Pigeonpea: a potential multipurpose crop

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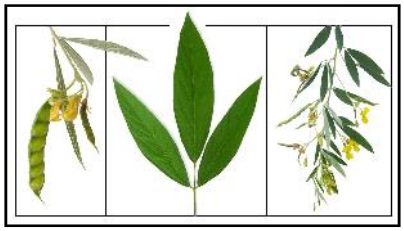
Pigeonpea (*Cajanus cajan* L.) is an annual or short-term perennial shrub that is usually 1–2 metres heigh, but may reach up to 4–5 metres. It is woody at the base and usually erect but with variable growth habit. It has a deep and quick growing tap root and an angular stem with three ribs. The leaves are pubescent trifoliate, the leaflets are oblong lanceolate about 5-10 cm long and 2-4 cm wide. The leaves are arranged alternately in a spiral fashion. The flowers of this plant are usually yellow but they may also be striated with purple streaks or plain red.



The cultivation of the pigeonpea goes back to at least 3,000 years. Its center of origin is India and there is a mention of this crop in Sanskrit and Buddhist literature dating back to 400 BC to 300 AD. From India, it traveled to East Africa subsequently to the American continent presumably via slave trade. Today, pigeonpea is widely cultivated in all tropical and semi-tropical regions of the world. Pigeonpea is an important grain legume crop of rain-fed agriculture in the semi-arid tropics. The Indian subcontinent, eastern Africa and Central America are the world's three main pigeonpea-producing regions. Pigeonpea is cultivated in more than 25 tropical and subtropical countries, either as a sole crop or as an intercrop with cereals and other legumes. Being a legume, pigeonpea enriches soil through nitrogen fixation. Besides this, it also enriches the soil through the addition of other valuable organic matter and micronutrients. It has a special mechanism to release soil bound phosphorus from vertisols by secreting piscidic acid to meet its own as well as that of subsequent crop's phosphorous needs. Pigeonpea has an extensive root system that enables it to tolerate drought and improve soil structure by breaking plough pans.

Pigeonpea is attacked by a range of biotic (diseases and insect pests) and abiotic (drought, salinity and water logging) factors, which are major constraints to the increased productivity of pigeonpea. Resistance to some of these constraints is not present in the cultivated genotypes, but the wild relatives have been found to be resistant. Besides this, wild species have contributed desirable agronomic traits such as cytoplasmic male sterility (CMS), dwarf growth habit and high protein content.

Utilization :

Food : Pigeonpea is a versatile crop grown primarily as a vegetable in the Caribbean and South America and as a multi-use pulse crop in India and some regions of Africa. Vegetable products include immature pods, fresh leaves and seeds that have just reached physiological maturity before the green color is lost. The matured dry seeds are dehulled and split as *dal*, then boiled and eaten as a pulse. Dehulling greatly reduces cooking time and improves the appearance, texture, palatability, digestibility and nutritional quality of the seeds. Pigeonpea is also used in the production of noodles and as flour additive to increase the nutritional value of pasta or baked products without affecting their sensory properties. In China, pigeonpea is mixed with wheat flour to improve the protein level of baked products and noodles. Millet/pigeonpea biscuits are reportedly highly nutritious and they provide a cheaper alternative to wheat imports in Nigeria. Dry seeds of pigeonpea also have other uses, such as in the preparation of *tempe*, a traditional Indonesian food prepared by fermenting the legume seeds with *Rhizopus* and ketchup; snacks, as finger foods and to produce wine.

Animal feed, fodder and forage : Legumes such as pigeonpea, which are widely distributed, have been highly favoured as an alternative to fishmeal in animal feed because they are rich in protein, carbohydrates and minerals. The present high cost of animal sourced protein in feeds makes pigeonpea ideal as a good plant protein substitute as it is less expensive. Equally important is the optimum utilisation of pigeonpea meal in fish production. From reports of grazing trials, it is clear that high levels of animal production are possible from pigeonpea forage for cattle. Pigeonpea produces forage quickly and can be used as a short-lived perennial forage crop. The leaves and young pods can be fed to the animals fresh or they can be harvested and conserved. The dried husks, cracked seeds, leaves and trash of the plant have been found to be palatable to livestock. While the protein content of this material maybe low, the inclusion of trash at rates of up to 500 g/kg of the ration improves overall digestibility and intake of accompanying low quality hays. Under good grazing management, pigeonpea can survive up to five years and with intensive management, forage yields can exceed 50 t/ha/annum.

