Rakesh Kumar Dubey, Vikas Singh,
Jyoti Devi, P M Singh and Jagdish Singh

Indigenous aquatic and minor vegetables

Indigenous vegetables have made an important contribution to food and nutritional security and also enhanced the livelihoods of marginal and smallholder farmers. Indigenous vegetables have been shown to be rich in micronutrients such as iron, zinc, pro-vitamin A and phytochemicals that help protect people against non-communicable diseases. Indigenous aquatic vegetables are predominantly in vogue where they are naturally available in plenty. Areas rich in water bodies like lakes, lagoons, ponds, ditches, marshy wet places are natural abode of most of the aquatic vegetables. Communities dominated in the wetland areas of the India do not only get their requirements of vegetables completed, it has been indispensable part of their life.

WATER spinach, water convolvulus, Kang Kong and swamp cabbage are some alternative names in English or kalmi saag in Hindi; originated in India and is member of morning glory family. It is a semi aquatic, tropical plant, grown as a leafy vegetable for its tender shoots and leaves. The leaves are good source of minerals, vitamins and also considered a possible source of food protein. The plant serves as high nutritive green fodder, fish food and feed for broilers. It has long, jointed and hollow stems, which allow the vines to float on water or creep across muddy ground. Adventitious roots are formed at nodes which are in contact with water or moist soil. They exude a milky juice and leaves are white or green, depending on variable forms. Leaves are 1-2.5 cm wide and 20-30 cm long and broad leaves are up to 5-7.5 cm wide and 15-25 cm long. Stems are 1- 2 meters long, rooting at the nodes, and they are hollow and can float. Water spinach easily forms new plants when fragments of stem break off and take root. The leaves are usually green and arrow-head or lanceolate in shape. The leaves grow alternately on the stem of the plant. The margins are entire or angular and sub lobed. The flowers peduncles are erect, 2.5 to 5.0 cm long, with 1-2 flowers, borne in the axils of the leaves. Typically look like "morning glory" flowers. They are trumpet shaped and showy, white to pale pink or lilac in colour and grow singly or in small groups. Sepals are green, oblong, about 8.0 mm long. Corolla is narrowing bell-shaped, about 5.0 cm long, and purplish; limb nearly white or pale pink purple, about 5 cm in diameter, the tube deeper purple inside. Capsules are smooth and ovoid, about 1.0 cm long. Fruits are an oval or spherical capsule, woody at maturity, 1.27 cm wide, each capsule holds 1-4 grayish seeds, about 4-5 cm in diameter. The pods and seeds can easily float and travel to spread new plants.

Table 1. Nutritional value of water spinach, Indian palak and spinach (per 100 g of raw)

Water spinach		Indian Palak	Spinach
Energy	19.0 kcal	46.0 kcal	23.0 kcal
Carbohydrates	3.14 g	6.5 g	3.63 g
Dietary fiber	2.1 g	0.7 g	2.2 g
Fat	0.2 g	0.8 g	0.39 g
Protein	2.6 g	3.4 g	2.86 g
Vitamins			
Vitamin A equiv.	1890.0 µg	1758.6 µg	469.0 µg
Thiamine (B1)	0.03 mg	0.26 mg	0.078 mg
Riboflavin (B2)	0.1 mg	0.56 mg	0.189 mg
Niacin (B3)	0.9 mg	3.3 mg	0.724 mg
Vitamin C	55.0 mg	70.0 mg	28.1 mg
Minerals			
Calcium	77.0 mg	380.0 mg	99.0 mg
Iron	1.67 mg	16.2 mg	2.71 mg
Phosphorus	39.0 mg	30.0 mg	49.0 mg

Health benefits of water spinach

It is an excellent option to lose weight and reduce cholesterol naturally. Research has proved that consumption of water spinach results in the reduction of cholesterol level and triglycoside. Water spinach has been used in Ayurvedic medicine for the treatment of jaundice and liver problems by its modulation of detoxification enzymes; antioxidant and free radical scavenger properties. Being rich in iron, the new water spinach leaves are extremely beneficial for anemia as well as pregnant women who require iron in their diets. Water spinach is rich in fiber and hence, it aids in digestion, providing relief from different digestive disorders. Juice from boiled water spinach can loosen constipation and also used in the treatment of intestinal worm infestation. It contains latex which is used as a purgative agent. It has been found that regular consumption of water spinach helps in developing resistance against diabetes induced

