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REVIEW ARTICLE

ORIGIN, DOMESTICATION, TAXONOMY, BOTANICAL DESCRIPTION, GENETICS AND CYTOGENETICS, GENETC DIVERSITY AND BREEDING OF COWPEA (*Vigna unguiculata* L. Walp.)

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ABSTRACT

Cowpeabelongs to the family Fabaceae/Leguminosae (Pea family), genus *Vigna* and the spesies *Vigna unguiculata* (L.) Walp. Cowpea (*Vigna unguiculata* L. Walp.) (2n= 2x = 22) is a member of the Phaseoleae tribe of the Legumi- nosae family. Members of the Phaseoleae include many of the economically important warm season grain and oilseed legumes, such as soybean (*Glycine max*), common bean (*Phaseolus vulgaris*), andmungbean (*Vigna radiata*). The name cowpea probably originated from the fact that the plantwas an important source of hay for cows in the southeastern United States and in other parts of the world. Some important local names for cowpeaaround the world include "niebe," "wake," and "ewa" in much of West Africa and "caupi" in Brazil.In the United States, other names used to describe cowpeas include "southernpeas," "blackeyed peas," "field peas," "pinkeyes," and "crowders." Thesenames reflect traditional seed and market classes that developed over time in the southern United States. The first written reference of the word 'cowpea' appeared in 1798 in the United States.The name was most likely acquired due to their use as a fodder crop for cows. Cowpea is also known as bachapin bean, southern pea, black eyed cowpea, black eyed dolichos, poona pea, black-eyed pea, rope bean, black-eyed bean, red pea, china bean, marble pea, common cowpea, macassar bean, cowgram, cowpea, kafir bean, cultivated african cowpea, crowder bean, field pea, horse bean, yard long bean, asparagus bean and crowder pea. Name in Indian Languages are in Bengali: Ghangra; Hindi: Chauli, Kulath; Kannada: Alasabde, Alasande; Malayalam: Perumpayar; Marathi: Chavali, Alasunda; Sanskrit: Rajamasah, Mahamasah; Tamil: Kaattu Ulundu, Thattapayir; Telugu: Kaaraamanulu, Alasandalu. Black-eyed peas, a common name for a cowpea cultivar, are named due to the presence of a distinctive black spot on their hilum. There are 7 varieties of cowpea which are named as black eye or purple eye peas, brown eye peas, crowder peas, cream, white acre type, clay types and forage cultivars. Cowpea is an important food and fodder legume cultivated in thetropics and sub-tropics covering 65 countries in Asia and Oceania, the Middle East, Southern Europe, Africa, southern USA and Central and South America. In spite of its importance and wide cultivation, the overall productivity of cowpea is very low with average yield particularly in Africa ranging from 100 to 400 kg/ha. This is due to several biotic, abiotic and physiological constraints. Vegetable cowpea popularly known as Yard long bean(*Vigna unguiculata* var. *sesquipedalis*) is an important leguminous vegetable crop of South India.Vegetable cowpea is an important vegetable grown as intercrop in different cropping systems. Vegetable cowpea or Yard long bean is a warm season leguminous crops grown especially for vegetable purpose along the west coast of India. In Goa, pole type varieties are preferred over bushy types as they offer multiple harvests with comparatively longer pods. There is wide variability found for different morphological and other traits in the local types cultivated in the state of Goa. Exploration of genetic variability in the available germplasm is a prerequisite for initiation of any successful breeding program. It is grown all over India, more particularly in the central and Peninsular regions. Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Madhya Pradesh and Rajasthan are the principle states of cowpea cultivation. The major cowpea growing countries are Nigeria, Niger, Burkina Faso, Ghana, Kenya, Uganda, Malawi, Tanzania (all in Africa) and India, Sri Lanka, Burma, Bangladesh, Philippines, Indonesia, Thailand and others. In India, the estimated area is about 50,000 hectares. In this review article on Origin, Domestication, Taxonomy, Botanical Description, Genetics and Cytogenetics, Genetic Diversity, Breeding, Uses, Nutritional Value and Health Benefits of Cowpea are discussed.

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INTRODUCTION

Cowpeabelongs to the family Fabaceae/Leguminosae (Pea family), genus *Vigna* and the spesies *Vigna unguiculata* (L.) Walp. (Vegetables, 2023). The first written reference of the word 'cowpea' appeared in 1798 in the United States. The name was most likely acquired due to their use as a fodder crop for cows. Cowpea is also known as bachapin bean, southern pea, black eyed cowpea, black eyed dolichos, poona pea, black-eyed pea, rope bean, black-eyed bean, red pea, china bean, marble pea, common cowpea, macassar bean, cowgram, cowpea, kafir bean, cultivated african cowpea, crowder bean, field pea, horse bean, yard long bean, asparagus bean and crowder pea (Waqas, 2018; Gayatonde, 2018; Vegetables, 2023; Britannica, 2023; Pallavi, 2023). Name in Indian Languages (Healthbenefits, 2023) are in Bengali: Ghangra; Hindi: Chauli, Kulath; Kannada: Alasabde, Alasande; Malayalam: Perumpayar; Marathi: Chavali, Alasunda; Sanskrit: Rajamasah, Mahamasah; Tamil: Kaattu Ulundu, Thattapayir; Telugu: Kaaraamanulu, Alasandalu. Black-eyed peas, a common name for a cowpea cultivar, are named due to the presence of a distinctive black spot on their hilum. There are 7 varieties of cowpea which are named as blackeye or purple eye peas, browneye peas, crowder peas, cream, white acre type, clay types and forage cultivars (Vegetables, 2023).

Cowpea is an important food and fodder legume cultivated in thetropics and sub-tropics covering 65 countries in Asia and Oceania, the Middle East, Southern Europe, Africa, southern USA and Central and South America. In spite of its importance and wide cultivation, the overall productivity of cowpea is very low with average yield particularly in Africa ranging from 100 to 400 kg/ha. This is due to several biotic, abiotic and physiological constraints (Singh,2015). Cowpea is an important pulse crop of India cultivated in all seasons. The cowpea is a predominately hot weather crop. It is more tolerant to drought, infertile soils. Genes from wild cowpeas or related *Vigna* species may be necessary to develop cultivars for better phenotypic and genotypic characteristics. Cowpea ($2n = 2\times = 22$)] is an important legume crop in the tropics and sub-tropical regions of the world, and it is often the primary source of protein and minerals for low-income populations in such regions. Cowpea is an important food legume crop that provides quality nourishment for both humans and livestock, particularly in sub-Saharan Africa (SSA). The interactive effect of high lysine and tryptophan from cowpea, as well as high cysteine and methionine along with energy from cereals enhances the meal protein quality and nutritional balance of cereal-based diets of both rural and urban population of the region (Singh *et al.,* 2002). Cowpea plant biomass is a source of nutritious fodder for ruminants in the Savanna of West and Central Africa (Boukar *et al.* , 2016). In West and Central Africa, an estimated 200 million people consume cowpea daily (Kormawa *et al*., 2002). Therefore, trading fresh cowpea produce, processed food and snacks provides rural and urban women with opportunity for earning cash income. Cowpea is multipurpose, leguminous, high protein crop in the tropics that provides food for humans and fodder for animals. The crop adds nitrogen and other nutrients to the soil through symbiotic relationship with rhizobia and direct decomposition of cowpea by-products (Singh, 2014). Cowpea is an important legume crop in developing countries, with 80% of production occurring in the dry Savannas of tropical West and Central Africa. Cowpea is one of the most widely adapted; drought-tolerant, versatile, and nutritious grain legumes or pulse crop.

Vegetable cowpea popularly known as Yard long bean (*Vigna unguiculata* var. *sesquipedalis*) is an important leguminous vegetable crop of South India.Vegetable cowpea is an important vegetable grown as intercrop in different cropping systems (Khanpara *et al*., 2016).Vegetable cowpea or Yard long bean is a warm season leguminous crops grown especially for vegetable purpose along the west coast of India. In Goa, pole type varieties are preferred over bushy types as they offer multiple harvests with comparatively longer pods. There is wide variability found for different morphological and other traits in the local types cultivated in the state of Goa. Exploration of genetic variability in the available germplasm is a prerequisite for initiation of any successful breeding program (Thangam *et al*., 2020). Cowpea is of major importance to the livelihoods of millions of relatively poor people in less developed countries of the tropics. From production of this crop, rural families variously derive food, animal feed, and cash, together with spill over benefits to their farmlands through, for example, *in situ* decay of root residues, use of animal manures, and ground cover from cowpea's spreading and low growth habit. In addition, because the grain is widely traded out of the major production areas, it provides a cheap and nutritious food for relatively poor urban communities (Brader, 1957). Cowpea is also known as black eye pea, southern pea, frijole, lubia, feijao caupi, and niébé. One of its distinguishing features is its adaptation to the hot, low-and-erratic rainfall climates of the Sahelian and Sudanian zones in Africa. Historical records of the domesticationof cowpea are sparse, but it may have been domesticated and spread as a crop together with sorghum and pearl millet (Steele, 1976). In parts of East Africa, there is a substantial commercial market for dried leaves, and in the Sahel, cowpea hay sometimes commands very high prices. In addition to protein, cowpea grain is an excellent source of bulk carbohydrate (CHO); indeed, in this regard it is nearly as good as cereals, containing roughly60% CHO by weight, principally starch. Cowpea grain also offers key vitamins including thiamin, riboflavin, ascorbic acid, niacin, and folic acid. It is low in fat, containing about 1% by weight, andit represents a fair source of fiber at about 6%. It is relatively low in sulfur amino acids but highin lysine and other essential amino acids, making it a good complement to the mainly cereal diets.Thanks to the nutrition it offers, cowpea has beenconsidered by the US National Aeronautics and Space Administration as a possible space station crop (Ohler and Mitchell, 1992). There are good reasons for the economic importance of cowpea; one of them being theexcellent nutrition it offers. At different places and times in Africa the grain, the green pods,the dried leaves, and hay all command good market prices. One factor driving demand is the high-quality protein it offers. On average, the grain contains about 23–25% protein by weight. Dried cowpea foliage is likewise protein rich,offering on a dry weight basis levels similar tothe grain (Ohler *et al*., 1996). In many parts of Africa, fresh tender green cowpea leaves picked before flowering are the first part of the cropharvested. These leaves provide needed protein during the period Africans call the" hungry time".