Fuel wood : Since pigeonpea has strong woody stems that grow up to 4m tall and branch freely, its spindly stalks are

extensively used as a fuel wood in energy short villages of several African countries and in India, Nepal and Sri Lanka. Historically, the stalks were employed to make the charcoal used in gunpowder. Farmers in Africa grow pigeonpea for its wood instead of its grain. Its productivity levels more than make up for the comparatively poor fuel characteristics but the heat value is about ½ that of the same weight of coal. In the *lac* growing areas of China, after harvesting the *lac* resin, pigeonpea plants are chopped and dried for fuel use.

Soil ameliorants : In addition to food uses, pigeonpea has outstanding soil amelioration and conservation properties. For more than 100 years, the legume symbiosis as shown by pigeonpea was known to be the most efficient way of transformin atmospheric nitrogen into plant nutrients. Leaf fall at maturity adds to the organic matter in the soil and provides additional nitrogen. The root system is reported to break plough pans, thus improving soil structure, encouraging infiltration, minimizing sedimentation and smothering weeds. The crop nodulates with wide ranges of *Rhizobium* and consistently fixes 20 to 140 kgs/ha of N in fertile soil.

Pigeonpea produces more nitrogen from plant biomass per unit area of lan than many other legumes. The plant can fix atmospheric nitrogen of about 70 kg/ha per season by symbiosis until the mid-pod-fill stage. Rarely does the plant need to be inoculated because it nodulates on *Rhizobium*, which is naturally present in most soils. Pigeonpea offers the benefits of improving long-term soil quality and fertility when used as green manure, cover crop, or alley crop. The legume also has the ability to reduce the level of root-knot nematodes in the succeeding crop when used as green manure.

Pigeonpea grows well in soils with low phosphorus level. It seems to have special mechanisms to extract phosphorus from black Vertisols. Pigeonpea root exudates have an unusual ability to solubilize iron bound phosphorus, which increases total phosphorus availability in soils with low available phosphorus. Pigeonpea was later shown to exude significant amounts of malonic and oxalic acids along with piscidic acid. Those acids seem to release phosphorus from Iron-Phosphorus and Aluminum-Phosphorus in soils of low phosphorus fertility. The crop is deep-rooted, so their ability to release more phosphates means that valuable nutrients are being brought up from the deeper soil layers. The release of phosphorus benefits not only the crop, but also the subsequent crops grown in the same field.

Folk medicines : Pigeonpea finds wide application in traditional medicine. Diarrhea, gonorrhea, measles, burns, eye infections, earache, sore throat, sore gums, toothache, anemia, intestinal worms, dizziness and epilepsy are treated with leaf preparations. Root preparations are taken to treat cough, stomach problems and syphilis. Cajanol, a novel anticancer agent from Pigeonpea roots, induces apoptosis in human breast cancer cells through a ROS-mediated mitochondrial pathway. Stem ash is applied on wounds, and stalks and roots are chewed against toothache. Powdered seeds serve as a poultice on swellings. In Madagascar, the leaves are used to clean teeth. 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. Leaves are also used for toothache, mouthwash, sore gums, child delivery and dysentery. Scorched seed, added to coffee, are said to alleviate headache and vertigo. In Argentina the leaf decoction is prized for genita and other skin irritations, especially in females. Floral decoctions are used for bronchitis, coughs and pneumonia. Chinese shops sell dried roots as an alexiteric, anthelminthic, expectorant, sedative and vulnerary. Fresh seeds are said to help incontinence of urine in males, while immature fruits are believed to be useful in liver and kidney ailments.