oxidative stress. The nutrients present in water spinach act as antioxidants to reduce free radicals in the body, thus preventing cholesterol from becoming oxidized. Besides, folate contained in water spinach helps to convert a potentially dangerous chemical called homocysteine, which in high levels can lead to heart attack. Magnesium lowers blood pressure and provides protection against heart disease as well. Being loaded with 13 different types of antioxidant compounds, water spinach is a perfect diet for prevention of cancer. Water spinach is said to be most beneficial in the prevention of colo-rectal and stomach cancers as well as skin and breast cancers and making the skin cells more resistant from damage from exposure to the sun and minimizing wrinkling to a significant extent. Regular consumption of this vegetable can prevent and reverse ageing. Water spinach has a high content of carotenoids, vitamin A and lutein. These nutrients are vital for eye health and also boosts glutathione levels, which play an important role in preventing cataracts. Being a storehouse of nutrients, this leafy green vegetable is an inexpensive and natural way of boosting the body's immunity in comparison to vitamin C supplements. Consumption of this green leafy vegetable on a regular basis boosts your body's immune system and promotes healthy development of bones. Drinking of water spinach juice is extremely beneficial for skin health as it keeps skin ever rejuvenated by eliminating harmful toxins from the body. The wide array of nutrients contained in water spinach is beneficial for hair and prevents hair loss besides improving the quality and texture of hair. In addition to the benefits discussed above, water spinach is effective in treating ulcers, menstrual pains, toothache, launched urination, nosebleed etc. It acts as a sedative for people who have insomnia or sleeping difficulty. The juice of water spinach mixed with water is used as a cold compress to treat fever. Being anti-venom, it is used to promote vomiting in case of poisoning.

Uses of water spinach

Young shoots and leaves can be eaten as raw in salads or cooked with other vegetables, spices and meat. Stir-fried (stir-fried water spinach with garlic) water spinach is a popular vegetable dish. In the South India, the water spinach is julienned into thin strips and eaten with many kinds of noodles. It is also commonly cooked in sour soup with tomatoes and other vegetables. Water spinach is also eaten raw or parboiled along with other vegetables in dip dishes. In the Philippines, the tender shoots are cut into segments and cooked together with the leaves in fish and meat stews. In Singapore and Malaysia, the tender shoots along with the leaves are usually stir-fried with chili pepper, garlic, ginger and other spices. In West Bengal, it is known as kolmishak and stir-fried preparation of the leaves is a very popular dish.

Genetic resources

Water spinach is extremely widespread and not in danger of genetic erosion. Diverse germplasm collections are being maintained at ICAR- Indian Institute of Vegetables Research, Varanasi, Uttar Pradesh with holdings of more than 30 diverse genotypes. World Vegetable Center, Taiwan and National Research Institutes, South-East Asia are holding many genotypes of water spinach.

Crop improvement

Consumers have specific preferences with regard to the quality of the product, viz. number of leaves, stem length, percentage of fibre and taste. ICAR-IIVR, Varanasi has selected superior genotype from landraces for different horticultural traits and rapid development. The genotype VRWS-1 with broad leaves and grown year-round and is suitable for multiple harvesting indentified at ICAR-IIVR, Varanasi. Important variants on the basis of leaf size, colour and growing habits are as follows:

Light green: Plants of this group have light green stem. The shoots are tender, soft and glabrous with ovate, oblong and lanceolate leaves and spread densely in shallow water.

Green red: Stems of this group of plants are green red. Shoots are tender, soft and glabrous with thick leaves, mostly hastate. The plants spread and produce long trailing branches. It is the most common type.

Red stem : Stem of this plant group possesses dark red colour and they are soft, glabrous with a diameter thinner than of the other varieties.

Climatic and soil requirement

Water spinach responds well at optimal temperature of 20-30°C. Flowering occurs under short-day conditions. It tolerates very high rainfall, but not frost. It prefers full sun but where summer temperatures are very high, it is sometimes grown as a ground cover beneath climbing plants. Water spinach should be sheltered from strong winds. It requires fertile soil rich in organic matter with soil pH of 5.5 to 7.0.

Sowing and planting

In moist soil culture, the crop is grown on raised beds 60-100 cm wide. Seeds are sown directly or nursery grown seedlings are transplanted. Seed should not be more than 2 years old and can be soaked for 24 hours before sowing to encourage germination. Seed should be sown 5-10 mm

Variation in shape, size and colour in water spinach grown at ICAR-IIVR, Varanasi

deep in trays with potting mix deep enough to allow the plants to develop a good root system. Transplanting should take place when plants are 10-15 cm high with four true leaves. Highest yields are obtained by spacing plants at 20 × 15 cm. They can also be grown in rows about 20 cm apart with plants at 15 cm spacing within rows. Water spinach can be grown as an upland field crop. The 1000 - seed weight is about 50-60 g. The seed rate of 60–100 kg is found to be sufficient for a hectare sowing. Final plant densities may range from 3,00,000-17,00,000 plants/ hectare. Upland field water spinach is more productive and has a better market quality.

