doctor) for mild cases of diabetes. A bean pod diet for this purpose would mean eating 9-16 lb. of pods per week (they can be cooked like vegetables). The pods are most effective before the beans are ripe, and fresh pods are more effective than dried.
- Dried pods are particularly to be used in conjunction or rotation with other efficacious herbs, such as bilberry, milfoil, dandelion, and juniper. These can be taken alone or mixed, as a tea.
- Bean pod tea is useful for dropsy, sciatica, chronic rheumatism, kidney and bladder problems, uric acid accumulations, and loss of albumin in the urine during pregnancy. Externally, promotes healing of ulcers and sores.
- Prolonged use of the decoction made from the beans is recommended for difficult cases of acne. Bean meal can also be applied directly to the skin for moist eczema, eruptions, and itching. Wash the skin every 2-3 hours with German chamomile tea and apply new meal.
- Use anywhere from 2 tbsp. to 3 handfuls of dried small-cut pods with 1 qt. water. Boil for 3 hours. Take 1/2 to 3/4 qt. per day.
- Immature seedpods - raw or cooked.
- The green pods are commonly used as a vegetable, they have a mild flavor and should only be cooked for a short time. When growing the plant for its seedpods, be sure to pick them whilst they are still small and tender. This will ensure the continued production of more pods by the plant. Flowering is

reduced once the seeds begin to form inside the pods.

- The immature seeds are boiled or steamed and used as a vegetable. The mature seeds are dried and stored for future use. They must be thoroughly cooked before being eaten and are best soaked in water for about 12 hours prior to this. They can be boiled, baked, pureed, ground into a powder or fermented into "tempeh" etc.
- The powdered seed makes a protein-enriching additive to flour, it can also be used in soups etc.
- The seed can also be sprouted and used in salads or cooked. The roasted seeds have been used as a coffee substitute.
- Young leaves - raw or cooked as a potherb. The very young leaves are sometimes eaten as a salad, the older leaves are cooked.

Ethno-medicinal Potential

- The green pods are mildly diuretic and contain a substance that reduces the blood sugar level. The dried mature pod is used according to another report. It is used in the treatment of diabetes.
- The seed is diuretic, hypoglycemic and hypotensive.
- Ground into a flour, it is used externally in the treatment of ulcers. The seed is also used in the treatment of cancer of the blood.
- When bruised and boiled with garlic they have cured intractable coughs.
- The root is dangerously narcotic.
- A homeopathic remedy is made from the entire fresh herb. It is used in the treatment of rheumatism and arthritis, plus disorders of the urinary tract.

Phaseolus vulgaris Linn.; Common bean, Doufuto fu (bean curd), Green bean, Kidney bean, Navy bean, Pinto bean, Snap bean, String bean, Wax bean.

The Kidney bean is an annual, twining plant; the leaves are alternate, each leaf consisting of 3 broad-ovate to rhombic-ovate, entire, pointed leaflets. The white, yellow or purplish flowers grow in sparse, axillary clusters. The fruit is a green or yellow pod; the color of the seeds, or beans, depends on the variety. Diverse as they are, all the beans named above are varieties of the kidney bean. The dry beans are picked when mature, the others at various stages of maturity.

Nutritional value

The nutritional value of the marama bean is astonishingly very high for an unimproved legume. The tubers have a high protein content of 9.0% and also have a high amino acid content. The tubers of cassava, for example, only have a protein content of 1-3%, while yam has one of 7%. Also the grain is relatively high in protein with a share of 30-39%. The concentration of sulphur-containing amino acids is high as well (with a lysine content of 5.0% and a methionine content of 0.7%). This shows that the protein content of the seeds is comparable to the one of commercial soybeans, which have a content

of 38-40%. Therefore, the potential of the marama bean is high to replace the soybean as a protein source, once there have been genetical improvements.

The tuber can grow very large - at least 10 kg, perhaps much larger. In Botswana a tuber of 277 kg has been found.

Chemical and nutritional composition

The marama bean has a very low moisture content as the dry matter content ranges from 93.4% to 98.7%. The moisture content may also vary due to external factors (Bower et al., 1988; Holse et al., 2010 and Wehemeyer et al., 1969).

It was reported that the content of lipids ranges between 24% and 42%. This high amount of lipids is an advantage, especially in Southern Africa where it helps improving the status of the undernourished people (Jackson et al., 2010). The lipid content of the marama beans can be compared to sunflower seeds (22-36 %) and rapeseed (22-49 %) and almost reaching the amount that is found in peanuts (45-55 %) (Belitz et al., 2004 and Salunkle and Kadam, 1989). The amount of lipids is twice as high as found in soybeans (17-20 %) (Belitz et al., 2004 and Street and Opik, 1975).

The protein range of marama beans ranges from 29% to 39% on a dry matter basis. Thus, it is comparable or slightly higher to most other legumes. This amount of protein makes the marama bean a great nutritive food but can be also used as a protein-rich ingredient for supplementing other products (Jackson et al., 2010). Sixteen samples of *Tylosema esculentum* from Botswana, Namibia, and South Africa were tested, and the plant's chemical composition was analyzed. The results showed that the Marama bean seeds contained high lipid and protein levels (29-38% protein content, 32-42% lipid content, and 19-27% dietary fiber content), which are higher in value than other legumes (Holse et al., 2010).

Ethno-botanical Potential

- The plant is a significant food-source for the people of the Kalahari because of the high protein and oil content of its large seeds (20-30gm each).
- The seeds are usually roasted, imbuing them with a more palatable flavour - comparable to cashew or chestnut.
- The seeds can also be ground or boiled. The beans keep well, due to their hard outer shell.
- The tuber is also edible, but needs to be harvested from young plants (one or two years old) - after this age the tuber becomes astringent and fibrous.
- Another interesting marama bean product is its flour. The flour of *Tylosema esculentum*, prepared from heated or unheated marama beans, has a potential as a functional food ingredient. However, although studies about its nutritional and physicochemical properties are lacking, the flour is protein-rich.