Cowpea is an important legume of the tropics, with its various uses: as grains in processed foods, as a vegetable (fresh leaves, peas, and pods), and as dry haulms and fodder. It is an inexpensive source of vegetable protein, and a hardy crop well adapted to relatively dry environments. In combination or association with cereals and other grain legumes, it contributes to the sustainability of cropping systems in marginal lands of semiarid areas, with its fixation of nitrogen, ground cover, and the soil improvement it provides from plant residues (Singh *et al*., 1997). Legumes provide high-quality protein food for people, protein-rich fodder for livestock, and fixednitrogen for the soil. In Africa, all threeare in shortsupply. And in Africa, where it took its origin as an agricultural crop, cowpea is the most importantlegume, at least in terms of economics (Langyintuo*et al*., 2003). Cowpea provides excellent ground cover and so helps to preserve precious moisture in the semi-arid zones where it thrives. Thanks to its ability to fix nitrogen (Bado *et al*., 2006), it adds substantially to soil fertility as well. The cowpea is an annual herbaceous legume from the genus *Vigna* (Wikipedia, 2023). Its tolerance for sandy soil and low rainfall have made it an important crop in thesemiarid regions across Africa and Asia. It requires very few inputs, as the plant's root nodules are able to fix atmospheric nitrogen, making it a valuable crop for resource poor farmers and well suited to intercropping with other crops. The whole plant is used as forage for animals, with its use as cattle feed likely responsible for its name. (Wikipedia, 2023). Cowpeas thrive in poor dry conditions, growing well in soils up to 85% sand. This makes them a particularly important crop in arid, semi-desert regions wherenot many other crops will grow. As well as an important source of food for humans in poor, arid regions, the crop can also be used as feed for livestock. Its nitrogen-fixing ability means that as well as functioning as a sole crop, the cowpea can be effectively intercropped with sorghum, millet, maize, cassava, or cotton (Wikipedia, 2023). Cowpea is the most important grain legume in the third world, particularly Africa. It is grown all over India, more particularly in the central and Peninsular regions. Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Madhya Pradesh and Rajasthan are the principle states of cowpea cultivation (Pallavi, 2023). The major cowpea growing countries are Nigeria, Niger, Burkina Faso, Ghana, Kenya, Uganda, Malawi, Tanzania (all in Africa) and India, Sri Lanka, Burma, Bangladesh, Philippines, Indonesia, Thailand, etc. In India, the estimated area is about 50,000 hectares (Vidhi, 2023).

Cowpea is today grown throughout the world,with the most intense production in the Northern Savannahs of sub-Saharan Africa, with Nigeria and Niger the leading producers. According to Langyintuo *et al.* (2003), some 10 million hectaresare under cowpea cultivation worldwide, with thesub-Saharan Africa cowpea belt producing about two-thirds ofthe annual world yield. Total annualgrain production is about 3.7 million tons. The second largest production area after Africa is Brazil, where the crop is well suited to the relativelylow rainfall and poor soils in the northeastern part of the country. Cowpea is also grown in marginal areas of eastern and southern Africa, especially in Sudan, Somalia, Mozambique, Botswana, and southern Zimbabwe. Cowpea is mostly grown as an intercrop with cereals, but little of that harvestreaches regional markets. The most important export market for cowpea in West Africa is Nigeria, simultaneously the world's largest cowpeaconsumer as well as producer. There is significantcowpea production in the Mediterranean, South Asia, and in the southern and southwestern UnitedStates.

ORIGIN AND DOMESTICATION

The precise location of the center of origin of a species is rather difficult to determine. Previous speculation on the origin and domestication of cowpea had been based on botanical and cytological evidence, information on its geographical distribution and cultural practices, and historical records (Faris 1965; Steel and Mehra 1980; Ng and Marechal 1985; Ng 1995). De Candolle (1886) thought that the origin of a cultivated plant could be found where it grows wild. This procedure of locating the place of origin of a crop is correct to a certain degree, but too often it produces erroneous interpretation. The wild plant may have been common in one area but domestication may have taken place in another, such as in the case of African cottons and the Peruvian tomato (Hawkes 1967). A detailed study of the variation of a crop, both morphological and genetical, in relation to the geographical distribution of such variation could help in speculating on the origin of cultivated plants. Vavilov (1926) postulated that an area with intensive variation was one where the crop must have been cultivated for a long time, since in that area there would have been time for large numbers of mutations and gene recombinations to take place, as a result of interbreeding among different varieties. It is generally observed that a very large number of varieties or high variation of the species is found towards the center of the distribution area of the crop, and this is accompanied by a corresponding thinning out of the variability towards the periphery.

The range of variation and number of varieties found in wild cowpea, as well as their primitive characteristics, such as perenniality, hairiness, small size of the pods and seeds, pod shattering, with pronounced exine on the surface of pollen, outbreeding, and bearded stigma, the highest genetic diversity and most primitive of the wild *V. unguiculata* occur in southern Africa in the region encompassing Namibia from the west, across Botswana, Zambia, Zimbabwe, and Mozambique to the east, and the Republic of South Africa and Swaziland to the south. Probably, the Transvaal region (The name "Transvaal" refers to the province's geographical location to the north of the Vaal River. Its capital was Pretoria, which was also the country's executive capital.) of the Republic of South Africa was the center of speciation of *V. unguiculata,* due to the presence of most primitive wild varieties, var. *rhomboidea,* var. *protracta,* var. *tenuis,* and var. *stenophylla.* Variety *rhomboidea* has a very narrow geographical distribution in the Transvaal, stretching approximately from 20 to 27 °S and 26 to 32 °E, with an isolated occurrence in Cape Town. It is found growing in the mid-altitude region. It is very commonly found in Swaziland, especially in the northwest region of the Highveld (Padulosi *et al.,* 1990). This taxon shows a relatively high degree of variability among populations found in the region. It overlaps in geographic distribution with var. *protracta,* while the latter taxon has a wider range of geographical distribution stretching from Republic of South Africa and Swaziland to Mozambique and Zimbabwe (Padulosi *et al.,* 1991). The var. *protracta* thrives well in a range of geographical regions and in a wide range of altitudes (from sea level up to 1800 masl). This might suggest that var. *rhomboidea* represents a sort of relic species, which has undergone a speciation process of its own, or it could well be the ancestral form of other varieties of the species *V. unguiculata.* There exists a strong genetic barrier for gene flow between var. *rhomboidea* and other taxa, and it was pointed out earlier that this taxon may well be a distinct species.

Continuing on our speculation on the possible evolution of *V. unguiculata,* we further hypothesize that from the Transvaal, the species moved northward to Mozambique and Tanzania where it evolved into subspecies *pubescens.* The two glabrous subspecies, *tenuis* and *stenophylla,* have high morphological similarities, and they share some similar ecogeographical distribution from South Africa to Zimbabwe and Mozambique. The taxa are found in woodland and savanna ecologies, on sandy soils. Genetically, they are probably closer to one another than to other wild taxa. They probably evolved in the Natal Transvaal region of South Africa, from where they radiated outwards to the coastal regions in South Africa and Mozambique, and to the west in Namibia and Angola. Variety *congolensis* closely resembles ssp. *tenuis* and it also shows some similar characteristics with ssp. *stenophylla.* It is a perennial plant with a tuberous root. It is found in the Congo Basin. This suggests that a process of natural selection must have taken place in the Zairean and Congo region, operating on materials naturally distributed there in the early history of the evolution of *V. unguiculata.* Variety *huillensis,* var. *dekindtiana,* var. *ciliolata,* and var. *grandiflora* of the subspecies *dekindtiana* represent the latest varieties in the evolutionary line of *V. unguiculata.* Var. *huillensis* is found in the savanna ecology in Angola and Zambia, and in woodland/savanna regions across Namibia and Miombo vegetation in South Africa. It was found at different altitudes, but with a higher frequency in the mid-altitude region. It is quite similar to var. *dekindtiana,* but it has a perennial growth habit, with a thick woody/tuberous root system. This is a pyrophytic species. It may represent the most primitive variety among the subspecies *dekindtiana.* Variety *ciliolata* is found in the forest ecologies in Burundi, Malawi, Zambia, Zimbabwe, southwestern Cape Flora in South Africa, and in the eastern Kivu region in Zaire. It is found growing in places of a medium to high altitude (600-1800 masl). Except for its long calyx tubes, it resembles var. *dekindtiana.* Variety *grandiflora* is occasionally found in parts of East and West Africa. Except for its large flower size, var. *grandiflora* resembles var. *dekindtiana* and var. *ciliolata.* Taxa within the subspecies *dekindtiana are* closely related. Variety *dekindtiana* is a pantropical variety, which is distributed throughout Africa, south of the Sahara, including Madagascar. This taxon has a wide range of morphological variation and ecological tolerance. It has the largest seeds, while the smallest seeds are those of subspecies *pubescens,* subspecies *tenuis* and subspecies *stenophylla.* Variety *dekindtiana* is believed to be the probable progenitor of the cultivated cowpea (Rawal 1975; Lush 1979; Steele and Mehra 1980; Ng and Marechal 1985). However, it is not certain to what extent the other wild varieties or subspecies of *V unguiculata* have contributed to the origin and diversity of cowpea.

Ng (1995) postulated that during the process of evolution of *V. unguiculata,* there was a change of growth habit, from perennial to annual breeding and from predominantly outbreeding to inbreeding, while cultivated cowpea (subsp. *unguiculata)* evolved through domestication and selection of the annual wild cowpea (var. *dekindtiana).* During the process of domestication and after the species was brought under cultivation through selection, there was a loss in seed dormancy and pod dehiscence, corresponding with an increase in seed and pod size. The precise location or region where cowpea was first domesticated is still under speculation. The wide geographical distribution of var. *dekindtiana* throughout sub-Saharan Africa suggests that the species could have been brought under cultivation in any part of the region. However, the center of maximum diversity of cultivated cowpea is found in West Africa, in an area encompassing the savanna region of Nigeria, southern Niger, part of Burkina Faso, northern Benin, Togo, and the northwestern part of Cameroon (Ng and Marechal 1985; Ng 1995). In this region, many weedy forms of var. *dekindtiana,* intermediate between truly wild forms and those very small-seeded cultivated cowpeas are found (Rawal 1975). Carbon dating of cowpea (or wild cowpea) remains from the Kimtampo rock shelter in central Ghana has been carried out (Flight 1976), and this is the oldest archaeological evidence of cowpea found in Africa. This shows the existence of gathering (if not cultivation) of cowpea by African hunters or food gatherers as early as c. 1500 BC.

Ng (1995) postulated that cowpea cultigroup Unguiculata was, in the first place, domesticated in West Africa through this process of selection c. 2000 BC. Later, the selection for types with very long peduncles for fiber resulted in the cultigroup Textillis (Ng and Marechal 1985). The crop was brought to Europe probably through northeastern Africa around 300 BC and to India about 200 BC. The cowpea underwent further diversification in India and Southeast Asia, producing the cultigroup Sesquipedalis with its long pods used as a vegetable and the cultigroup Biflora for its grain (Steele and Mehra 1980). The crop was introduced from Africa to the tropical Americas in the 17th century by the Spanish in the course of the slave trade. It has been grown in southern USA since the early 18th century. Southernmost region of Africa is most probably the center of origin for the species *V unguiculata,* while its domestication might have taken place in West Africa (Padulosil and Ng, 1997). Cowpea plays a critical role in the lives of mil- lions of people in Africa and other parts of the de- veloping world, where it is a major source of diet- ary protein that nutritionally complements staple low-protein cereal and tuber crops, and is a valu- able and dependable commodity that produces in- come for farmers and traders (Singh, 2002; Langyintuo *et al.,* 2003). Cowpea is a valuable component of farming systems in many areas because of its ability to restore soil fertility for succeeding cereal crops grown in rotation with it (Carsky *et al.,* 2002; Tarawali *et al.,* 2002; Sanginga *et al.,* 2003). Early maturing cowpea varieties can provide the first food from the current harvest sooner than any other crop (in as few as 55 d after planting), therebyshortening the "hungry period" that often occurs just prior to harvest of the current season's crop in farming communities in the developing world.