Propagation from cuttings

Water spinach can also be raised from stem cuttings 30-40 cm long, taken from the young growth just below a node and planted about 5.0 cm deep. For aquatic culture, cuttings from the broad leaved cultivars are transplanted in puddled soil.

ICAR-IIVR, Varanasi developed package of practices for upland field water spinach

Water spinach is commonly grown in waterlogged areas. However, such cultivation requires cumbersome practices for plant protection measures and harvesting. This also invites water pollutants harmful for human health. Therefore, an attempt was made for cultivation of water spinach in upland field conditions and promising results were obtained for the same. This technology can prove to be simple and be cultivated round the year which can serve as boon for the socio-economic upliftment of farmers.

Cultivation of water spinach in upland field condition at ICAR-IIVR, Varanasi

Advantages of upland field–water spinach

- Multiple cuttings.
- Can be grown throughout the year.
- Can be grown in upland field condition, submerged condition is not necessary.
- Produce may be free from water pollutants.
- Technology promises “Safe Biomass” as “Upland Water Spinach”.
- Promotion of cultivars VRWS-1 for socioeconomic prosperity among growers.

Crop management

Before transplanting, the crop must be given sufficient nutrients to produce quality water spinach. Plants respond well to nitrogen but over-feeding must be avoided because it can result in high nitrate concentrations in the leaves and stems which is undesirable. A general fertilizer recommendation includes manure applied before sowing/ transplanting at the rate of 30 t/ha with N 50.0 kg/ hectare, P 30.0 kg/ha and K 40.0 kg/ha. This is followed by three top dressing at 10 days interval with N at a rate of 30, 8 and 8 kg/ha. In case of multiple cuttings, which is most desirable in home gardens, additional top dressing is recommended after each cutting. Application of large amounts of nitrogen fertilizer increases yield and leaf/stem ratio, but also the nitrate content, whereas the dry matter content decreases. In wet cultivation the water level is raised in accordance with the development of the crop, reaching a depth of 15–20 cm. Fertilizer application is similar to upland cultivation, also with a top dressing of nitrogen after each cutting.

Harvesting, yield and post harvest management

Water spinach should be harvested before it flowers. Crop becomes ready for harvesting 50-60 days after sowing and 35-40 days after planting. Many harvests can be taken if shoots are cut above ground level; allowing secondary shoots to grow from nodes below the cut in upland field condition. The frequency of harvesting will depend on the growth rate of the crop. The upper part of the main shoot, about 30 cm long is cut about 5 cm above water level. About 35-40 tonnes/hectare fresh greens can be harvested from three or more cuttings. Rapid and careful post-harvest handling is required to minimize damage to the crop, especially due to wilting caused by moisture loss. To prevent this, the plants should be harvested during the coolest part of the day. After bunching, a fine spray of cold water should be applied and the leaves kept in a cool place away from the wind. Leaves are usually sold in 500 g bunches in the markets at the rate of ₹ 60-80/kg.

For long-distance transport and supermarkets, water spinach bundles are packed in layers of 15 cm in bamboo crates with crushed ice in between. Water spinach harvested from upland field has a longer shelf life because the leaf area of the young shoots is small.

Prospects

Upland field water spinach is an excellent vegetable, worth promoting in tropical Indian lowland areas. The popularization of improved germplasm line VRWS-

Leaf bundle of water spinach

1 developed by ICAR-Indian Institute of Vegetable Research, Varanasi for upland field water spinach might be successful especially in areas where sweet potato leaves are traditionally consumed. Research should focus on the improvement of fertilizer application and non-chemical control of insect damage. Breeding efforts should concentrate on cultivars/germplasm lines adapted to specific environments and resistant to biotic and abiotic stresses.

Indian lotus (*Nelumbo nucifera*)

Lotus is also known as Kamal, Padma, sacred lotus, Indian lotus, East Indian lotus, Oriental lotus, Lily of Nile and Bean of India. Young leaves, petioles and flowers are eaten as vegetables. Rhizome (Kamal-Kakadi) is edible and sold as vegetable. Fresh rhizomes are eaten after boiling and fried slices are used in curry or fried as chips. Fresh rhizomes can be preserved in frozen conditions and used as precooked food. Generally two types of rhizomes, white and red are available. Rhizomes varied 60-120 cm in length and 6-9 cm in diameter, white to buff orange in colour and possess a few large cavities in cross section. The leaves are used as a flavouring agent and to wrap sweet and spicy mixtures for steaming.