- Protein-based ingredients of marama bean are similar to those commercially available from soybean. Therefore, the flour of *Tylosema esculentum* has the potential to be used as a protein supplements in composite flours with cereals to improve the protein quality (Maruatona et al., 2010).
- The milk of the marama bean is a creamy white water extract very similar to dairy milk or soymilk. The milk can be consumed in the form of a refreshing and nutritious beverage just like dairy milk or soymilk. Though it is not available commercially (Jackson et al., 2010).
- The milk of the marama bean has high levels of sodium (47.9 mg/100 g) and iron (3.7 mg/100 g) compared to soymilk and dairy milk, with much a lower calcium content (6.8 mg/100 g).[8]In order to get marama milk several processing steps are involved: Thermal treatment (blanching and roasting of the beans), cracking, milling, suspending in water, boiling and filtration to obtain a milk-like phase (Jackson et al., 2010).
- It is most common to eat the marama beans as mature beans when the seeds are surrounded by a hard and woody seed coat, which has a reddish to brownish color. But the beans can also be eaten when they are still immature green beans (Jackson et al., 2010).
- *Tylosema esculentum*, also known as the Marama bean, is a perennial legume that grows in arid Southern African environments. Indigenous natural food sources, such as this specific perennial legume, are essential for rural livelihoods, especially for communities living in extremely harsh environmental conditions where there is little to no rainfall. The plant's ability to be cultivated in harsh and arid environments is due to its large tuber structure that stores high amount of water and soil nutrients, making *Tylosema esculentum* a drought tolerant crop. Many families of Southern African regions grow the Marama bean locally, but are unaware of its high nutritional value.
- *Tylosema esculentum* can also be used for other nutritional sources such as for oil, milk, and flour. After learning more about the benefits of nutrition of this perennial legume, many families hope to have the Marama bean as part of the commercial market in order to stabilize food security and improve food diversity.

Forage

- The potential uses of the marama bean go beyond the role of only being a food plant. The foliage of the plant serves as forage for livestock and wildlife in Southern Africa because the leaves are highly palatable. Since the marama bean is used to grow in harsh environments it could be used as a feed crop in the drier parts of Africa. While using it as forage one does also protect the soil by conserving its moisture and preventing from soil erosion by wind and water. Furthermore, there would be a build-up in organic

matter, which would be beneficial for soils which are poor in nutrients (Dakora, 2013).

Vigna aconitifolia (Jacq.) Maréchal: Moth bean, Moth gram, Mat bean, Dew bean, Dew gram, Haricot mat, Mat, Haricot papillon.

Synonym: *Phaseolus aconitifolius* Jack. (1768).

Annual, slender, hairy herb with short, angular, erect stem up to 40 cm tall and many prostrate branches up to 150 cm long. Leaves alternate, 3-foliate; stipules lanceolate, c. 12 mm long, peltate; petiole 5–10 cm long, grooved; stipels small; leaflets 5–12 cm long, deeply divided into 3–5 narrow lobes. Inflorescence an axillary, head-like, dense false raceme; peduncle 5–10 cm long. Flowers bisexual, papilionaceous; pedicel 5–8 mm long; calyx campanulate, c. 2.5 mm long; corolla yellow, standard orbicular, up to 8 mm long, wings c. 6 mm long, keel sickle-shaped, c. 7 mm long; stamens 10, 9 united and 1 free; ovary superior, sessile, c. 4 mm long, style incurved. Fruit a cylindrical pod 2.5–5 cm × 0.5 cm, brown, covered with short stiff hairs, 4–9-seeded. Seeds rectangular to cylindrical, 3–5 mm × 1.5–2.5 mm, whitish green, yellow to brown, often mottled with black; hilum white, linear. Seedling with epigeal germination.

Nutritional and Chemical constituents

Mature, raw moth bean seeds contain per hundred g edible portion: water 9.7 g, energy 1435 kJ (343 kcal), protein 22.9 g, fat 1.6 g, carbohydrate 61.5 g, Ca 150 mg, Mg 381 mg, P 489 mg, Fe 10.9 mg, Zn 1.9 mg, vitamin A 32 IU, thiamin 0.56 mg, riboflavin 0.09 mg, niacin 2.8 mg, vitamin B6 0.37 mg, folate 649 µg and ascorbic acid 4.0 mg.

The essential amino-acid composition per hundred g edible portion is: tryptophan 147 mg, lysine 1248 mg, methionine 220 mg, phenylalanine 1028 mg, valine 734 mg, leucine 1541 mg and isoleucine 1138 mg.

The principal fatty acids are per 100 g edible portion: linoleic acid 485 mg, palmitic acid 313 mg, linolenic acid 265 mg, oleic acid 129 mg and stearic acid 51 mg (USDA, 2005).

The protein has a lower digestibility than that of mung bean (*Vigna radiata* (L.) R. Wilczek). The digestibility of the starch and protein is considerably improved by processing treatments such as soaking, removal of the seed coat, germination and pressure cooking (Negi et al., 2001).

Ethno-botanical Potential

- The ripe whole or split seeds of moth bean are eaten cooked or fried.
- Sprouted and cooked seeds are preferred as breakfast items in India whereas fried splits are consumed in the form of a ready to eat product.

- The seeds are sometimes ground into flour, which is mixed with other flours to make unleavened bread.
- The immature pods are sometimes eaten boiled as a vegetable.
- In India the pod walls and residues left after the preparation of dal are fed to animals.
- Moth bean is also grown for green manure, forage and hay and as a cover crop.
- In India moth bean is grown as a sole crop or intercropped with pearl millet, sorghum or other cereals, occasionally with pulses. It is grown as a green manure in rotation with cotton.

Ethno-medicinal Potential

- Seeds are used medicinally in diets to treat fevers; roots are said to be narcotic.

Production and international trade

- In India moth bean is grown on 1.5 million ha producing annually about 0.4 million t of seed which is traded and consumed within the country. Worldwide moth bean is grown on about two million ha.

Vigna radiate (Linn.) R. Wilcz.: Green gram, Mudga, Mung, Pesalu, Thua khieo, Balatonge: Wild Moong, Mung bean, Wild black gram, Ban Urad, Golden gram, Greed gram.

Synonyms: *Phaseolus radiatus* Linn., *Phaseolus aureus* Roxb., *Phaseolus mungo* var *radiates* (Linn) Baker.