Dry grain for human consumption is the most important product of the cowpea plant, but fresh or dried leaves (in many parts of Asia and Africa) (Nielsen *et al.,* 1997; Ahenkora *et al.,* 1998), fresh peas (the southeastern USA and Senegal), and freshgreen pods (humid regions of Asia and in the Caribbean) may be the most important in some local situations. Cowpea hay plays a particularly critical role in feeding animals during the dry season in many parts of West Africa (Singh and Tarawali 1997; Tarawali et al. 1997, 2002). Cowpea has considerable adaptation to high temperatures and drought compared to other crop species (Hall *et al.,* 2002; Hall 2004). As much as 1000 kg ha^{-1} of dry grain has been produced in a Sahelian environment with only 181 mm of rainfall and high evaporative demand (Hall and Patel 1985). Presently available cultivars of other crop species cannot produce significant quantities of grain under these conditions. The crop is more tolerant of low fertility, due to its high rates of nitrogen fixation (Elawad and Hall 1987), effective symbiosis with mycorrhizae (Kwapata and Hall 1985), and ability to better tolerate soils over a wide rangeof pH when compared to other popular grain legumes (Fery 1990). Dry grain yields above 7000 kg ha^{-1} have been achieved in large field plots with guard rows in the southern San Joaquin Valley of California (Sanden 1993), where growers often obtain yields above 4000 kg ha^{-1}. Clearly, cowpea is both responsive to favorable growing conditionsand capable of growing under drought, heat, and other abiotic stresses.

Cowpea most certainly evolved in Africa, as wild cowpeas only exist in Africa and Madagascar (Steele 1976). Interestingly, while West Africa ap- pears to be the major center of diversity of cultivated forms of cowpea (Ng and Padulosi 1988) andwas probably domesticated by farmers in this region (Ba *et al.,* 2004), the center of diversity of wild *Vigna* species is southeastern Africa (Padulosi and Ng 1997). Some evidence that domestication oc- curred in northeastern Africa, based on studies of amplified fragment length polymorphism (AFLP) analysis, has also been presented (Coulibaly *et al.,* 2002). The wild cowpea *Vigna unguiculata* ssp. *unguiculata* var. *spontanea* is the likely progenitor of cultivated cowpea (Pasquet, 1999). It is likely that the crop was first introduced to India during the Neolithic period, and therefore India appears to be a secondary center of genetic diversity (Pant *et al*., 1982). "Yard long beans," a unique cultivar group (*Sesquipedialis*) of cowpea that produces very long pods widely consumed in Asia as a fresh green or "snap" bean, apparently evolved in Asia and is rare in African landrace germplasm. Cowpea has been cultivated in south-ern Europe at least since the 8th century BC andperhaps since prehistoric times (Tosti and Negri, 2002). Cowpea was introduced to the West Indies in the 16th century by the Spanish and was taken to the USA about 1700 (Pursglove, 1968). Presum- ably it was introduced into South America at about the same time.

Cowpea was domesticated in Africa, presumably in the northeastern part of the continent in present-day Ethiopia. The progenitor of the modern cultivated *V. u. unguiculata* is probably the wild annual form, *V. unguiculata* var. *spontanea*. In support of the idea that the crop originated in northeastern Africa, Steele (1976) noted that the variability of the wild relative *V. unguiculata* spp.*dekindtiana*—which has also been considered asa possible progenitor of cultivated cowpea—is greater in that part of Africa than in West Africa. Pasquet and Baudoin (2001) likewise support a Horn of Africa origin based on ethnobotanical, linguistic, as well as phyto-geographical considerations. Still, some scientists have consideredWest Africa a possible site oforigin because of the high variability of *V. u. dekindtiana* inthis region (Faris, 1965). Lack of archeological records for cowpea cultivation hinders efforts to establish its site of origin unequivocally. Like its New World relative, common bean, cowpea may prove to have two or more sites of origin. The current consensus seems to be that domesticated cowpea originated in the northeastern region of sub-Saharan Africa (cf. Smartt, 1985) and spread westward and southward fromthere. This Horn ofAfrica origin is also supported by recent studies using molecular markers (Ba *et al.*, 2004). If cowpea domestication occurred before 1500 BC in Harlan's African non-center, a precise center of domestication is yet to be identified (Pasquet and Padulosi, 2010).

Cowpea is one of the most versatile and resilient food legumes among the cultivated crop plants. A native of southern African regions, cowpea has spread far and wide and has become deeply entrenched in the local cropping and food systems of more than 100 countries in the tropics and subtropics, covering all the continents. There has been considerable discussion and speculation about the center of origin and domestication of cowpea. Based on the parallel presence of diverse and morphologically different types of cowpeas in the Indian subcontinent, as well as in Africa, it was initially speculated that both India and Africa may be independent centers of origin and domestication of cowpea. In view of the distribution of diverse cowpeas, southeastern Africa is considered to be the primary center of diversity, with west-central Africa the secondary center of diversity, and the Indian subcontinent as the third center of diversity (Singh, 2014). The primary centre of origin of cowpea is Africa, the secondary centre of origin is India and China and the places of domestication are Ehiopia, Central, South, and West Africa (Waqas, 2018; Gayatonde, 2018). Cowpea was originally domesticated in sub-Saharan Africa but is now cultivated on every continent except Antarctica. Utilizing archeological, textual, and genetic resources, the spread of cultivated cowpea has been reconstructed. Cowpea was domesticated in Africa, likely in both West and East Africa, before 2500 BCE and by 400 BCE was long established in all the modern major production regions of the Old World, including sub-Saharan Africa, the Mediterranean Basin, India, and Southeast Asia. Further spread occurred as part of the Columbian Exchange, which brought African germplasm to the Caribbean, the southeastern United States, and South America and Mediterranean germplasm to Cuba, the southwestern United States, and Northwest Mexico (Herniter *et al.,* 2020).

Cowpeas were domesticated in Africa and are one of the oldest crops to be farmed. A second domestication event probably occurred in Asia, before they spread into Europe and the Americas (Wikipedia, 2023). Compared to most other important crops, little is known about the domestication, dispersal, and cultivation history of the cowpea. Although there is no archaeological evidence for early cowpea cultivation, the centre of diversity of the cultivated cowpea is West Africa, leading an early consensus that this is the likely centre of origin and place of early domestication. New research using molecular markers has suggested that domestication may have instead occurred in East Africa and currently both theories carry equal weight. While the date of cultivation began may be uncertain, it is still considered one of the oldest domesticated crops. Remains of charred cowpeas from rock shelters in Central Ghana have been dated to the 2nd millennium BC. In 2300 BC, the cowpea is believed to have made its way into Southeast Asia, where secondary domestication events may have occurred. From there they travelled north to the Mediterranean, where they were used by the Greeks and Romans. The first written references to the cowpea were in 300 BC and they probably reached Central and North America during the slave trade through the 17th to early 19th centuries **(**Fig. 1**)** (Wikipedia, 2023).

Fig. 1: The cowpea was believed to have originated in West Africa

The plants are thought to be native to West Africa and are widely cultivated in warm regions around the world (Britannica, 2023). Cowpea might have originated in central Africa or India. Its domestication dates back to 4000 years. It has spread from subsaharian Africa to Middle East and Europe but reached Americas in sixteenth century during the great slave trade. It is now cultivated throughout subsaharian Africa, southeast Asia, Latin America, Australia and USA (Pallavi, 2023). All the evidences indicate that cowpea originated in Africa. The exact place of domestication is uncertain. Ethiopia, Central Africa, Central and South Africa and West Africa, all have been considered as probable centers of domestication. In India, cowpea is known since Vedic times. West Africa and India both are modern centers of diversity for this crop. However, it is generally agreed that the cowpea is of African origin as conspecific wild forms are found in Africa but are absent in Asia (Vidhi, 2023). Cowpea is native of Africa and widely grown in Africa, Southeast Asia, southern United States and Latin America. The cowpea was introduced into India and Europe around 200 BC and 300 BC respectively (Healthbenefits, 2023). It was found in Africa but nowadays it is also cultivated in Southeast Asia, Africa, Southern United States and Latin America. Around 200 BC and 300 BC, it was introduced to India and Europe respectively (Vegetables, 2023).

TAXONOMY

Vigna is a genus of plants in the legume family, Fabaceae, with a pantropical distribution. It includes some well-known cultivated species, including many types of beans. Some are former members of the genus *Phaseolus*. According to *Hortus Third*, *Vigna* differs from *Phaseolus* in biochemistry and pollen structure, and in details of the style and stipules. *Vigna* is also commonly confused with the genus *Dolichos*, but the two differ in stigma structure. *Vigna* are herbs or ccasionally subshrubs. The leaves are pinnate, divided into 3 leaflets. The inflorescence is a raceme of yellow, blue, or purple pea flowers. The fruit is a legume pod of varying shape containing seeds. Familiar food species include the adzuki bean (*V. angularis*), the black gram (*V. mungo*), the cowpea (*V. unguiculata*, including the variety known as the black-eyed pea), and the mung bean (*V. radiata*). Each of these may be used as a whole bean, a bean paste, or as bean sprouts. The genus is named after Domenico Vigna, a seventeenth century Italian botanist and director of the Orto botanico di Pisa. The genus *Vigna* contains at least 90 species,including (Wikipedia, 2023).