Nutritive and medicinal value

Fresh rhizomes contains moisture 83%, crude protein 2.7%, fat 0.11%, reducing sugar 1.56%, sucrose 0.41%, starch 9.25%, fiber 0.80%, Ash 1.10%, calcium 0.06%, thiamine 0.22 mg, riboflavin 0.06 mg, niacin 2.1 mg and ascorbic acid 15.0 mg. Decoction of its leave significantly reduces the serum triglyceride and cholesterol levels. Lotus has been found to have 77% antioxidant activity. Rhizome of lotus is known for its hypoglycemic, antipyretic, anti diarrheal, antibacterial and anti-inflammatory activity.

Description of Indian lotus plant

Apart from its aesthetic value, the entire lotus plant is of considerable economic and medicinal value as well. Every part of the plant is consumable. The petals are often used for ornamental purposes. The mature leaves are often used for packaging as well as serving food. The rhizome and leaf stalks are used as vegetables in most of the East Asian countries like China, Korea and Indonesia. The rhizome is boiled, sliced and fried, used in salads and pickled in vinegar. It is rich in fiber, contains vitamins B_1, B_2, B_6, and C and minerals like potassium, manganese, phosphorous and copper. The lotus seed are also quite popular as nuts and are often eaten raw. They may also be fried or dry roasted to produce a sort of popcorn. The lotus has several curative properties in traditional medicine. The lotus tea brewed using the flower is used to relieve cardiac ailments. It also has detoxifying properties and helps stop blood flow in injuries. The lotus rhizome is good for the general wellness of stomach and reproductive organs. It is good for healthy development of foetus during pregnancy. The lotus leaves are used for wrapping other food items and it helps preserve their freshness.

The lotus stem remains underground in the muddy soil at the bottom of the inhabiting water body. It modifies into a structure known as the rhizome which serves as both an anchoring device and storage organ. Roots are short and fibrous, growing out in bunches from the stem internodes. The lotus plants have simple leaves meaning one per leaf stalk. The stalks emerge upwards from the rhizomatous stem – are green, long, round and hollow. The vasculature is porous enabling the stems and stalks to remain afloat in water. The upper surface of the leaves is waxy and impervious to water. The flowers are the key focus of the plant, and are large and showy, predominantly pink. The cone shaped central female reproductive structure is termed the thalamus which is framed by the delicate petals. The lotus bud resembles the shape of a tear-drop with pointy tip and tightly packed petals. The petals are translucent and open in overlapping spiral pattern. The flowers open in the morning and bloom for three days. The petals close after sunset trapping in the pollinating agents. The central yellow receptacle of the spongy thalamus contains the ovaries which develop into seeds after fertilization and are embedded in single chambers. Seeds are hard, oval in shape and dark brown in colour.

Cultural importance

The lotus flower is deeply imbibed with symbolism of Indian philosophy. In his essay "The Secret of Work", Swami Vivekananda impressed upon the significance of lotus leaves as a symbol of spiritual detachment by saying, "Just as water cannot wet the lotus leaf, so work cannot bind the unselfish man by giving rise to attachment to results." The lotus plant itself is evocative of this powerful imagery symbolizing this spiritually desired way of life; the way it grows among mud and murk yet remain pristine and upholds something of immense beauty. It is considered sacred in both Hinduism and Buddhism. Many Hindu deities like Brahma, Lakshmi and Saraswati are depicted to be seated on a lotus flower. In Buddhist philosophy, the lotus represents the preserved ability of purity of one's soul amidst the grime of mortal life. The lotus flower is a symbol of divine beauty and is often used as a simile to describe someone with pure and delicate attribute.

Distribution of Indian lotus

Indian lotus distribution ranges throughout the semi-tropical climatic condition. It is predominant in the India, Bangladesh, and Myanmar; but also very common in other

south-east Asian countries like Bali, Indonesia, Malaysia etc. It is cultivated in Australia as well as in European countries for its aesthetic value. The national flower of India is Lotus and has been an integral part of the Indian culture from time immemorial. A prominent feature of the Indian mythology, the lotus is one with the Indian identity and represents the core values of Indian psyche. The Indian lotus symbolizes spirituality, fruitfulness, wealth, knowledge and illumination. The leaves and flowers have long stems that contain air spaces in them. The Indian lotus flowers have many petals overlapping in a proportional pattern.

Propagation

In general, lotus is grown from seeds or rhizomes. For one hectare planting, 10-12 kg of seed is required to raise seedling. To propagate through the seeds; first step is Scar the seeds. If we do not scar the seed, it will not grow and may rot. The seeds should be placed into a glass of warm water. The water should not be chlorinated and must be changed every day until the lotus seeds sprout. After the first day of soaking, the seeds should swell to nearly twice their original size. Seeds that float are almost always infertile. If these seeds do not swell like the others, discard them to avoid letting them cloud up the water. Growth should start after four or five days of soaking and wait until the seedling is at least 15-20 cm long before transplanting. For propagation through rhizomes; rhizomes are cut into small pieces and planted with eyes above the soil surface in March-April. Rhizomes should not be exposed to direct sunlight or freezing temperatures. Plant the lotus within a few weeks after the rhizomes sprouts. Plant will be ready for deeper water once the growing tips show leaves. Smaller types of lotus need only 1 to 15 cm of water covering the top of the soil, but larger varieties may need up to 1 m of water.