It is a trailing or twining annual herb. Leaves trifoliate. Flowers yellow. Pods cylindrical. Commonly cultivated crop, rarely found as an escape. Phenology- February-March.

Chemical constituents

During the past few decades, flavonoids, phenolic acids, organic acids and lipids have been identified from the seeds and sprouts of mung beans and have been shown to contribute to its pharmaceutical activities.

Flavonoids: Flavone, isoflavone, flavonoids, and isoflavonoids are the important metabolites found in the mung bean (Prokudina et al., 2012 and Wang et al., 2008). Most flavonoids have polyhydroxy substitutions and can be classified as polyphenols with obvious antioxidant activity. Vitexin (apigenin-8-C-β-glucopyranoside) and isovitexin (apigenin-6-C-β-glucopyranoside) have been reported to be present in mung bean seeds at about 51.1 and 51.7 mg g⁻¹, respectively (Li et al., 2012 and Dong et al., 2008). Flavonoids are involved in stress protection (i.e., oxidative and temperature stress), early plant development, signaling (i.e., legume nodulation), and protection from insect and mammalian herbivores (Koes et al., 1994).

Chemical constituents identified from mung bean seeds and sprouts

Phenolic acids: Phenolic acids are secondary metabolites primarily synthesized through the pentose phosphate pathway (PPP) and shikimate and phenylpropanoid pathways (Randhir et al., 2004). Phenolic acids are major bioactive phytochemicals, and their presence in wild plants has facilitated the trend toward the increasing use of wild plants as foods (Estomba et al., 2006 and Singh et al., 2009). Twelve phenolic acids have been identified from mung bean seeds and sprouts (Sosulski and Dabrowski, 1984 and Sawa et al., 1999). Based on high levels of total phenolics and total flavonoids, mung beans show the benefits of 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activities, tyrosinase inhibition, and antiproliferative and alcohol dehydrogenase activities, which allow it to be used as a substitution for proper prescription drugs and as a preventative or therapeutic agent for the treatment of human diseases (Kim et al., 2012).

Others: Organic acids and lipids have also been found in mung beans and sprouts. Twenty-one organic acids, including phosphoric and citric acid, and 16 lipids, including γ -tocopherol, were reported to be the major components of mung beans by gas chromatography/mass spectrometry (GC/MS) (Bowles, 1990).

Dynamic changes in metabolites

Under biotic and abiotic stress, plant physiology dramatically changes. The induction of defense systems, such as those involving proteinase inhibitors, produces a response that protects the plant from these types of stresses (Jon et al., 2011). As a part of this response, accumulation of secondary metabolites with various health benefits has been observed (Bowles, 1990 and Kessler and Baldwin, 2002). However, in the absence of stress, healthy plants can also be stimulated by stress inducers to artificially produce secondary metabolites. Targeted analyses have demonstrated that the germination of mung beans is accompanied by a spectrum of significant changes in metabolite contents, such as decreased antinutrient concentrations (Kotaria et al., 1989) and increased levels of free amino acids (Mubarak, 2004; Kotaria et al., 1989; Kavas and Sedaf, 1991; Abdel Rahman et al., 2007 and Kirehkhoff, 2002).

Germination significantly reduces the levels of reducing sugars and starches by 36.1% and 8.78%, respectively (Mubarak, 2004). Interestingly, until 60 h of incubation, levels of the monosaccharides fructose and glucose increase dramatically in the germinating material. However, significant reductions in the levels of both sugars have been observed during the final germination stage from 60 to 75 h. The concentration of the disaccharide sucrose increases within the first 24 h, but rapidly declines after the initial germination phase (El-Adawy et al., 2003; Mubarak, 2004 and Bowles, 1990). Moreover, raffinose and stachyose are completely eliminated during germination. The decline of sucrose in

the latter stages of sprouting may be due to the lack of raffinose, resulting in the hydrolysis of sucrose for the energy supply (Mubarak, 2004).

Compared to cereals, mung beans contain higher amounts of protein (Kirchhoff, 2002). As described earlier, proteolytic cleavage of proteins during sprouting leads to a significant increase in the levels of most amino acids. Additionally, increased levels of free amino acids in germinated mung beans and lentils have been observed via targeted analysis (Kavas and Sedaf, 1991 and Chau and Cheung, 1997).

Gentistic acid, cinnamic acid, and p-hydroxybenzoic acid are the major phenolic acids of metabolites that are found throughout the sprouting process (Amarowicz et al., 2009). Within the first day of incubation, the levels of caffeic acid, ferulic acid, and shikimic acid are relatively low in mung bean seeds. However, after the initial soaking and early germination phase, mung bean samples exhibit significantly increasing amounts of these compounds (Singh et al., 2009). Moreover, the levels of gallic acid, chlorogenic acid, and coumarin increase dramatically in the germination material until day 3 or 4, and catechin levels increase during the final stage of mung bean sprout development (i.e., on the eighth day of incubation) (Sosulski and Dabrowski, 1984).

The overall levels of organic acids also increase during sprouting. Phosphoric and citric acid are 2 of the major organic acid metabolites. A distinct and continuous increase in lactic acid is observed, while malic acid and citric acid peak after only 24 h of incubation (Bowles, 1990).

Fatty acid methyl esters (FAMES) are formed mainly from trans esterification of the crude lipid extract and reflect the presence of mung bean triglycerides. Within the first 24 h of incubation, changes in the levels of most FAMES are relatively minimal. However, after the initial soaking and early germination phase, mung bean samples exhibit significant decreases in the levels of FAMES. In contrast, the levels of γ -aminobutyric acid in mung bean sprouts are enhanced throughout sprout development and may be of special interest for human nutrition because of its health-promoting effects (Bowles, 1990 and Moumita et al., 2010). Protease inhibitors are proteins or peptides capable of inhibiting catalytic activities of proteolytic enzymes that play essential roles in biological systems, regulating proteolytic processes, and participate in defense mechanisms against a large number of insects, fungi, and other pathogenic microorganisms (Lawrence and Kounddal, 2002). During the first 5 days of germination, there is a gradual decrease in the levels of extractable trypsin inhibitors in mung bean seeds (Lorensen et al., 1981). The hemagglutinin activity of mung bean seeds has also been reported to decrease by about 84.4% after 3 days of germination (Messina, 1999).