Leaf decoction is diuretic and is used to control nervous breakdown, pulmonary troubles, stomach troubles, naso-

Table : Nutritional composition of pigeonpea for dal, sun-dried seeds and immature seeds

Chemical composition	Dal	Sun dried seeds	Immature seeds
Starch content (%)	57.6	53	48.4
Carbohydrates (%)	66.7	64.2	21.3
Protein (%)	24.6	20.5	21
Fat (%)	1.6	1.9	2.3
Fiber (%)	1.2	6.6	8.2
Calcium	16.3	120.8	94.6
Magnesium	78.9	122	113.7
Iron	2.9	3.9	4.6
Copper	1.3	1.3	1.4
Zinc	3.0	2.3	2.5
Vitamin A	220 IU/100g	28 IU/100g	67 IU/100g

Source: Mula and Saxena, 2004

pharyngeal affections, smallpox, chicken-pox and measles. The roots are used to cure venereal diseases and the seeds as sedatives. Pigeonpea leaves have been used to treat malaria in Nigeria, while in Southern Africa pigeonpea is currently one of the indigenous crops being promoted for potential medicinal use.

The pigeonpea is easily digested and therefore suitable for invalids. While it may have many medicinal properties, excessive use of pigeonpea causes hyper acidity and wind in the intestines. The natural benefits and curative properties derived from this plant includes cure of baldness, jaundice, checking breast milk secretion, inflammation and piles.

In another important development in China, pigeonpea leaves, due to the presence of flavonoids, are considered an excellent traditional Chinese medicine (TCM) for the therapy of ischemic necrosis of femoral head. Flavonoids or bioflavonoids (also collectively known as Vitamin P and citrin) are a class of secondary metabolites. This medicine can make the dead bone cells and vessels regenerate. The Chinese government has given authorization to produce a new Chinese medicine (*Sheng mai Cheng Gu Pian*) for this illness.

Other potential uses : Pigeonpea stems are used in fencing crop fields and livestock and weaving cribs and baskets. The wood is used in light construction such as roofing, thatch, wattling on carts, tubular wickerwork lining for wells, shelter for barns, huts and other crafts from branches and stem. Tall perennial pigeonpea are often used as live fences in homesteads of farmers of Africa and the Caribbean. In Southeast Asia, pigeonpea is grown as a support for vanilla while in China, pigeonpea is also grown along highways, on river banks, mountain slopes, as substrate for mushroom production .

In some experimentation, pigeonpea has been found to produce a pulp for paper similar to that of hardwoods, which might be suitable for making good quality writing and printing material. In addition, the plant has been observed to be a good source for apiculture . The nectar collected by honeybees produce honey that has a distinctive greenish hue in the comb (World Agroforestry Centre). The pigeonpea glue had high plywood bond strength which meet the national standards and it was higher than that of soybean glue (*Glycine max*). The pigeonpea glue processing technology is relatively simpler and economical.

Nutritional quality : The pigeonpea is well balanced nutritionally and an excellent source of protein whether eaten as a green pea or as dried grain. In addition to protein, pigeonpea provides carbohydrates and 5-fold higher levels of Vitamin A and C. Pigeonpea seeds are known to be rich in proteins (generally varying from 18 to 25% and as high as 32%), carbohydrates and minerals. Likewise, the seeds are rich in sulfur-containing amino acids, methionine and cystine. Its abundance in protein makes it an ideal supplement to traditional cereal, banana or tuber-based diets of poor farmers that are generally protein deficient.

Economic potential of pigeonpea: In spite of the great potential of use of pigeonpea as a food crop, improvement in technologies for creating value addition in pigeonpea-based products and innovations in marketing can significantly improve the crop's global economic prospects. Pigeonpea is emerging as an international crop. With the world facing water crisis, its popularity has become more pronounced in the last decade. Current predictions estimate that by the year 2050, at least 1 in every 4 persons is likely to live in a water deficient area. An important challenge facing scientists is to increase food production with less water. The ability of pigeonpea to withstand severe drought better than many legumes is attributed to its deep roots and osmotic adjustment (OA) in the leaves. The legume also maintains photosynthetic function during stress better compared to other drought-tolerant legumes such as cowpea.

Crops that were once considered 'orphan' are now being incorporated into major breeding programs, as they seem to hold the key to the future's food security. The importance of a drought- tolerant legume such as pigeonpea, which combines several desirable traits for addressing climate change without jeopardizing its economics, cannot therefore be left unnoticed.

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