Propagation technique of Indian lotus through leafy stem cutting standardized at ICAR-IIVR, Varanasi

Lotus is usually propagated by the seed or division of enlarged rhizomes. Vegetative propagation allows the cloning of superior individuals and enables nurseries to supply uniform planting stock to growers. Since enlarged rhizomes are divided and planted for propagation in late March, before the sprouting of terminal buds, the propagation of lotus is limited to a relatively short period of the year when lotus does not grow actively. During the growth period in early summer, farmers who cultivate edible lotus generally use rhizome straps with enlarged rhizomes as materials for propagation. They consider that rhizome straps without enlarged rhizomes would not be suitable as materials. However, excavation of enlarged rhizomes from lower depths in soil is laborious and the buds often break vigorously in response to heavy pruning. Rhizome straps without enlarged rhizomes may have the potential to produce many roots, and it could be possible to develop a propagation method that uses rhizome straps. Thus rigorous studies were undertaken at ICAR-IIVR, Varanasi to determine whether lotus could be propagated through some other plant parts than seeds or rhizomes and also their survival rate evaluation. Large number of plants could be raised by leaf-stem cuttings for vegetative propagation. Through this method, we could produce true to characters as of source material within a very short period of time and plant survival rate was also found to be more than 90%. The present finding encourages for rapid multiplication technique of lotus and proven as easy and most effective method of propagation of lotus over seed /rhizome propagation methods.

Standard agrotechniques

Rhizome yield with tune of 250-350 quintal per hectare could be obtained by application of 270 kg N, 120 kg K_2O and 15 kg B per hectare. It is found that lotus is more responsive to B application. Harvested rhizome of lotus is very much vulnerable to browning disorders. Rhizome with browning has low market value. Rhizome grown in substrate low in Fe showed less browning from those grown in one with a high Fe content. To avoid enzymatic browning of external cut surface of pre-cut lotus root treatment with a solution of 2% erythorbic acid + 1% citric acid is most effective.

Commercial viability

Indian lotus is a well-known flower to everybody especially in our country where it is considered as a

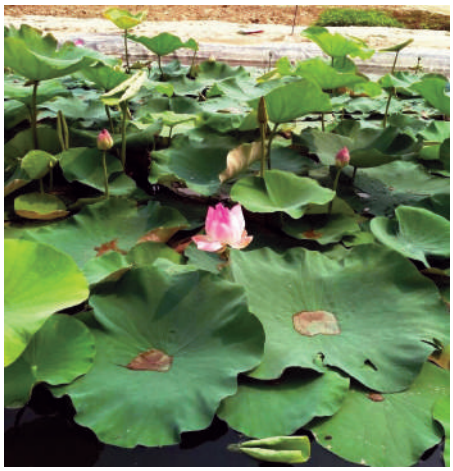
Cutting-preparation

Planting of cutting

Plants developed through leafy-stem cutting

Flowered plant propagated by leafy-stem cutting

Lotus propagation technique of leafy stem cutting



Lotus grown in pond at ICAR-IIVR, Varanasi

National flower. Lotus has many practical uses, beneficial uses (as medicine) as well as cultural uses (to worship Laxmi). Generally we collect lotuses from spontaneous growth of the plant, but to cultivate the plant commercially is out of conception. Growing demand of lotus especially flower has motivated farmers and lotus lovers to think about it. For people who are busy but want to maintain the water plant is the right choice. Maintenance of the lotus plant does not require much time and not technically complex. Durga puja is an important festival all over India and during this festival there is huge demand of lotus flowers according to rituals. Each Puja pandel requires about 108 lotus flowers. Therefore, how much number of lotus flowers is needed? Then the price of flower is not a matter, but availability of flower is really a matter. Hence, there is a good business opportunity. To catch that potentiality, farmers must be motivated by the public or private extension system. In general lotus rhizomes are sold at the rate of ₹150-200 per kg.