Ethno-botanical Potential

- Used as a pulse.
- Soup is given as a diet to patients of enlarged liver and spleen, and after recovery from acute illness.
- A poultice of it is used for checking secretion of milk and reducing distention of the mammary glands. [Indian Medicinal Plants an Illustrated Dictionary]
- Being low in antinutritional factors it is a good source of minerals, proteins, provitamin A and vitamin B complex.
- The clinical evidences suggests that plant-derived foods have various potential health benefits and as a result the consumption has been growing at a rate of 5%-10% per year (Tham et al., 1998).
- Moreover, many worldwide health organizations have recommended an increase in the intake of plant-derived foods to improve health status and prevent chronic diseases (Espin et al., 2007).
- The mung bean (*Vigna radiata*) has been consumed as a common food in China for more than 2,000 years. It is well known for its detoxification activities and is used to refresh mentality, alleviate heat stroke, and reduce swelling in the summer.
- In the book Ben Cao Qiu Zhen, the mung bean was recorded to be beneficial in the regulation of gastrointestinal upset and to moisturize the skin (Min, 2001).
- The seeds and sprouts of mung beans are also widely used as a fresh salad vegetable or common food in India, Bangladesh, South East Asia, and western countries (Fery, 1990).
- As a food, mung beans contain balanced nutrients, including protein and dietary fiber, and significant amounts of bioactive phytochemicals. High levels of proteins, amino acids, oligosaccharides, and polyphenols in mung beans are thought to be the main contributors to the antioxidant, antimicrobial, anti-inflammatory, and antitumor activities of this food and are involved in the regulation of lipid metabolism (Kanatt et al., 2011; Randhir et al., 2004; Vanamala et al., 2006 and Anjum et al., 2011).
- In recent years, studies have shown that the sprouts of mung beans after germination have more obvious biological activities and more plentiful secondary metabolites since relevant biosynthetic enzymes are activated during the initial stages of germination. Thus, germination is thought to improve the nutritional and medicinal qualities of mung beans (El-Adawy et al., 2003).
- Highly efficient use of mung beans according to evidence demonstrated from scientific experiments will be beneficial to the application of mung beans as a health food, medicine, and cosmetic (Golob, 1999).
- The knowledge about the nutritional value, chemical constituents, and metabolite changes during the sprouting process, as well as pharmacological activities, and clinical applications of mung beans, will provide a better understanding of the potential applications of this common food. Nutritional value of mung beans as a common food:
- Mung beans are a pulse or food legume crop used primarily as dried seeds and occasionally as forage or green pods and seeds for vegetables (Tomooko, 2002).
- Dried seeds may be eaten whole or split, cooked, fermented, or milled and ground into flour.
- Mung beans can also be made into products like soups, porridge, confections, curries, and alcoholic beverages. In western cultures, mung bean sprouts are popularly used as a fresh salad vegetable (Lambrides, 2007).
- Importantly, mung beans are composed of about 20%–24% protein. Globulin and albumin are the main storage proteins found in mung bean seeds and make up over 60% and 25% of the total mung bean protein, respectively. Therefore, due to its high protein content and digestibility, consumption of mung beans in combination with cereals can significantly increase the quality of protein in a meal (Wang et al., 2004 and Kuare et al., 2013).
- Mung bean protein is rich in essential amino acids, such as total aromatic amino acids, leucine, isoleucine, and valine, as compared with the FAO/WHO (1973) reference. However, compared with the reference pattern, mung bean protein is slightly deficient in threonine, total sulfur amino acids, lysine, and tryptophan (Mubarak, 2004). Moreover, the proteolytic cleavage of proteins during sprouting leads to a significant increase in the levels of amino acids.
- Mung beans have much greater carbohydrate content (50%–60%) than soybeans, and starch is the predominant carbohydrate in the legume. Due to its high starch content, mung beans have typically been used for the production of starchy noodles, also called muk in Korea. Oligosaccharides, including raffinose, stachyose, and verbascose, in raw or poorly processed legumes are associated with flatulence in the human diet. While these oligosaccharides are present in mung beans, they are soluble in water and can be eliminated by adequate presoaking, germination, or fermentation. The energy offered by mung beans and sprouts is lower than that of other cereals, which is beneficial for individuals with obesity and diabetes (Zheng, 1999). In addition, trypsin inhibitors, hemagglutinin, tannins, and phytic acid found in the mung bean have also been reported to have biological functions, promoting digestion and eliminating toxins (Lin and Li, 1997).
- In addition to high protein and low energy content, mung beans also contain various enzymes and plentiful microelements. For example, superoxide dismutase (SOD) extracted from the mung bean can be chemically modified and made into an SOD oral liquid. This chemically modified SOD can avoid

destruction by gastric acid and pepsin, thereby extending its half-life, making it suitable for human oral absorption (Lin and Li, 1999).

- Overall, regular consumption of mung beans could regulate the flora of enterobacteria, decrease the absorption of toxic substances, reduce the risk of hypercholesterolemia and coronary heart disease, and prevent cancer (Kruawan et al., 2012).

Ethnomedicinal Potential

- Used in Ayurveda, Unani and Sidha.
- Seeds used for paralysis, rheumatism, coughs, fevers and liver ailments.
- Veterinary medicine, seed paste mixed with turmeric powder applied to treat dislocated bone of cattle. [CRC World Dictionary of Medicinal and Poisonous Plants]
- In ancient books, mung beans were well known for their detoxification activities.
- Mung bean protein, tannin, and other polyphenols are thought to combine with organophosphorus pesticides, mercury, arsenic, and other heavy metals, promoting the excretion of sediments from the body (Zhang, 1988).
- Mung beans have been shown to possess antioxidant, antimicrobial, and anti-inflammatory activities.

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During the germination process of the mung bean, its chemical constituents undergo a series of biochemical reactions. One such reaction is the synthesis of small active compounds from macromolecular substances, promoting absorption and utilization.

Another change observed during germination is the formation and accumulation of many types of active substances, such as polyphenols, saponins, vitamin C, etc. Therefore, we believe that these changes in the chemical composition of mung beans during germination

will lead to substantial and important changes in the pharmacological activities of mung beans as well.