Subgenus *Ceratotropis*

- *Vigna aconitifolia* (Jacq.) Maréchal—moth bean, mat bean, Turkish gram
- *Vigna angularis* (Willd.) Ohwi & H. Ohashi—adzuki bean, red bean
  - *Vigna angularis* var. *angularis* (Willd.) Ohwi & H. Ohashi
  - *Vigna angularis* var. *nipponensis* (Ohwi) Ohwi & H. Ohashi
- *Vigna glabrescens* Maréchal *et al*.
- *Vigna grandiflora* (Prain) Tateishi & Maxted
- *Vigna hirtella* Ridley
- *Vigna minima* (Roxb.) Ohwi & H. Ohashi
- *Vigna mungo* (L.) Hepper—black gram, black lentil, white lentil, urd-bean, urad bean
  - *Vigna mungo* var. *silvestris* Lukoki, Maréchal & Otoul
- *Vigna nakashimae* (Ohwi) Ohwi & H. Ohashi
- *Vigna nepalensis* Tateishi & Maxted
- *Vigna radiata* (L.) Wilczek—mung bean, green gram, golden gram, mash bean, green soy, celera-bean, Jerusalem-pea
  - *Vigna radiata* var. *radiata* (L.) Wilczek
  - *Vigna radiata* var. *sublobata* (Roxb.) Verdc.
- *Vigna reflexopilosa* Hayata—Creole-bean
  - *Vigna reflexopilosa* var. *reflexopilosa* Hayata
  - *Vigna reflexopilosa* var. *glabra* Tomooka & Maxted
- *Vigna riukiuensis* (Ohwi) Ohwi & H. Ohashi
- *Vigna stipulacea* Kuntze
- *Vigna subramaniana* (Babu ex Raizada) M. Sharma
- *Vigna tenuicaulis* N. Tomooka & Maxted
- *Vigna trilobata* (L.) Verdc.—jungle mat bean, jungli-bean, African gram, three-lobe-leaved cowpea
- *Vigna trinervia* (Heyne ex Wall.) Tateishi & Maxted
- *Vigna umbellata* (Thunb.) Ohwi & H. Ohashi—ricebean, red bean, climbing mountain-bean, mambi bean, Oriental-bean

Subgenus *Haydonia*

- *Vigna monophylla* Taub.
- *Vigna nigritia* Hook. f.
- *Vigna schimperi* Baker
- *Vigna triphylla* (R. Wilczek) Verdc.

Subgenus *Lasiospron*

- *Vigna diffusa* (Scott-Elliot) A. Delgado & Verdc.
- *Vigna juruana* (Harms) Verdc.
- *Vigna lasiocarpa* (Mart. ex Benth.) Verdc.
- *Vigna longifolia* (Benth.) Verdc.
- *Vigna schottii* (Bentham) A. Delgado & Verdc.
- *Vigna trichocarpa* (C. Wright ex Sauvalle) A. Delgado
- *Vigna vexillata* (L.) A. Rich.—zombi pea, wild cowpea
  - *Vigna vexillata var. angustifolia*
  - *Vigna vexillata* var. *youngiana*

Subgenus *Vigna*

- *Vigna ambacensis* Welw. ex Bak.
- *Vigna angivensis* Baker
- *Vigna filicaulis* Hepper
- *Vigna friesiorum* Harms
- *Vigna gazensis* Baker f.
- *Vigna hosei* (Craib) Backer—Sarowak/sarawak bean
- *Vigna luteola* (Jacq.) Benth.—Dalrymple vigna
- *Vigna membranacea* A. Rich.
  - *Vigna membranacea* subsp. *caesia* (Chiov.) Verdc.
  - *Vigna membranacea* subsp. *membranacea* A. Rich.
- *Vigna monantha* Thulin
- *Vigna racemosa* (G. Don) Hutch. & Dalziel
- *Vigna subterranea* (L.) Verdc.—Bambara groundnut, Congo goober, hog-peanut, jugo bean, *njugumawe* (Swahili) (sometimes separated in *Voandzeia*)
- *Vigna unguiculata* (L.) Walp.—cowpea, crowder pea, Southern pea, Reeve's-pea, snake-bean
  - *Vigna unguiculata* subsp. *cylindrica*—catjang
  - *Vigna unguiculata* subsp. *dekindtiana*—wild cowpea, African cowpea, Ethiopian cowpea
  - *Vigna unguiculata* subsp. *sesquipedalis*—yardlong bean, long-podded cowpea, asparagus bean, Chinese long bean, pea-bean
  - *Vigna unguiculata* subsp. *unguiculata*—black-eyed pea, black-eyed bean

Genus Vigna

Vigna is a genus of flowering plants in the legume family, Fabaceae, subfamily: Faboideae, tribe: Phaseoleae, subtribe: Phaseolinae, with a pantropical distribution. It includes some well-known cultivated species, including many types of beans. Vigna are herbs or occasionally subshrubs. The leaves are pinnate, divided into 3 leaflets. The inflorescence is a raceme of yellow, blue, or purple pea flowers. The fruit is a legume pod of varying shape containing seeds. Familiar food species include the adzuki bean (Vigna angularis), the black gram (Vigna mungo), the cowpea (Vigna unguiculata), and the mung bean (Vigna radiata), which is used as a whole bean, a bean paste, or as bean sprouts. The genus is named after Domenico Vigna, a seventeenth-century Italian botanist and director of the Orto botanico di Pisa (Hai, 2015).

The genus Vigna has 5 subgenera (Hai, 2015)

1.Subgenus **Ceratotropis** [18 species]
2. Subgenus **Haydonia** [4 species]
3. Subgenus **Lasiospron** [7 species
4. Subgenus **Vigna** [12 species]
5. Subgnus **Incertae Sedis** [19 species]

Taxonomy of the Subgenus Vigna **[12 species**] (Hai, 2015)

1- Vigna ambacensis Welw. ex Bak.
2- Vigna angivensis Baker
3- Vigna filicaulis Hepper
4- Vigna friesiorum Harms
5- Vigna gazensis Baker f.
6- Vigna hosei (Craib) Backer - Sarawak-bean
7- Vigna luteola (Jacq.) Benth. - Dalrymple vigna
8- Vigna membranacea A. Rich.
- Vigna membranacea subsp. caesia (Chiov.) Verdc.
- Vigna membranacea subsp. membranacea A. Rich.

9- Vigna monantha Thulin
10- Vigna racemosa (G. Don) Hutch. & Dalziel
11- Vigna subterranea (L.)Verdc. - Bambara groundnut, Congo goober, hog-peanut, jugo bean, njugumawe (Swahili) (sometimes separated in Voandzeia
12- Vigna unguiculata (L.) Walp. - cowpea, crowder pea, Southern pea, Reeve's-pea, snake-bean
- Vigna unguiculata ssp. Cylindrica - catjang
- Vigna unguiculata ssp. Dekindtiana -wild cowpea, African cowpea,
- Ethiopian cowpea
- Vigna unguiculata ssp. Sesquipedalis - yardlong bean, long-podded
- Cowpea, asparagus bean, Chinese long bean, pea-bean.
- Vigna unguiculata ssp. Unguiculata - black-eyed pea, black-eyed bean

Important Species of Cowpea (Hai, 2015)**ś**

- Vigna unguiculata (L.)Walp. - cowpea, crowder pea, Southern pea, Reeve's-pea, snake-bean
- Vigna unguiculata ssp. Cylindrica - catjang
- Vigna unguiculata ssp. Dekindtiana -wild cowpea, African cowpea, Ethiopian cowpea
- Vigna unguiculata ssp. Sesquipedalis - yardlong bean, long-podded cowpea, asparagus bean, Chinese long bean, pea-bean.
- Vigna unguiculata ssp. Unguiculata - black-eyed pea, black-eyed bean

Cowpea is a *Dycotyledonea* belonging to the order *Fabales*, family *Fabaceae*, subfamily *Faboideae*, tribe *Phaseoleae*, subtribe *Phaseolinae*, genus *Vigna*, and section *Catiang* (Verdcourt 1970; Marechal et al., 1978). Vigna is a pantropical genus with several species, whose exact number varies according to authors: 184 (Phillips 1951), 170 (Faris 1965), between 170 and 150 (Summerfield and Roberts 1985), 150 (Verdcourt 1970), 154 (Steele 1976), and about 84 (of which some 50 species are indigenous to Africa) (Marechal et al., 1978). In their revision of the genus *Vigna*, Marechal et al.,(1978) subdivided the genus described earlier by Verdcourt (1970) into seven subgenera. In this classification, V. *unguiculata* (L.) Walpers and V. nervosa Markotter constitute the section *Catiang*, one of the six sections of the subgenus *Vigna*. Species of the section *Catiang* are characterized by spurred stipules below the attachment point of the leaf stalks and canoe-shaped keel with beak. The surface of their pollen grains are reticulate with raised exine (De Leonardis et al.,1993).

Interspecific crosses made between the two species have not been successful (Mithen 1987; Ng and Apeji 1988; Ng 1995). On the basis of a study on isoenzyme variation in the genera *Phaseolus* and *Vigna,* Jaaska and Jaaska (1988) proposed to raise the section *Catiang* to the rank of a subgenus. All cultivated cowpeas are grouped under *V. unguiculata* subspecies *unguiculata,* which is subdivided into four cultigroups, namely Unguiculata, Biflora, Sesquipedalis, and Textilis (Westphal 1974; Marechal et al. 1978; Ng and Marechal 1985). The classification and nomenclature of the wild taxa within *V. unguiculata,* however, is complicated, and could sometimes be confusing. More than 20 epithet names have been used in the past to designate wild taxa within *V. unguiculata* species complex. An extensive work on characterization of over 400 wild *V.unguiculata* accessions was conducted at International Institute of Tropical Agriculture (IITA) (Ng and Padulosi 1991; Padulosi 1993).

Table 1. Classification and nomenclature of the wild Vigna unguiculata species complex

Maréchal et al. (1978)	Pienaar (1992)	Pasquet (1993a)	Padulosi (1993)
V. unguiculata	*V. unguiculata*	*V. unguiculata* ssp. *unguiculata* var. *spontanea*	*V. unguiculata*
ssp. *dekindtiana* var. *dekindtiana*	ssp. *dekindtiana* var. *dekindtiana* var. *huliensis*	ssp. *dekindtiana* var. *dekindtiana*	ssp. *dekindtiana* var. *dekindtiana* var. *huliensis* var. *congolensis* var. *grandiflora*
var. *mensensis*	ssp. *mensensis*	ssp. *letouzeyi* ssp. *burundiensis* ssp. *baoulensis*	var. *ciliolata*
var. *protracta*	ssp. *protracta*	ssp. *stenophylla*	ssp. *protracta* var. *protracta* var. *kgalagadiensis* var. *rhomboidea*
var. *pubescens*	ssp. *protracta*	ssp. *pubescens*	ssp. *pubescens*
ssp. *stenophylla* ssp. *tenuis*	ssp. *stenophylla* ssp. *tenuis* var. *tenuis* var. *ovata*	ssp. *stenophylla* ssp. *tenuis*	ssp. *stenophylla* ssp. *tenuis* var. *tenuis* var. *oblonga* var. *parviflora*

For clarity, the synonyms of the various wild *V. unguiculata* species and their classification system proposed by different researchers are presented in **Table 1.**