Tree bean (*Parkia roxburghii*)

Several vernacular names are available for tree bean viz. Khorial (Assamese); Manipuri seem (Bengali); Zongto (Mizo); Yongchak (Manipuri); Aoelgap (Garo); Bire-phang (Kachari); Themuk-arang (Mikir); Unkamn-pinching (Naga) among the tribal population of the NEH region. Tree bean belongs to family Leguminosae and is regarded as a colourful tree species of Manipur and grown mostly in the home garden, slash and burn or jungle throughout the region. The fruit (pod) is consumed in all its developmental stages and is one of the favourite food items among the people of Manipur as well as to the neighboring states for its unique smell, taste or flavour. The pungent smell of tree bean tells the presence of Thiazolidine-4-Carboxylic acid (TCA, Thioproline), a cyclic sulphur containing amino acids. The tree bean serves as the basic needs of protein and fat to meet the even increasing requirements. The seeds as well as tender pods are known to cure stomach disorders and regulate liver function. Pods pounded in water are used in cleaning the face and head. The pods are reported to be good source of ascorbic acid (26.0 mg/100 g), fat (20.28%), proteins (32.82%) and minerals (4.45%). Studies on protein fractionation reveal that globulin and albumin are the major fractions and the globulin to albumin ratio is very less (1.6). The higher amounts of albumins (8.14%) with the globulins (13.05%) indicate more protein digestibility and higher content of sulphur containing amino acids means more nutritive values as these are the limiting amino acids in legumes. Protein content of the pod ranged from 12.1% in tender to 18.8% in mature pods. Like any other grain legumes, protein content of the kernels (28.8%) was much higher than the pods. Though, protein content of tree bean kernel is lower than soybean (43.0%) it is higher than most other grain legumes such as Bengal gram (23%), cowpea (24%), green gram (24.0%) and red gram (22.0%). Also, the fat content of tree bean kernel is lower than oilseeds such as groundnut (42.0%) however; it is higher than other grain legumes such as winged bean (18.0%) or soybean (20.0%). Maturity of the pods leads to an increase in protein and fat content accompanied by a decrease in the ash as well as carbohydrate content. In addition, unsaturated fatty acids in the tree bean kernel as well as the pods range from 63–67%. The high degree of unsaturated and the substantial amount of fat in the kernels warrants their screening for edible oil production. Compared to other grain legumes, tree bean kernel, as well as the pods has also been reported with good mineral content too. Thus, many investigation envisages that different plant parts of tree bean were found to have high amounts of phenols and AOA; low IC_{50}, low EC_{50}, reasonably good values of ARP which explains their effectiveness towards protection of DNA nicking indicating strong free radical scavenging activity. The antioxidant capacity of extracts varied according to the system-generating reactive species. It is well known that the performance of a complex mixture such as plant extracts in different antioxidant systems is related to the type of radical generated and to the polarity of the substrate system. In most of the assays, the pod extracts showed even higher potency in scavenging of free radicals than quercetin which was used as a standard. Further, it holds promise to identify the potential sources of natural polyphenols with promising AOA, FRSA and wide range of other biological activities. The wood can be used as a source of paper pulp. Pods from the plant growing in different agro-climatic conditions exhibit a high degree of morphological variations. The best season for tree beans is the month of November, the festive

Tree bean plant with flower, pod and ripened seed

season of *Ningol Chakouba*. The leaves are shed mainly in May-June, the flowers appear from mid August and the fresh fruit (pod) start plucking from mid October. Natural regeneration is found to be limited in warm and non shady places. It reproduces and grows well under fairly dense sunshine area. The growth rate is normal and tree lives to some great extent. Artificial regeneration is now a day's very common because seeds do not take time to germinate and growth of seedlings is quite fine. Flying foxes represent a major role in the principal pollination pattern and seed dispersal of tree bean. It is a large tree (up to 25 m height) with spreading branches, generally found in lowland rainforests. Tree bean being a fast-growing leguminous species with multiple uses can be easily propagated through seeds. One- or two-year old seedlings can be transplanted in the field. The leaves are bipinnate with numerous small curved leaflets and flowers in dense turbinate or clavate heads hanging on long peduncles. The fruit comprises bunches of green pods which may be up to 50 cm in length. On maturation, the pods turn black and contain yellow dry powdery pulp in which are embedded several black seeds. The inflorescence head or capitulum arises terminally with clusters of yellowish-white tiny flowers, hanging at the top of long stalks from the branches. The fruits in early stages are soft, tender and bright green in colour. They turn blackish when fully mature in March–April. Pods are formed in clusters of 10–15, each measuring 25–50 cm in length and 3–5 cm in breadth. At the age of 6 years the plant starts its production; however, full bearing stage is only after 10 years. The lifespan of this tree may be 80–90 years or more. During favourable season a full-grown plant bears 10,000–15,000 pods fetching a market value of ₹ 100–150/ kg. Tree bean pods are considered a delicacy in the North-eastern region of India which is consumed either fresh or cleaned and sundried for future use during off seasons.