Research into the chemical constituents and biological activities of mung bean seeds and sprouts have a solid theoretical basis for the development and utilization of mung beans. Combined with analysis of the metabolites of these chemical constituents, research investigating the physiological functions of these compounds is required for further advancement of this field. Thus, future studies may focus on the extraction and purification of new physiologically active substances in agriculture, health foods, cosmetics, and pharmaceutical applications.

Vigna subterranea (Linn.) Verdc. Bambara groundnut. Bambara groundnut *Vigna subterranea* is a leafy, annual, creeping legume with glabrous (hairless) leaves supported by a petiole 5-30 cm long. Each leaf is composed of three leaflets (trifoliate) and can be up to 11 cm long. Yellow flowers are clustered 1-3 on an unbranched axis, known as a raceme. They are papilionaceous, typical of species belonging to the subfamily Papilionoideae, and resemble, for example, the pea flower. The peduncle (the stalk supporting the raceme) is up to 3 cm long, hairy and after flowering it expands and bends downwards so that the fruits develop underground. The ovary, which develops into the seed pod, contains 1-4 ovules. Once mature the seeds, which can be of various colours, are almost spherical and are 8-15 mm in diameter. Bambara groundnut has a deep taproot surrounded by lateral roots bearing nitrogen-fixing nodules. Bambara groundnut grows best in dry areas with sandy soils.

Bambara groundnut (*Vigna subterranea*) is an important grain legume which grows in the semi-arid regions of Africa. Its ability to fix nitrogen and its resistance to high temperatures and drought makes it a valuable crop in areas where soils are too poor for other leguminous crops to grow. By burying its fruits in the soil it protects them from insect damage which can devastate other crops such as cowpea, common bean and soybean, whose tastiest parts are above ground.

Since it is common in the wild and in cultivation so it is not globally threatened.

Bambara groundnut most likely originated in north-eastern Nigeria and northern Cameroon, where it can still be found growing wild today. It is cultivated throughout tropical Africa and to a lesser extent in the tropical parts of the Americas, Asia and Australia.

Ethnobotanical Potential

- Bambara groundnut is very nutritious, boasting a 65% carbohydrate content and an 18% protein content, making it an important addition to the diets of people who cannot afford expensive animal protein. It is considered to be a complete food and

people can survive exclusively on bambara groundnut for all of their nutritional needs.

- Bambara groundnut is a lifesaver during the hungry season, the period that exists when the old crops have been eaten and the new crops have not yet been harvested.
- Despite all of these benefits it is a much underutilised and has the potential to be more than just a subsistence crop. Part of the problem is its stigma as a 'poor person's crop'.
- Bambara groundnut is cultivated mainly for its seeds which can be boiled, roasted or fried to make a delicious snack or mixed in with maize or plantains to serve as a meal.
- The seeds can be ground into flour after roasting and used to prepare porridge or they can be soaked, boiled and ground into a paste and used in fried or steamed dishes popularly eaten in Nigeria.
- The flour can also be used as a thickener in soups and stews and in Zambia it is commonly made into bread.
- Milk can be made from the seeds and fermented products similar to tempeh and dawadawa can be prepared. Besides being a food crop, the seeds and leafy shoots of bambara groundnut, which are rich in protein and phosphorus make good fodder for pigs and poultry.
- The Millennium Seed Bank and the Global Crop Diversity Trust are engaged in a ten-year project, called 'Adapting Agriculture to Climate Change'. The project aims to protect, collect and prepare the wild relatives of 29 key food crops, including bambara groundnut, so that they are available to pre-breederers for the development of new varieties that are more resilient to the effects of climate change.
- Its ability to fix nitrogen and its resistance to high temperatures and drought makes bambara groundnut a valuable crop with enormous potential to be grown on a larger scale, providing food security for many more people.
- The Millennium Seed Bank Partnership aims to save plants worldwide, focusing on those plants which are under threat and those which are of most use in the future. Once seeds have been collected they are dried, packaged and stored at -20°C in Kew's Millennium Seed Bank vault.
- It is being used as food, fodder and as medicine.

Ethnomedicinal Potential

- Bambara groundnut also has a number of medicinal uses.
- In Senegal leaf preparations are applied as a poultice for infected wounds and abscesses.
- The leaf sap is applied to the eyes as a treatment for epilepsy.
- The pounded seeds mixed with water are used to treat cataracts.
- The roots of the plant can be taken as an aphrodisiac.

- Evidence suggests that high fibre foods such as bambara groundnut can reduce the incidence of heart disease and help to prevent colon cancer.
- Bambara groundnut improves the quality of the soil because of its ability to fix nitrogen from the air. It is therefore a good companion in crop rotations.

Vigna umbellata (Thunb.) Ohwi & H. Ohashi, Rice bean.

Synonym: *Phaseolus calcaratus* Linn.

Rice bean, a less known and underutilized legume, has emerged as a potential legume because of its nutritional potential. The nutritional quality of rice bean is higher as compared to many other legumes of *Vigna* family.

Vigna umbellata (Thunb.) Ohwi and Ohashi is a warm-season annual vine legume with yellow flowers and small edible beans. To date, it is little known, little researched and little exploited. It is regarded as a minor food and fodder crop and is often grown as intercrop or mixed crop with maize (*Zea mays*), sorghum (*Sorghum bicolor*) or cowpea (*Vigna. unguiculata*), as well as a sole crop in the uplands, on a very limited area. Like the other Asiatic *Vigna* species, rice bean is a fairly short-lived warm-season annual. Grown mainly for dried pulse, it is also important as a fodder, a green manure and a vegetable. Rice bean is most widely grown as an intercrop, particularly of maize, throughout Indo-China and extending into southern China, India, Nepal and Bangladesh. In the past it was widely grown as lowland crop on residual soil water after the harvest of long-season rice, but it has been displaced to a great extent where shorter duration rice varieties are grown. Rice bean grows well on a range of soils. It establishes rapidly and has the potential to produce large amounts of nutritious animal fodder and high-quality grain. The cultivated Asiatic *Vigna* species belong to the sub-genus *Ceratotropis*, a fairly distinct and homogeneous group, largely restricted to Asia, which has a chromosome number of $2n = 22$ (except *V. glabrescens*, $2n = 44$). There are seven cultivated species within the sub-genus, including mung bean or green gram (*V. radiata*), black gram or urad bean (*V. mungo*), adzuki bean (*V. angularis*) and moth bean (*V. aconitifolia*) as well as a number of wild species. Artificial crosses have been made between *V. mungo* and *V. umbellata* to produce improved mung bean varieties (Singh et al., 2006). There are three more or less secondary gene pools within the group: ricebean is closer to *V. angularis* than to the other species, being in the *Angulares* group (Kaga et al., 1996, Tomooka et al., 2003). Rachie and Roberts (1974) classed rice bean as adapted to sub humid regions with 1000–1500 mm precipitation, although they noted that other factors were also involved in adaptation, for example rainfall pattern, moisture distribution, temperature, cloud cover and relative humidity, soil characteristics, pests and diseases. They noted the importance of human needs in assessing adaptation – for example taste, the need for a particular use, or market price. Average yields were between 200 and 300 kg