In this discussion, the nomenclature and classification system proposed by Padulosi (1993) was usesd. In this classification system, the three subspecies *dekindtiana, tenuis,* and *stenophylla* as recognized by Marechal *et al*. (1978) were retained, but var. *protracta* and var. *pubescens* were raised to the level of two distinct subspecies, because of their very distinctive hairy characteristics in pods and other plant parts, morphology of their flowers, pollen, grains, and leaves, as well as their root systems. Within subspecies *protracta,* three varieties, namely var. *protracta,* var. *rhomboidea,* and var. *kgalagadiensis,* were distinguished. Similarly, three varieties *tenuis, oblonga,* and *parviflora* were recognized within the subspecies *tenuis,* while four new varieties, namely var. *huillensis*, var. *congolensis*, var. *ciliolata*, and var. *grandiflora*, have also been proposed and added to the subspecies *dekindtiana.* Most nomenclature problems in the cultivated cowpeas and related wild species have been resolved to great extent. Experts agree that cowpeas belong to the botanical species *Vigna unguiculata* (L.) Walp. There are more than 20 synonyms for *V.unguiculata*. There are three cultivated (*unguiculata, cylindrica* and *sesquipedalis*) and two wild sub-species (*dekindtiana* and *mensensis*) of cowpea. Some authors do not consider the three cultivated subspecies as distinct and group them under one subspecies *V. unguiculata* subsp unguiculata and differentiate them by the intraspecific category/cultigroup. The subspecies *unguiculata, cylindrica* and *sesquipedalis* are renamed by Marechal and his colleagues as cultigroups *Unguiculata, Biflora and Sesquipedalis*, respectively (Vidhi, 2023). Cultigroup *Unguiculata* is the most diverse of the cultivated subspecies unguiculata and has the widest distribution. It is commonly called cowpea and is grown in Africa, India and Brazil. These are prostrate, semi-erect, erect or climbing. Pods are coiled, round, crescent or linear. Pods are 20-30 cm long and small seeded. *Biflora* is commonly called catjang bean and is used as dry seeds and fodder. It is frequently prostrate and sometimes climbing. Pods are usually smaller (7-13 cm) and are held upright on the raceme axis. Pods are more or less erect. Seeds are small and kidney shaped (5-6 mm long). *Sesquipedalis* is known as yard-long or asparagus bean. Its pods and sometimes leaves also are used as vegetable. It is mostly climbing. Flowers are larger. Plants are trailing or climbing. Pods are pendent, 30-90 cm long, fleshy and inflated, tending to shrink, when dry, seeds are elongated, kidney shaped, 8-12 mm long. Such cultivars are found in Indonesia, Philippines, Sri Lanka and are also grown in India.

Scientific classification Cowpea (*Vigna unguiculata*) is that it belongs to the Family Fabaceae, Subfamily Faboideae, Tribe Phaseolinae, Genus *Vigna* and Subgenus *Vigna.* There are five Subgenera, viz., *Vigna, Ceratotropis, Haydonia, Lasiospron and Plectrotropis* (**Hai, 2015;** Gayatonde, 2018; Wikipedia, 2023a) .

According to PL (2013) the Synonyms of *Vigna unguiculata* are as follows:

Name

1. *Dolichos biflorus* L.
2. *Dolichos catjang* Burm.f.
3. *Dolichos catjang* L.
4. *Dolichos hastifolius* Schnizl.
5. *Dolichos lubia* Forssk.
6. *Dolichos melanophtalmus* DC.
7. *Dolichos melanophthalamus* DC.
8. *Dolichos monachalis* Brot.
9. *Dolichos obliquifolius* Schnizl.
10. *Dolichos sinensis* L.
11. *Dolichos sphaerospermus* (L.) DC.
12. *Dolichos tranquebaricus* Jacq.
13. *Dolichos unguiculata* L.
14. *Dolichos unguiculatus* L.
15. *Liebrechtsia scabra* De Wild.
16. *Phaseolus sphaerospermus* L.
17. *Phaseolus unguiculatus* (L.) Piper
18. *Vigna brachycalyx* Baker f.
19. *Vigna catjang* (Burm.f.) Walp.
20. *Vigna catjang* Savi
21. *Vigna catjiang* (Burm.f.) Walp. [Spelling variant]
22. *Vigna scabra* (De Wild.) T.Durand & H.Durand
23. *Vigna scabrida* Burtt Davy
24. *Vigna sinensis* (L.) Savi ex Hausskn.
25. *Vigna sinensis* (L.) Savi ex Hassk.
26. *Vigna sinensis* var. *catiang* sensu Chiov.
27. *Vigna sinensis* subsp. *sinensis*
28. *Vigna sinensis* var *spontanea* Schweinf.
29. *Vigna unguiculata* subsp. *dekindtiana* "sensu Verdc., p.p.C"
30. *Vigna unguiculata* subsp. *unguiculata*
31. *Vigna unguiculata* var. *unguiculata*

According to TB (2020) the Synonyms of *Vigna unguiculata* are as follows:

1. Vigna unguiculata subsp. alba
2. Vigna unguiculata subsp. baoulensis
3. Vigna unguiculata subsp. cylindrica
4. Vigna unguiculata subsp. dekindtiana
5. Vigna unguiculata subsp. pawekiae
6. Vigna unguiculata subsp. pubescens
7. Vigna unguiculata subsp. sesquipedalis
8. Vigna unguiculata subsp. stenophylla
9. Vigna unguiculata subsp. tenuis
10. Vigna unguiculata subsp. unguiculata (cowpea)
    - Vigna unguiculata subsp. unguiculata Textilis Group
    - Vigna unguiculata var. spontanea

According to Vegetables (2023) the Synonyms of *Vigna unguiculata* are as follows:

1. Dolichos biflorus L.
2. Dolichos sesquipedalis L.
3. Phaseolus cylindricus L.
4. Vigna baoulensis A. Chev.
5. Vigna catjang (Burm. f.) Walp.
6. Vigna cylindrica (L.) Skeels
7. Vigna sesquipedalis (L.) Fruwirth
8. Vigna sinensis (L.) Savi ex Hassk.
9. Vigna sinensis subsp. sesquipedalis (L.) Van Eselt.
10. Vigna sinensis subsp. sinensis
11. Vigna triloba Walp.
12. Vigna unguiculata subsp. cylindrica (L.) Verdc.
13. Vigna unguiculata subsp. dekindtiana (Harms) Verdc.
14. Vigna unguiculata subsp. sesquipedalis (L.) Verdc.
15. Vigna unguiculata subsp. stenophylla (Harv.) MarÃ©chal, Mascherpa & Stainier
16. Vigna unguiculata subsp. unguiculata

The taxonomy of domesticated cowpea (*V.unguiculata* var.*unguiculata*) has a history of revisions, changes, and modifications that leave thenonexpert perplexed. The pantropical genus *Vigna* forms part of the subfamily Papilionoideae under the family Fabaceae (Leguminosae). Cowpea belongs to the subgenus *Vigna*, section Catiang. It is genetically isolated from other *Vigna*, which includes only one other distinctly African species, bambara groundnut (*V. subterranea*). There are several Asian *Vigna* crop species such as urdbean (*V.mungo*), mothbean(*V.aconitifolia*), and mung-bean (*V.radiata*). Morphological, ethnographical, molecular and other criteria led Pasquet (1999) to a classification of *V. unguiculata* that recognizes 11subspecies, 10 of which are perennial and one of which cowpea is annual. Annual cowpea has two forms, the cultivated *V. unguiculata unguiculata* var.*unguiculata* and the wild/weedy form *V.u. u*.var. *spontanea*, both of which are inbreeding.

V.u.u.spontanea is typically found only near the borders of cultivated cowpea fields and within them The 10 perennial V.unguiculata subspecies include (i) some that are exclusively outcrossing: subspecies baoulensis (A.Chev.) Pasquet, ssp.burundiensis Pasquet, ssp. letouzeyi Pasquet, ssp. aduensis Pasquet, and ssp.pawekiae Pasquet, and (ii) others that are both outbreeding as well as inbreeding: ssp. dekindtiana (Harms) Verdc.,ssp. stenophylla (E. Mey) Verdc., ssp. tenuis (E.Mey) Marechal, Mascherpa, and Stainier, ssp.alba (G. Don) Pasquet, and ssp. pubescens (R.Wilczek) Pasquet. It is reported that the number of subspecies is likely to change as Additional living material becomes available for study and as new molecular characterization tools areapplied. Originally only three, then later four cowpea cultigroups were recognized (Baudoinand Marechal, 1985). A fifth has recently been added (Pasquet, 1998). Smartt (1985) accounted for the emergence of two of the cultigroups on the basis of selection practiced in Asia after cowpea reached that continent, probably via India, about 2000 years ago. The cultigroups are: (1) Unguiculata, the African cowpea treated here, (2) Biflora, an erect woody perennial grown for fodder and seed, (3) Sesquipedalis, grown for its long, succulent pods in the Far East, (4) Textilis, cultivated in northern Nigeria andNiger; it has long peduncles, and is grown for the textile fibers it provides, (5)Melanopthalamus, originally from West Africa, is able to flower quickly under inductive conditions; the seeds have thin and often-wrinkled testa (Pasquet,1998).

At the infraspecific level, although a precise phylogeny is not yet established, the different wild and domesticated Cowpea groups are now well known. The nine subspecies can be split between a " mensensis" forest group (remote secondary gene pool) and a "dekindtiana" savanna group (close secondary gene pool) which includes subsp. *nguiculata*. Subsp. *unguiculata* represents the primary gene pool and includes the domesticated cowpea,var. *unguiculata*,and its wild progenitor, var. *spontanea* (previously known as subsp. *dekindtiana sensu* Verdcourt non Harms) (Pasquet and Padulosi, 2010).