This tree legume could prove to be an inexpensive and rich nutritious source for human consumption and if properly exploited may be a supplementary source of diet protein. Standardization of its cultivation techniques and augmenting the potential of this 'Wonder Tree' can play an important role to uplift the socio-economic status of the tribal communities too. Besides, harnessing its antioxidant potential along with medicinal properties through scientific insights would provide new paradigms of this multipurpose tree species.

Cluster bean (*Cyamposis tetragonoloba*)

Cluster bean is a drought and high temperature tolerant, deep rooted, annual legume of high social and economic significance. The crop holds great potential like high adaptation towards erratic rainfall, multiple industrial uses, importance in cropping system for factors such as soil enrichment properties, low input requirement, etc. India produces the maximum level of production in the world and contributes to around 80% share in the world's total production. In India it is mainly grown in the dry habitats of Rajasthan, Haryana, Gujarat and Punjab and to a limited extent in Uttar Pradesh and Madhya Pradesh. Rajasthan occupies first position in India both in area and product. The nutrient composition of cluster bean is given in table 2.

In Rajasthan, guar is mainly grown in Barmer, Churu, Sriganganagar, Nagaur, Jalore, Sikar, Jaisalmer, Bikaner, Jaipur, Jhunjhunu and Alwar districts. In Gujarat (Kutch, Banaskantha, Mehsana, Sabarkantha, Vadodara and Ahmedabad), Harayana (Bhiwani, Gurgaon, Mahendragrh and Rewari) and Punjab (Bhatinda, Ferozpur, Muktsar and Mansa). The crop is now being cultivated in dry

Flowering plant of Cluster bean

Table 2. Nutritional composition of green cluster bean pods

Constituent (Per 100 g edible portion)	Content
Energy (Kcal)	16.00
Moisture (g)	81.00
Protein (g)	3.20
Fat (g)	1.4
Carbohydrate(g)	10.8
Vitamin A (IU)	65.3
Thiamine (mg)	0.09
Riboflavin (mg)	0.03
Niacin (mg)	0.60
Ascorbic acid (mg)	49.0
Calcium (mg)	57.0
Phosphorous (mg)	57.0
Iron (mg)	4.5

tracts of Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Karnataka, Tamil Nadu and other parts during *kharif* as well as in summer season. Cluster bean is three-four months crop.

From sowing to harvesting it takes about 90 to 110 days. Crop cycle starts with sowing by first to second week of July. In general flowering stage starts after 40 to 60 days after sowing. The pod formation takes place after 50 to 70 days from the date of sowing. Pod matures in 80 to 90 days of sowing. The harvesting of the crop begins when 90% pods are matured, that is roughly between 90 to 110 days of sowing (depending on the variety, soil and climatic conditions). Cluster bean is a photosensitive crop and requires specific climatic condition to grow. In arid condition cluster bean grows as rainfed crop which requires 300 to 400 mm rainfall in 3 to 4 spells. Cluster bean has the ability to fix nitrogen to the tune of 30-40 kg/ hectare. Several improved varieties of cluster bean have been evolved by Universities and ICAR Institutes in the country. The major research on Cluster bean is being done at ICAR-Indian Institute of Vegetable Research, Varanasi, UP; SKRAU, Bikaner; CAZRI, Jodhpur, Rajasthan and CCSHAU, Hisar, Haryana. Many of the varieties are suitable for cultivation in arid and semi-arid regions. The varieties differ in maturity period, branching habit, quality and quantity of seed yield.

ICAR-IIVR, Varanasi standardized package of practices for early cultivation of cluster bean

To get early crop harvest; four varieties/germplasm namely Pusa Navbahar, Avani-117, Dilojan-3 and RSG 052 of cluster bean were sown on four different dates i.e. on 28th March, 28th April, 28th May and 28th June, 2019 with standard package of practices at ICAR-IIVR, Varanasi. First fruit harvesting was done 55 days after seed sowing. Pod length varies from 9.5-15.5 cm, number of pod per plant varies from 30-65. March 28th, 2019 date of sowing was found best date of sowing to get maximum number of pod per plant and yield per plant followed by 28th June,

Field view of Cluster bean

2019 date of sowing. Hence, early sowing (second fortnight of March) is found to be most suitable date of sowing to get early crop of cluster bean which may fetch high price returns after sell of produce in the market.