ha⁻¹, although with the potential for 1200 kg ha⁻¹, the crop would grow on a range of soils, and was resistant to pests and diseases. It would mature in as little as 60 days, and although performing well under humid conditions, was also tolerant to drought (NAS, 1979) and high temperatures. It is tolerant to some degree of waterlogging, although the young plants appear to be susceptible (de Carvalho and Veira, 1996). Rice bean is also known to be tolerant to acid soils (Dwivedi, 1996). Shattering is a problem in comparison with other grain legumes, and can be particularly serious under conditions of frequent wetting and drying.

Wild forms are typically fine-stemmed, freely-branching and small-leaved, with a twining habit, photoperiod sensitivity and indeterminate growth (Lawn, 1995). Flowering is a synchronous, and there is a tendency to hard seeds. In many areas, landraces which retain many of these characteristics persist, in particular with regard to daylight sensitivity, growth habit and hard seeds. Seed color is variable, but commonly red or yellow. The red type is commonly named in Chinese, literally meaning 'red small bean'. It's considered an herb in Traditional Chinese Medicine.

Ethno-botanical Potential

- Rice bean plays an important role in human, animal and soil health improvement. All varieties seem to be good sources of protein, essential amino acids, essential fatty acids and minerals (Mohan & Janardhanan, 1994), and the dried seeds make an excellent addition to a cereal-based diet.
- Rice bean is nutritionally rich legume, but despite its nutritional excellence, it has been put in underutilized category. Because of this and several other reasons the people are not aware of its nutritional benefits. Moreover, the complete nutritional details are also not available on this pulse. The study of Katoch (2013) provides vivid description of nutritional attributes of this legume for making people aware of its nutritional excellence and provoking improved work in rice bean.
- Rice bean is most often served as a dal, either soaked overnight and boiled with a few spices, or cooked in a pressure cooker.
- Apart from various recipes for dal soups and sauces, pulses are also used in a number of other ways, either whole, cooked or roasted, as flour, or ground to make various deep-fried dishes or snacks. Some recipes are specific to particular pulses, but many are open to substitution.
- The consumption of green pods as a vegetable has been recorded but is not widespread, although the indeterminate growth habit of many varieties is beneficial in providing a steady supply of green pods over long periods of the year.
- The raw protein content of rice bean is lower than that of most pulses, although there is considerable variation. Gopinathan et al. (1987) note that the protein content of related wild species (e.g. *Vigna*

minima) tends to be higher than of cultivated lines, so there may be potential to breed for improved protein content. However, the amino acid composition is reported by several authors to be well balanced for human consumption (e.g. Chandel et al., 1978; Mohan & Janardhan, 1994; de Carvalho & Vieira, 1996).

- As in other pulses, an important problem is that rice bean contains various antinutrients, notably phytic acid or phytate, polyphenols and fibres that reduce micronutrient uptake, in particular iron and zinc. Breeding for low phytate seeds is possible, but there are conflicting opinions about its desirability because phytate is also a human nutrient, and also plays various roles in the life cycle of the plant.
- Special concern for flatulence-producing substances is important when a pulse is promoted for human consumption (Smil, 1997). Revilla et al. (1990) tested the content of known flatulence-producing oligosaccharides in common legumes from the Philippines and ranked them on their flatulence-producing potential: Sam-samping (*Clitoria ternatea*) > hyacinth bean (*Lablab purpureus*,) > Lima bean (*Phaseolus lunatus*) > swordbean (*Canavalia gladiata*) > ricebean > jack bean (*Canavalia ensiformis*). Two different varieties of ricebean contained 2.25 and 2.55% oligosaccharides. Kaur and Kawatra (2000) measured the effect of soaking, open pan cooking, pressure cooking, sprouting and combinations of these. All led to a significant reduction of the content of flatulence-producing sugars, although the most effective was a combination of sprouting and pressure cooking.
- While most legumes contain one or several enzyme inhibitors and similar antinutritive or toxic factors (Smil, 1997), the content of such substances appears to be low in ricebean.
- Ricebean is valuable as a high-class fodder which is known to increase milk production in livestock (Baek et al., 2010).

Ethno-medicinal Potential

- No information is available regarding any "folk medicine" use in Nepal or India.
- In South Asia, the idea of a division of foods into hot, cold and neutral is very common. This has an important bearing on dietary choices, as this perception not only promotes a balance between hot and cold food stuffs in daily nutrition, but also encourages or discourages the consumption of various items according to season, and during sickness. An account of the perception of a number of food items in Nepal has been published by Gittelsohn et al. (1997). Their data shows that there is hardly any "scientific" basis for the division into hot and cold foods. For instance, yogurt is cold while goat milk is hot, buffalo meat is cold while fish and chicken is hot, and black gram is cold while red gram (cowpea) is hot. It should be noted that this perception tends to be location-specific, so these

findings cannot be generalised all over Nepal (or South Asia!). In Nepal, ricebean tends to be categorised as a cold food (e.g. in Gulmi, Kailali, Syangja, Dang, Gorkha districts) and it is said to cool people in the summer. However, it is also said to make people warm during the winter. In Ilam District in Eastern Nepal, ricebean is considered hot, and there it is advised that old and sick people should not eat it during the hot season, as it is not easily digested and weak people would get stomach problems from eating it.