Morphology of wild cowpea: Great variability in plant morphology has been observed in wild cowpea. Considerable variation in protein and molecular marker electrophoretic band patterns has also beendetected (Vaillancourt and Weeden, 1992; Vaillancourt *et al.,* 1993; Panella *et al.,* 1993; Pasquet 1993b). Fig.2 and 3 depict the general morphology of plants of a typical variety of each of the five subspecies described. Fig. 4 shows the detailed morphology of the stigmas of the different subspecies. Most subspecies, except var. *dekindtiana* and var. *ciliolata* of the subsp. *dekindtiana,* and var. *kgalagadiensis* of the subsp. *protracta,* have the tendency to live for longer than a year (biennial or perennial). Subsp. *pubescens* and *protracta* are pubescent, with their stems, leaves, and pods covered with hairs. Vestiture of the former subspecies is sericeous, with its hairs generally longer and denser than those of the latter species. The hairs are silky, straight, soft, and appressed to the surface of the stems and pods. On the other hand, the hair type of the subsp. *protracta* is hispid. The hairs are bristly, erect, straight, and harshly stiff They are especially pronounced in var. *rhomboidea,* a taxon with typical rhombic leaves ranging from 4 to 15 cm long and 1.7 to 5 cm wide. This taxon has thick root stock and its stigmas are strongly bearded and thus easily recognizable from all other taxa. The varieties *protracta* and *kgalagadiensis* can be distinguished from one another by the shape and size of leaves, as well as by length of rachis and peduncle. Variety *protracta*is an annual or a perennial herb up to 2 m long, with a prostate growth habit. Its inflorescence rachis is shorter than 0.7 cm and peduncle about 7 (4-15) cm long. Its lateral leaflet is oblique, slightly to deeply lobed on the inside only, up to 7 cm long and 6 cm wide; terminal leaflet ovate to subhastate or hastate, 5 (3-8) cm long and 3 (2-6) cm wide. Leaflets of var. *protracta* are wider than var. *kgalagadiensis,* whose lateral leaflet is up to 3 cm wide and terminal leaflet 2 cm wide. Inflorescence rachis of var. *kgalagadiensis* is 3-4 cm long and peduncle 9.5 (5-20) cm long. This taxon is an annual herb up to 1.5 m long, with a prostate growth habit. Subsp. *pubescens* has the longest peduncles and rachis, and thickest stems, as compared to other taxa within wild *V unguiculata.* It has a deep mauve flower. Plants of the subsp. *tenuis* are small, delicate, and tender. They produce small fleshy tuberous roots. Occasionally, adventitious rooting occurs from nodes of creeping branches. Their peduncles and rachis, similar to those in var. *protracta,* are shortest among the wild *V unguiculata.*Three varieties are recognized in this subspecies, namely var. *tenuis* (with ovate-shaped leaves), var. *oblonga* (with oblong leaves), and var. *parviflora* (with smallflowers). Subspecies *stenophylla* has very narrow (lanceolate) and sometimes, hastate terminal leaflets, 6 (3-10) cm long and 1 (0.3-2) cm wide. Its lateral leaflets are oblique, slightly lobed on the inside, up to 7 cm long and 3 cm wide. It also produces small tuberous root. Its peduncle is intermediate in length (12 cm). Rachis is shorter than 1.5 cm. Its flower is small, pale, and mauve. Subspecies *dekindtiana* consists of a very diverse group of varieties, represented by five taxa. Variety *grandiflora* has the largest flower in the species and is easily distinguished from all others by the size of its flowers. The standard color of the flower is pale mauve. Variety *congolensis* has small leaves; terminal leaflet is ovate-lanceolate to subhastate, 5 (3-8) cm long and 2.5 (1.2-7) cm wide; lateral leaflets are oblique, upto 6 cm long and 3 cm wide. This variety from Congo is quite similar to subsp. *tenuis*. Variety *huillensis*has a very long peduncle, with an average of 20 (8-27) cm. It has a large purple flower, with its keel markedly beaked. Its leaves are rather leathery. It is a pyrophytic species. It produces abundant flowers from peduncles originated directly from its woody rootstock, soon after bush fires occur in the savanna. It also produced flowers without bushfires, during growing seasons in Ibadan, Nigeria. Variety *ciliolata,* on the other hand, is an annual plant which is distinguishable from others by its long calyx lobes (over 9 cm long); otherwise it is very similar to var. *dekindtiana.* The calyx lobe length seems to be stable, across the different environments in Ibadan and in East Africa. The general morphology and growth habit of var. *dekindtiana* is very similar to cultivated cowpea landraces, except that its mature pods are usually black, scabrous, and much smaller than the cultivated cowpea. The pods which shatter at maturity contain tiny, dark speckled or solid black seeds, similar to other varieties of the wild species. Variation in the seed size of this variety is greater than others, and the average size (2 g/100 seeds) is also bigger (Padulosil and Ng, 1997).

Fig. 2. *Vigna unguiculata* ssp. .dekindtiana var. . dekindtiana (left) and ssp. pubescens (right)

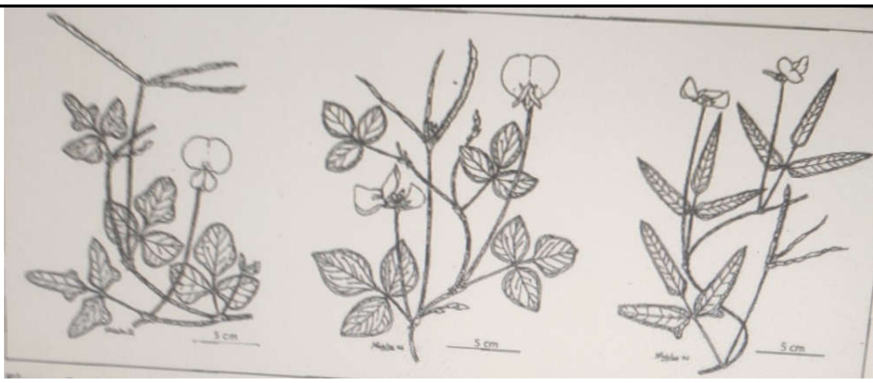
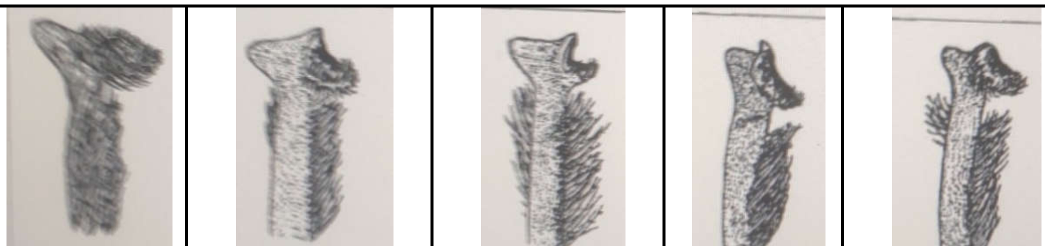


Fig. 3 *Vigna unguiculata* ssp.*protracta* var. *protracta* (left), ssp. *tenuis* var. *tenuis* (centre), and ssp. *stenophylla* (right)



1. var.protracta	2. var. pubescens	3. var. dekindtiana	4. var. tenuis	5. ssp. Stenophylla

Fig. 4. Stigma of the indicated subspecies of *Vigna unguiculata*

BOTANICAL DESCRIPTION

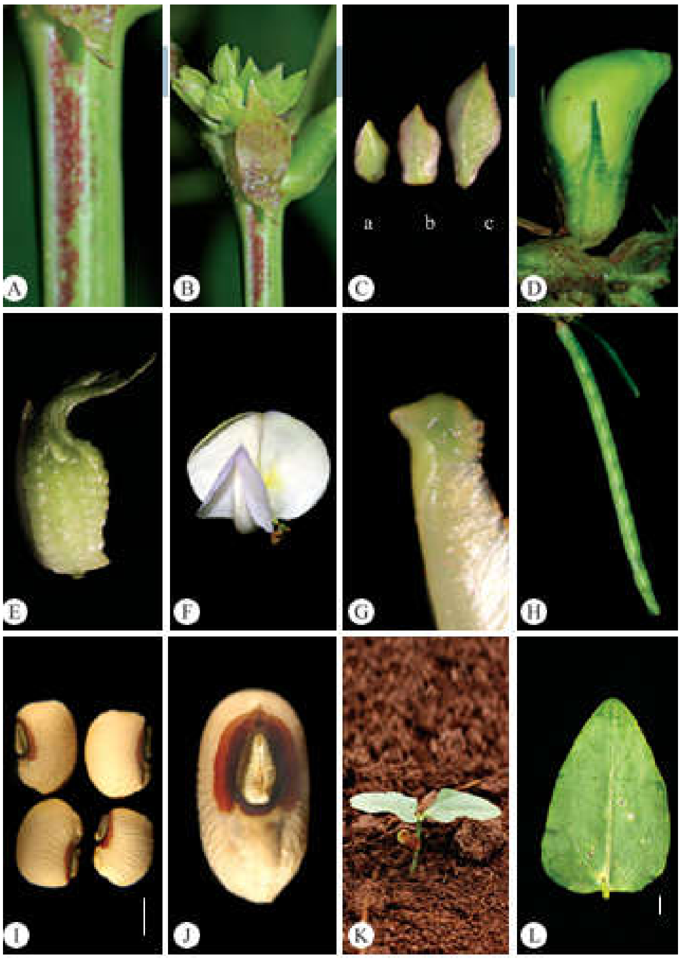
Cowpea is an herbaceous warm-season annual that is similar in appearance to common bean except that leaves are generally darker green, shinier, and less pubescent. Cowpeas also are generally more robust in appearance than common beans with better developed root systems and thicker stems and branches. Plant growth habit can be erect, semi-erect, prostrate (trailing), or climbing depending mostly on genotype, although photoperiod and growing conditions can also affect plant stature. Most cowpea accessions have indeterminate stem and branch apicies. Early flowering cowpea genotypes can produce a crop of dry grain in 60 days, while longer season genotypes may require more than 150 days to mature depending on photoperiod. Flowers are borne on racemes on 15- 40 mm peduncles that arise from the leaf axils. Two or three pods per peduncle are common, and often four or more pods are carried on a single peduncle if growing conditions are very favorable. The presence of these long peduncles is a distinguishing feature of cowpea, and this characteristic also facil-itates hand harvesting (Timko *et al.,* 2007). Cultivated cowpea seed weighs between 8 and 32 mg and ranges from round to kidney shaped. Pods are cylindrical and may be curved or straight, with between 8 and 15 seeds per pod. The seed coat can be either smooth or wrinkled and of various colors including white, cream, green, buff, red, brown, and black. Seed may also be speckled or patterned. Seeds of well-known cowpeatypes, such as "blackeye pea" and "pinkeye," are white with a round irregular-shaped black or red pigmented area encircling the hilum, giving theseed the appearance of an eye (Fig. 5) (Timko *et al.,* 2007).

Fig. 5. Seed color-Black, Red, Brown, White, Green (Singh, 2016)

The growth habit of cowpea ranges from indeterminate to determinate. As regards plantarchitecture, there is great variability. Plants range from erect, semi-erect, and prostrate (spreading, creeping) to climbing. One of the key features of cowpea is its long tap root, which enables the plant to obtain moisture at depths that cannot be reached by most plants (Murdock *et al.,* 2008).

Emergence is epigeal (similar to common bean and lupin), where the cotyledons emerge from the ground during germination. This type of emergence makes cowpea more susceptible to seedlinginjury, since the plant does not regenerate buds be- low the cotyledonary node. The open display of flowers in and above the canopy and the presence of extra floral nectaries contribute to the attraction of insects. Cowpea primarily is self-pollinating, but out-crossing rates as high as 5% have been recorded and care needs to be taken to avoid out-crossing during the production of breeder and foundation seed, or unacceptable levels of "off-types" will result. Cowpea is a short day plant, and many cowpea accessions exhibit photoperiod sensitivity with respect to floral bud initiation and development, while others are day neutral (Ehlers and Hall 1996; Craufurd *et al.,* 1997). For some genotypes, the degree of sensitivity to photoperiod (extent of delay in flowering) is modified by temperature (Weinand Summerfield 1980; Ehlers and Hall 1996). In West Africa, selection for differing degrees of photosensitivity or differences in juvenility has occurred in different climatic zones such that pod ripening coincides with the end of the rainy season in a given locale, regardless of planting date, whichis often variable due to the variable onset of wet seasons (Steele and Mehra 1980). This attribute allows pods to escape damage from excessive moisture and pathogens. Photoperiod sensitivity, when appropriately deployed in a breeding program, can be valuable to ensure crop maturity after wet seasons or before drought or cold weather limits crop growth. However, it may constrain the direct usefulness of an otherwise desirable cultivar to a smallarea of adaptation or even to a specific season within this restricted area.