Cluster bean varieties for vegetables purposes are - Goma Manjari, Pusa Domausami, Durga Bahar, Pusa Navbahar, Pusa Sadabahar. For fodder- HFG-119, HFG-156, Durgajay, Durgapura Safed, Agaita Guara-111, Agaita Guara-112, FS-277, HG-75, Guara-80, HG-182, Maru guar, HFG-156, Bundel Guar 1, Bundel Guar 2, Bundel Guar 3. The cluster bean seed consists of three parts: the seed coat (14-17%), the endosperm (35-42%), and the germ (43-47%). It is from the endosperm that guar gum is derived, which is the prime marketable product of the plant. This spherical-shaped endosperm contains significant amount of galactomannan gum (19 to 43% of the whole seed), which forms a viscous gel in cold water. The USA is the largest importer of cluster bean and its derivatives from India. The demand of processed cluster bean in world market is expected to increase with the expansion of shale oil gas tracking to new countries like China and Russia and scaling up in prominent existing countries like USA along with other uses in food and textile industries owing to increased food safety and health concerns. This makes it relevant to study the supply response of cluster bean crop particularly when the cultivation of crop is confined to a limited geographical area. The supply response of a crop may be estimated in terms of area, yield and output response. The expansion of uses of cluster bean to new areas like extraction of natural and shale gas has transformed cluster bean in recent years into an important export crop. Increasing demand of cluster bean on account of growth in shale gas

Variability in pods of different genotypes at ICAR-IIVR, Varanasi

Variability in shape and size of cluster bean pods

industry along with other factors has made cluster bean a golden crop. There are number of cluster bean processing units in Jodhpur, Bikaner, Ganganagar, Alwar and Jaipur districts of Rajasthan, Bhiwani and Sirsa districts of Haryana and Ahmadabad district of Gujarat. These units can be grouped into cluster bean split manufacturers and guar gum processors. Though the involvement of processing and high demand in international market have made the marketing and distribution of cluster bean crop very complex, Agriculture Produce Marketing Committee (APMC) markets have an important role to play in the supply chain. The APMC market provides a platform for aggregation and operation for various players operating at the wholesale level like traders, stockist, etc. The trade in these markets is facilitated by commission agents and the traders have to pay prescribed market fee on the value of transaction. At processors level, the splits are packed in plastic bags of 50 kg size while cluster bean powder is packed in paper bags of size 25 kg of powder. There are a few large manufacturers like HICHEM, Dabur, Vikas WSP etc. who produce value added derivative for export as well as domestic market. If crop is grown by adopting all improved package of practices, it is possible to get nearly 7- 8 quintal per hectare seed yield of cluster bean under rainfed condition and 12-15 q/ha in irrigated condition during *kharif* season and 10-12 q/ha during summer season. Average cost of cultivation per hectare occurs about ₹ 28,000-30,000 per for rainfed crop and about ₹ 35,000-40,000 per hectare for irrigated crop. Input: output ratio for cluster bean cultivation is about 1: 1.98.

Harnessing potential and commercial viability of aquatic and minor vegetables: Although aquatic and minor vegetables, both in terms of production and consumption find a place only in local/tribal communities of our country but holds immense potential to contribute towards food security and economic viability. The various parts of the country with swamp lands and shallow ponds have been adjudged to be entirely unsuitable for fish culture or agriculture and the present policy for such areas is to 'drain and develop' them for uses not in accord with their nature. This requires searching innovative techniques that would allow using wetlands sustainably and cultivation of aquatic and minor vegetables is one of the possible ways. However, popularization and proper augmentation of aquatic and minor vegetables on a large scale could make a significant contribution towards nutritional security and economic upliftment of the society. In addition, this is also likely to generate on-farm and off-farm (transportation, storage, processing, marketing etc.) employment. In view of the importance of aquatic and minor vegetables, crop improvement programme has been initiated at ICAR-IIVR, Varanasi, in order to popularize and augment aquatic and minor vegetable production among growers.

SUMMARY

Research is needed to better understand the potential, opportunities and perceived critical bottlenecks faced in their decisions to produce and consume indigenous vegetables to devise effective dissemination and adoption strategies. In order to facilitate effective utilization, it is important to focus on priority indigenous vegetable crops in traditional agricultural areas and development of procedures for assessing the sustainability of their use, tied to focus research to evaluate the potential and ecological requirements. This would facilitate to pave a long way in advancing knowledge and promoting their benefits to reach a larger population. The present compilation is expected to provide sufficient baseline information for further exploration of indigenous vegetables for nutraceuticals purposes as well as for developing new, cheaper, and safe food products. Such scientific insights in these lesser known indigenous food plants would be a significant step towards disease prevention and management through diets.

For further interaction please write to:
Dr Rakesh Kumar Dubey (Senior Scientist), ICAR-Indian Institute of Vegetable Research, Varanasi (UP) and **Dr Vikas Singh** (Senior Scientist), RRS, ICAR-IIVR, Sargatia, Kushinagar (UP). **Drs Jyoti Devi, P M Singh** and **Jagdish Singh,** ICAR-Indian Institute of Vegetable Research, Varanasi (UP). *Email:* rksdubey@gmail.com