- Another account from Ilam stated that rice bean, although creating some stomach unrest, was milder and more digestible than other pulses, and therefore often served to people who suffer from indigestion. Whether hot or cold, the major share of rice bean is consumed soon after harvest, so the crop will only indirectly impact on food security during the lean season in the pre- and early monsoon period.
- Some oral evidence from Nepal says that rice bean does not have a particular ceremonial role. This is in contrast to black gram which is used for ceremonial purposes among high caste Hindus, and also for instance among Rai people in the Arun Valley. In addition, black gram is considered tastier and fetches a higher market price, so will tend to replace rice bean if the farmer has to make a choice. Quantee (or kwati in Newari) is a mixed bean sprout soup served at the Janai Purnima or Raksha Bhandan festival. Rice bean is one of nine beans prescribed for this recipe. The festival marks the end of the monsoon where people by traditional perception (and probably also in reality) have been weak, undernourished and subject to diseases. In this respect, quantee is said "to make one strong" and to purify the stomach as the mixed bean sprouts are hard to digest and so cleans the stomach. In addition, eating quantee is said to kill a certain type of mosquito (Löwdin, 1998).
- While rice bean in Nepal is to some extent perceived as a "poor man's food", it is not particularly stigmatised, so no ethnic or caste group actually has a rule against it. In Dang, rice bean is particularly enjoyed by Tharu people, who have a version of quantee which requires ten different beans.
- One source mentioned that since ricebean is supposed to make you strong, people will often serve it to laborer's, while also occasionally consuming it themselves in connection with tasks requiring hard work.

Potential

So far little has been done to exploit rice bean's potential: there are several features that need attention from breeders before it could be widely adopted. Most varieties are highly photoperiod sensitive, and so when grown in the subtropics are late flowering and show strong vegetative growth. Their twining habit makes them very suitable for use as intercrops with such species as maize, sorghum and possibly some of the minor millet

species, which can provide support, but also makes them difficult to harvest. Many of the current varieties are susceptible to shattering, and show high levels of hard seededness. Some crop improvement work has been carried out on rice bean in India, but not in Nepal. However, the use of rice bean as a green manure crop was studied in a series of field experiments in Nepal, and this revealed that it is one of the best legumes for the purpose due to high biomass production over a short period of time, is easy to incorporate into the soil, and decomposes rapidly.

Ethno-botanical Potential

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- It is regarded as a minor food and fodder crop and is often grown as intercrop or mixed crop with maize (*Zea mays*), sorghum (*Sorghum bicolor*) or cowpea (*V. unguiculata*), as well as a sole crop in the uplands, on a very limited area

Vigna unguiculata (Linn.) Walp. subsp. **cylindrica** (Linn.) van Zeslaine, Cow pea, Croder pea, Black eyed pea, Southern pea.

Synonyms: *Vigna catiang* (Burm. F.) Walp, *Vigna sisensis* (Linn.) Savi ex Hassk., *Vigna unguiculata* var. *cating* (Burm.F) Bertoni and *Phaseolus cylindricus* Linn.

Annual herb, erect or suberect, spreading, to 80 cm or more tall, glabrous, taproot stout with laterals near soil surface, roots with large nodules, stems usually procumbent, often tinged with purple, first leaves above cotyledons are simple and opposite, subsequent trifoliate leaves are alternate, the terminal leaflet often bigger and longer than the two asymmetrical laterals, petiole, stout, grooved, 5–15 cm long; leaflets ovoid-rhombic, entire or slightly lobed, apex acute, 6.5–16 cm long, 4–11 cm wide, lateral leaflets oblique; inflorescence axillary, 2–4-flowered, crowded, near tips on short curved peduncles 2.5–15 cm long; calyx campanulate with triangular teeth, the upper 2 teeth connate and longer than rest; corona dull white, yellow, or violet with standard 2–3 cm in diameter, keel truncate; stamens diadelphous, the anthers uniform; pods curved, straight or coiled; seeds 2–12 mm long, globular to reniform, smooth or wrinkled, red, black, brown, green buff or white, as dominant color; full colored, spotted, marbled, speckled, eyed, or blotched; (5–30 g/100 seeds, depending on the cv). Germination phanerocotylar.

Vigna unguiculata ssp. **unguiculata** (Linn.) Walp is a vinous plant widely cultivated in Bangladesh for its

edible beans, which are cooked and consumed as vegetable. Various sub-species of *Vigna unguiculata* beans are consumed throughout the World including Bangladesh (Tazin et al., 2014).