Cultivated cowpeas have been divided into five cultivar groups based mainly on pod and seed characteristics (Pursglove 1968; Pasquet 1999). Cultivar group Unguiculata is the largest and includes most medium and large seeded African grain and forage type cowpeas. Cultivar group Melanophthalmus includes "black eye pea"-type cowpea with large, somewhat elongated seeds with wrinkled seed coats and fragile pods (Pasquet 1998). Cowpea (*Vigna unguiculata*) plant is) plant is erect or scandent or trailing or twining herb. Stem 1.-2.5 m long glabrous or sometimes sparsely covered with 0.8-1.0 mm long white hairs. Leaves 3-foliate, terminal leaflet ovate, lateral leaflets obliquely ovate. Stipule ovate to laceolate, medifixed, 15-18 x 4-5 mm. Inflorensce 8-10 flowerd; flowers bluish white or pale white or pink, 2.5-2.7 mm in diameter, calyx tuberculate. Pods subterete, subcompressed and glabrous or puberculate, 16-18 x 0.9-1.0 cm, pale yellow when mature. Seeds rounded, 10-16 per pod, smooth, pale yellow, 10x5x7 mm, aril slightly developed (Fig. 6) (Yadav *et al.,* 2014).



A.Stein, B.Stipule,C. Primary bract (a);Secondary bract (b); Bracteole (c),D.Bud,E.Calyx,F. Flower, G.Beak, H.Pod, I &J.Seed, K. Seedling and L. First leaf. ***Scalebar*** **3 mm**

Fig. 6. ***Vigna unguiculata*** **(L.)Walp(Yadav et al., 2014)**

Members of cultivar group Biflora (also known as "catjang") are common in India and characterized by their relatively small smooth seeds borne in short pods that are held erect until maturity. Cultivargroup Textilis is a rather rare form of cowpea with very long peduncles that were used in Africa as a source of fiber. Cultivar group Sesquipedialis (known as "yardlong bean," "long bean," "Asparagus bean," or "snake bean") is widely grown in Asia for production of its very long (40 to 100 cm)green pods that are used as "snap" beans. Despite the striking differences in morphological characteristics among the cultivar groups, there are no practical barriers to hybridization or recombination between members of the different groups. The plant ranges from erect, sub-erect, prostrate and are all annuals. The leaves are trifoliate with entire leaflets. Flowers join in clusters of 2-4 flowers and are white, yellow or violet (Gayatonde, 2018; Waqas, 2018).

As the plant is primarily self-pollinating, its genetic diversity within varieties is relatively low. Cowpeas can either be short and bushy (as short as 20 cm) or act like a vine by climbing supports or trailing along the ground (to a height of 2 m). The taproot can penetrate to a depth of 2.4 m after eight weeks. The size and shape of the leaves vary greatly, making this an important feature for classifying and distinguishing cowpea varieties. Another distinguishing feature of cowpeas is the long 20–50 cm peduncles, which hold the flowers and seed pods. One peduncle can support four or more seed pods. Flower colour varies through different shades of purple, pink, yellow, and white and blue. Seeds and seed pods from wild cowpeas are very small, while cultivated varieties can have pods between 10 and 110 cm long. A pod can contain six to 13 seeds that are usually kidney-shaped, although the seeds become more spherical the more restricted they are within the pod. Their texture and colour are very diverse. They can have a smooth or rough coat and be speckled, mottled, or blotchy. Colours include white, cream, green, red, brown, and black, or various combinations (Wikipedia, 2023). Cowpea, (*Vigna unguiculata*), also called black-eyed pea or southern pea, annual plant within the pea family (Fabaceae) grown for its edible legumes. Cowpeas are typically climbing or trailing vines that bear compound leaves with three leaflets. The white, purple, or pale-yellow flowers usually grow in pairs or threes at the ends of long stalks. The pods are long and cylindrical and can grow 20–30 cm long, depending on the cultivar. The plants are heat-adapted and drought-tolerant (Britannica, 2023). Growth habit ranges from erect, determinate, nonbranching type to prostrate or climbing, indeterminate, with profuse branching. It has strong tap root system with several lateral roots. Stems are cylindrical and slightly ribbed, twisting, sometimes hollow and glabrous. Stems may be green or pigmented (purple). Leaves are alternate, trifoliate, with one symmetrical terminal leaflet and two asymmetrical leaflets. Petioles are 3-25 cm long with a swollen pulvinus at the base. Inflorescence is an un-branched axillary raceme bearing several flowers at the terminal end of peduncles. The peduncles vary from 5 to 60 cm in length and are slightly twisted and ribbed. Calyx is longitudinally ribbed, tubular with 2-15 mm long subequal lobes. The corolla is papilionaceous with an erect standard petal spreading at anthesis. The pigmentation pattern of corolla varies from white to solid mauve with yellow spots near the base of the standard petal. The wings are adherent to the boat-shaped keel, enclosing the androecium and gynoecium. The stamens are diadelphous (9+1). Anthers are bright yellow. Ovary is monocarpellary, unilocular with many ovules. Pods are pendent or vertically attached to the raceme axis. They are mostly linear, although curved and coiled shapes are also found. The length of pods may vary from less than 11 to more than 100 cm (Vidhi, 2023). Herbaceous legume which is grown annually. Taproot and abundant lateral roots spreading in a soil. Stem smooth, striate, hairy, purple shades and length: 3 m. Leaf dark green, lanceolate- ovate, shiny to dull and 10 cm long.

Flower is bell shaped, dirty yellow, white, pale blue, pink, or purple. Seeds are kidney shaped, Length: 6–12 mm. Seed color is green, red, white, cream, black , and buff brown. Pod shape is slightly curved and cylindrical, length: 6 to 10 inch. Pod color is green, purple or yellow. Flavor/aroma is nutty. Varieties/Types are black eye or purple eye peas, brown eye peas, crowder peas, cream, white acre type, clay types, and forage cultivars (Healthbenefits,2023). Cowpea is an herbaceous legume which grows annually in a warm climate with adequate rainfall. It is the crop which grows well in the warm season, temperate zones and humid tropic. It prefers well drained, sandy soils or sandy loams. The plant grows up to 24 inches in height. The flower has got the shape of bell in the color of white, pink, dirty yellow, purple or blue. The leaves are dark green and 10 cm long with smooth, rhomboid, pubescent and shiny to dull appearance. The leaves are dark green with smooth, rhomboid, pubescent and shiny to dull appearance. The stem is 3 m long with smooth, straite, slender hairy and some shades of purple. The plant has got no branches at all. The plant has the taproot with an expansion of lateral roots in the soil. The parts of the plant which are edible are roots, green leaves, immature pods, seeds and green seeds. The pod is yellow, green or purple, slightly curved and cylindrical with 6-10 inch long. Each pod possesses 6-13 seeds. The seeds are white, green, cream, buff, brown, red and black. It has got the shape of kidney with 6-12 mm in length. It has got the flavor of nuts. The seed has got the lifespan of 5 years (Fig. 7) (Vegetables, 2023).

		
Seedlings	**Bushy plant**	**Perennial plant**
		
Plant	**Field**	**Flower buds**
		
Yellow flowers	**Yellow flowers**	**Pink flowers**
		
Pink flower	**Podding stages**	**Dry pods**
		
Sun drying of pods	**Seeds**	

Fig. 7: Botanical Description

GENETICS AND CYTOGENETICS

Qualitative Genetics of Cowpea*:* Several scientists have contributed to the understanding of qualitative genes of cowpea. Quite often different gene symbols were assigned to the same gene and some-times, no gene symbols were allotted. Fery (1985 a) has compiled an exhaustive list of 159 genes and proposed standard gene symbols based on standard gene nomenclature rules being followed by the International Committee on Gene Symbols and Tomato Genetics Cooperative. A few important genes from that list are given in Table 2 (Vidhi, 2023)**:**

Table 2. Some important genes of cowpea

Preferred symbol	Character
A	Alfalfa like pod shape
ax	Axillary buds, active buds in axils of cotyledons
B	Blue seed coat
Bc-1	Bacterial canker resistance-1
bc-2	Bacterial canker resistance-2
bcm	Blackeye cowpea mosaic virus resistance, likely a synonym of blc
Bcy	Brown calyx colour, dominant to green
Bk	Black pod, dominant to white pod
Bl	Black seed coat, also conditions anthocyanin production in the podtip, calyx, and penduncle, heterozygote produces mottled seeds
blc	Blackeye cowpea mosaic virus resistance, likely a synonym of bcm
Bp	Brown pod, dominant to straw colour
Bpl-1	Bacterial pustule resistance-1
Bpl-2	Bacterial pustule resistance-2
bpl-3	Bacterial pustule resistance-3
bpl-4	Bacterial pustule resistance-4
bpl-5	Bacterial pustule resistance-5
by	Bean yellow mosaic virus resistance
CC	Cowpea chlorotic mottle virus resistance, the recessive allele at the Mvi locus is likely a synonym
Ci	Compound inflorescence
Cls-1	Cercospora leaf spot resistance-1
cls-2	Cercospora leaf spot resistance-2
Cm	Cucumber mosaic virus resistance
crpt	Crumpled petal
Cy	Cylindrical-length pod
D	Dark flower colour
df	Dwarf (slow growth, dark green leaves, short internodes)
Ef-1	Early flowering-1
Ef-2	Early flowering-2
Er	Erect pod attachment, dominant to drooping pod attachment
Gp	Green pod, dominant to cream pod
Gr	Green bud, dominant to white bud
La	Lanceolate leaf
lg	Light-green pod
Llf	Long leaf
ls	Leaf size, small leaf recessive to large leaf
ms-1	Male sterile-1
ms-2	Male sterile-2
ms-3	Male sterile-3
ms-4	Male sterile-4
Nlf	Narrow leaf, dominant to broad leaf
Nv	Necrotic synergistic reaction associated with cowpea stunt
O	Hilum ring seed-coat pattern
P	Purple pod, dominant to green, also causes anthocyanin production in the calyx and penduncle
pa-1	Pod appearance-1 wrinkled dry pod recessive to smooth appearance
pa-2	Pod appearance-2 wrinkled dry pod recessive to smooth appearance
Pb	Purple petiole base
Pbr	Purple branch base
Pf	Purple flower
Pg	Pale-green plant
Pn	Penduncle length, long penduncle dominant to short
Pu	Purple pod, stem and petiole are completely purple
R	Red seed coat
rh	Beetle resistance
Rk	Root-knot resistance, allelic to rk^i
rk^i	Root-knot resistance-intermediate, allelic to Rk
S	Spotting pattern, patches of black pigment on certain types of seed coat
Sbm	Southern bean mosaic virus resistance
Sh	Spindly growth habit, marked elongation of the main stem and few side branches
shp	Shrunken pericarp
Sr	Stem-rot resistance
St	Standard petal exhibits full expression of colour
stx	*Sesquipedalis*-like texture of pod (soft)
Tr	Tobacco ring-spot virus resistance
un	Unifoliate leaf, petiole, all stipellae, and the two lateral leaflets with their petioles are missing
V	Seed-coat mottling
Vw	Verticillium wilt resistance
Ymr	Cowpea yellow mosaic virus resistance, conditions resistance to cowpea mosaic virus