Phytochemicals

Raw mature seeds typically contain (per 100 g): ca. 11.4% moisture, 338 calories, 22.5g protein. 1.4 g fat, 61.0 g total carbohydrate, 5.4g fiber. 3.7 g ash, 104 mg Ca, 416 g P, 0.08 mg thiamine, 0.09 mg riboflavin, 4.0 mg niacin, and 2 mg ascorbic acid. In results at IITA, based on several thousand distinct cvs, protein averaged 23–25%, protein, ranged from 18 to 29%, with potential for perhaps 35%. The proteins consist of 90%, water-insoluble globulins and 10% water-soluble albumins. The reported amino acid content is (mg/g N): isoleucine, 239, leucine 440, lysine 427, methionine 73, cystine 68, phenylalanine 323, tyrosine 163, threonine 225, tryptophan 68, valine 283, arginine 400, histidine 204, alanine 257, aspartic acid 689, glutamic acid 1027, glycine 234, proline 244, and serine 268. Although much variation occurs, cowpeas are deficient in cystine, methionine, and tryptophan. Total sugars range from 13.7 to 19.7% and include: 1.5% sucrose, 0.4% raffinose, 2.0% stachyose, 3.1% verbascose. Starch may vary from 50.6 to 67.0% with 20.9–48.7%, amylose, 11.4–36.6% amylopectin. The fatty acid composition of Pakistani seed oil is reported as: linolenic 12.3, linoleic 27.4, oleic 12.2, 1.1 lignoceric, 4.0 behenic, 0.9 arachidic, 7.1 stearic, 33.4 palmitic. Seeds also contain 0.025% stigmasterol. Immature pods also contain (per 100 g): 85.3% moisture, 47 calories, 3.6 g protein. 0.3 g fat, 10.0 g total carbohydrate, 1.8 g fiber, 0.8 ash, 45 mg Ca, 52 mg P, 1.2 mg Fe, 170 ug vitamin A, 0.13 mg thiamine, 0.10 mg riboflavin, 1.0 mg niacin, and 22 mg ascorbic acid. Raw immature seeds contain (per 100 g): 66.8% moisture, 127 calories, 9.0 g protein, 0.8 g fat, 21.8 g total carbohydrate, 1.8 g fiber, 1.6 mg ash, 27 mg Ca, 175 mg P, 2.3 mg Fe, 2 mg Na, 541 mg K, 370 IU vitamin A value, 0.43 mg thiamine, 0.13 mg riboflavin, 1.6 mg niacin, and 29 mg ascorbic acid. Tender shoot apices, raw, contain (per 100 g): 89% moisture, 30 calories, 4.8 g protein, 0.3g fat, 4.4 g total carbohydrate, 1.8 g ash, 73 mg Ca, 106 mg P, 2.2 mg Fe, 0.35 mg thiamine, 0.18 mg riboflavin, 1.1 mg niacin, and 36 mg ascorbic acid. The hay contains per 100 g: 9.6% moisture, 18.6 g crude protein, 23.3 g crude fiber, 2.6 g fat, 34.6 g N-free extract, and 11.3 g ash. Digestibility is improved by grinding the seeds into a fine powder. Seeds contain a trypsin inhibitor, a chymotrypsin inhibitor and a cyanogen in concentrations of ca. 2 mg/100 ml extract. Cooking improves the nutritive value, perhaps because the activity of trypsin inhibitors and/or the amount of other toxins are decreased by heat.

Ethnobotanical Potential

- The plant is cultivated for the seeds (shelled green or dried).

- The pods and/or leaves that are consumed as green vegetables.
- The plant is also used for pasturage, hay, ensilage, and green manure.
- The tendency of indeterminate cvs to ripen fruits over a long time makes them more amenable to subsistence than to commercial farming. However, erect and determinate cvs, more suited to monocultural production systems, are now available. If cut back, many cvs continue to produce new leaves, that are eaten as a potherb.
- Leaves may be boiled, drained, sun-dried and then stored for later use.
- In the United States, green seeds are sometimes roasted like peanuts.
- The roots are eaten in Sudan and Ethiopia.
- Scorched seeds are occasionally used as a coffee substitute.
- Peduncles are rented for fiber in northern Nigeria.
- The crop used to some extent as pasture, especially for hogs, and may be used for silage, for which it is usually mixed with corn or sorghum.
- The crop is very useful as a green manure, and leafy prostrate cvs reduce soil erosion.
- *Vigna unguiculata* ssp. *unguiculata* (Linn.) Walp is a vinous plant widely cultivated in Bangladesh for its edible beans, which are cooked and consumed as vegetable. Various sub-species of *Vigna unguiculata* beans are consumed throughout the World including Bangladesh Tazin et al., (2014).
- It is also a delicacy among other peoples in southern Africa The plant is regarded as having considerable potential as a crop for arid and semi-arid regions, and it is being investigated as a potential crop in several countries.

Folk Medicine

Cowpeas are sacred to Hausa and Yoruba tribes, and are prescribed for sacrifices to abate evil and to pacify the spirits of sickly children. Hausa and Edo tribes use cowpeas medicinally, 1 or 2 seeds ground and mixed with soil or oil to treat stubborn boils.

Ethno-Medicinal Potential

- The plant is considered to have ethnomedicinal importance (Tazin et al., 2014).
- Seeds of the plants are taken in Kerala, India, for menstrual disorders (Rajith et al., 2012).
- The seeds are also used for menstrual disorders in Northern Telangana, India (Suthari et al 2014).
- The roots are used against syphilis, gonorrhea, and sexually transmitted diseases in Nebbi district, Uganda (Anywar et al., 2014).

CONCLUSION

Many countries struggle with the consequences of unsustainable growth programs, affecting the climate, people and natural resources. Local authorities and their inhabitants are faced with droughts, floods, air pollution,

land degradation, deforestation and rising sea levels. By developing sustainable growth policies, local governments in partnership with the community, can improve the quality of life of citizens and contribute to protecting the global environment.

This course discusses how local authorities can respond and adapt to climate change, plan and implement solutions for environmental and natural resource challenges and promote more sustainable ways of development. Leading international experts and practitioners will share the latest insights on climate change adaptation and mitigation and the impact for local authorities. We will zoom in on the design and implementation of sustainable local development programs that protect the environment and improve the quality of life of citizens. In addition, we will discuss tools to recognize local vulnerabilities and instruments to become more resilient.

Best practices from different parts of the world will be discussed and linkages will be made to the local challenges that the participants are faced with. Furthermore, we will visit innovative projects in European cities that aim to prevent environmental pollution with respect to air, water and land. study highlight the need for more effective transformation and regeneration protocols in the more recalcitrant legumes, including bean and cowpea. Progress in the study of nodulation and N₂ fixation under drought or salinity stress has been minimal, largely because the legume and the process of nodulation are more susceptible to these constraints than is the microorganism.

Legumes play a critical role in natural ecosystems, agriculture, and agroforestry, where their ability to fix N in symbiosis makes them excellent colonizers of low-N environments, and economic and environmentally friendly crop, pasture, and tree species. Legume yields unfortunately continue to lag behind those of cereals. A research orientation that better balances the needs of third-world or sustainability oriented agriculture with the breakthrough technologies of genomics and bioinformatics is needed. It requires stronger and more adventurous breeding programs, better use of marker-assisted technologies, and emphasis on disease resistance, enhanced N fixation, and tolerance to edaphic soil constraints. It also requires extension of existing low-cost technologies, such as rhizobia inoculation, to the small farmer. Special attention will be given to Urban and Peri-urban Agriculture and Forestry (UPAF) which can play a strong role in enhancing food security for the urban poor, greening the city and improving the urban climate, while stimulating the productive reuse of urban organic wastes and reducing the urban energy footprint.

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