Classical Genetics: Significant long term genetic improvement efforts of cowpea have taken place within national labora- tories and universities in several West African countries, India, Brazil, and the USA, as well as at the International Institute of Tropical Agriculture (IITA), based in Ibadan, Nigeria. The accomplishments of some of these programs have been de- scribed recently (Ehlers et al. 2002 a; Singh et al.2002; Hall et al. 2003). Most cowpea breeders employ backcross, pedigree, or bulk breeding methods to handle segregating populations because cowpea is a self-pollinating species and varieties are pure lines. Grain yield and quality are primary breeding objectives of nearly all programs, but because losses to diseases and pests can be high, most programs are also concentrating on breeding for resistance to the major pests they face in their target environments. A com- prehensive review of cowpea breeding that is still relevant was published in 1997 (Hall et al. 1997). Sources of resistance to many viruses and fungal diseases have been identified, and screening techniques are well developed for many of these (Ehlers and Hall 1997). In general, good progress has been made using conventional techniques in breeding for resistance to the parasitic weeds *Striga gesneroides* (witchweed) and *Alectra vogelii*, root knot nematodes, viruses, and fungal and bacterial diseases. Unfortunately, resistance to these pathogens and parasites is usually governed by single genes that are often only effective in a restricted region due to pathogen/parasite variability and may be overcome in a relatively short period of time. Marker-assisted selection (MAS) can be helpful in assembling more durable resistance by incorporating an array of resistance genes from other regions or defeated resistance genes. Developing cultivars with sustainable resistance to insects is a key objective of breeding programs throughout the world for several reasons. Insect damage is the number one constraint for cowpea grain production in most cowpea producing regions (Singh and van Emden 1979; Daoust et al. 1985). There is also concern that new and significantly more stringent restrictions on the use of some popular insecticides are forthcoming, and currently there is a lack of new alternative insect control products registered for use on cowpea. The insecticides themselves, or the financial resources required to purchase them and the equipment required for proper application, are simply not available to the vast majority of farmers in Africa. In addition, there are concerns that the increased use of insecticides could cause major environmental and safety problems. Breeding insect resistant cowpeas would have a significant impact on food availability and nutritional status in many regions. Achieving this goal will not be easy, however, because of the number and diversity of pests that attack the crop and the nature of the pests. In many regions of the world, multiple pest resistance is needed to permit adequate grain production without the use of insecticides. This is because attacks by any one of the major pests can be devastating. For example, if cultivars were developed with a high level of resistance to flower thrips, capable of protecting their floral buds from damage, any resulting flowers and pods on these plants would likely be destroyed by pod bugs and pod borers. However, resistance to individual pests can reduce the number of sprays needed to obtain optimal yields and would generally increase yields without insect protection in regions where pest pressure is moderate, as in the case of the Sahel (Timko et al., 2007).

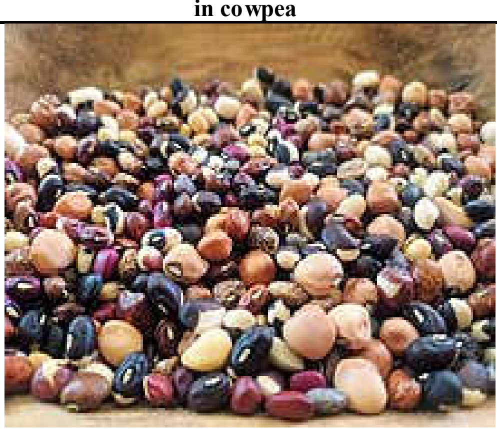
Cytology: The diploid chromosome number is 2n = 2x = 22. Mukherjee (1968) studied the pachytene chromosomes and reported that the 11 bivalent complement, consisted of 1 short (19 µm), 7 medium (26-36 µm), and 3 long (41-45 µm) chromosomes. Chromosomes are small and difficult to manipulate. Advanced cytogenetic techniques, such as fluorescent staining of chromosomes, silver staining of nucleolar organising regions, and in situ hybridization are beginning to be employed and promise to be useful to plant breeding programs in the future. A linkage map for cultivated cowpea has been constructed that spans 916 cM over 12 linkage groups and includes 133 RAPDs, 19 RFLPs, 25 AFLPs, and 3 morphological markers (Vidhi, 2023).

GENETIC DIVERSITY

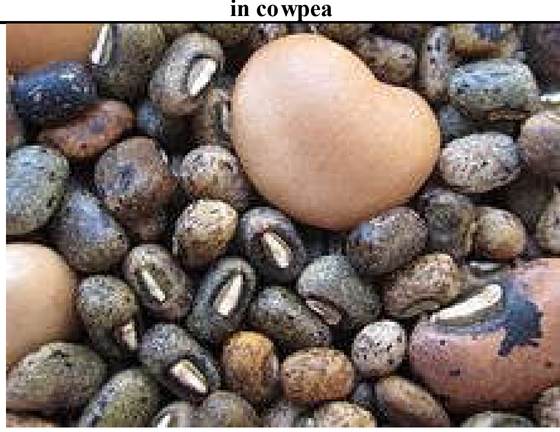
Several countries grow cowpea as a vegetable crop. The most preferred types are the yard long cowpeas with fleshy tender pods, but these varieties need staking to keep pods from touching the ground and rotting, which involves extra cost and thus restricts the area under cultivation. Hence bush-type vegetable cowpea are required (Singh *et al.,* 1957). Within the two types of cowpea varieties-grain type and fodder type-there is wide variation for seed type, seed size, seed color, hilum color, and plant type. Individual samples from 36 farmers' fields have shown from 1 to 11 seed types in cowpeas of early grain-type and from 3 to 7 seed types in the late fodder-type cowpeas. The varieties have local names that often describe their characteristics. The genetic diversity within each group of varieties is probably maintained by the farmers, to ensure stability under the harsh environmental conditions in which cowpea is grown (Fig. 8) (Mortimore *et al.,* 1997).

Variation in seed shape, color, and size in cowpea

Variation in seed shape, color, and size in cowpea



Variation in seed shape, color, and size in cowpea



Seeds from the wild-type cowpea (which are much smaller than the cultivated varieties)

Fig. 8. Genetic variability in seeds of cowpea

Forty cowpea genotypes were evaluated for 18 quantitative characters to estimate the genetic diversity existing among them by using Mahalanobis D^2 statistics. The genotypes were grouped into six clusters. The cluster strength varied from single genotype (Clusters III, IV and V) to 25 genotypes (Cluster I). Clusteres IV and VI had high inter cluster distance. Clusters II, III and I had maximum 100-seed weight, number of seeds per pod and seed yield respectively. Cluster IV had maximum seedling vigour index, germination per cent, peduncle length, number of clusters per plant and number of primary branches. The genotypes from clusters IV and IV may be inter crossed to obtain high variation (Brahmaiah *et al*., 2014). Genetic divergence using D^2 analysis was carried out in 50 diverse genotypes of cowpea. All the 50 genotypes were grouped into twelve clusters. Cluster I was largest comprising of twenty seven genotypes followed by Cluster II with twelve genotypes, cluster IV with three genotypes, and cluster III,V, VI, VII and VIII, IX, X, XI, XII were represented each by single genotype. Intra-cluster D^2 values ranged from 0 to 38.06. The inter-cluster D^2 values ranged from 44.08 to 276.55. The maximum inter cluster distance was observed between VII and XII clusters followed by clusters IV and XII and cluster X and VII. The maximum contribution towards genetic divergence is by days to 50% flowering (25.22%) followed by plant height (12.24%) and biological yield per plant. Hence it can be concluded that the diverse parent belonging to different cluster should be involved in the hybridization programme based on their merits of characters. Beside this more number of germplasm should be incorporated in hybridization programme (Sandeep *et al.,* 2014).

Field experiments were conducted at the Agricultural Research Council–Roodeplaat Vegetable and Ornamental Plant Institute in South Africa, in 2011 and 2012, to estimate the level of phenotypic variability among a collection of 25 cowpea genotypes. Analysis of variance for the phenotypic traits revealed that differences among genotypes were highly significant for all traits. This indicated the high level of genetic variability among the cowpea genotypes studied. Genetic and phenotypic coefficient of variation, and broad-sense heritability were estimated for all phenotypic traits. The first five principal components showed 79.30% of the total variability among the genotypes. Pod length, leaf area, leaf area index and number of seeds per plant contributed mainly to PC1 and leaf number, plant height, dry biomass and fresh biomass contributed mainly to PC2. Cluster analysis of the phenotypic traits resulted in five distinct groups of genotypes. The phenotypic traits therefore provide a useful measure of genetic distances among the cowpea genotypes and will enable the identification of potential parental materials for future breeding efforts. Genotypes IT93K129-4, Fahari, Glenda and Veg cowpea Dakama Cream were associated with desirable grain yield characteristics and are recommended as suitable parental lines for improvement of grain production. Genotypes 5431, Tatro mix, Kisumu mix and Okalulenu were identified to possess good vegetative traits and are also recommended for use as suitable parents when breeding for leafy vegetable or for fodder production (Gerrano *et al.,* 2015). The genetic diversity of cowpea was analyzed, and the population structure was estimated in a diverse set of 768 cultivated cowpea genotypes from the USDA GRIN cowpea collection, originally collected from 56 countries. Genotyping by sequencing was used to discover single nucleotide polymorphism (SNP) in cowpea and the identified SNP alleles were used to estimate the level of genetic diversity, population structure, and phylogenetic relationships. The aim of this study was to detect the gene pool structure of cowpea and to determine its relationship between different regions and countries. Based on the model-based ancestry analysis, the phylogenetic tree, and the principal component analysis, three well-differentiated genetic populations were postulated from 768 worldwide cowpea genotypes. According to the phylogenetic analyses between each individual, region, and country, we may trace the accession from off-original, back to the two candidate original areas (West and East of Africa) to predict the migration and domestication history during the cowpea dispersal and development. To our knowledge, this is the first report of the analysis of the genetic variation and relationship between globally cultivated cowpea genotypes. The results will help curators, researchers, and breeders to understand, utilize, conserve, and manage the collection for more efficient contribution to international cowpea research (Xiong *et al*., 2016).

Genetic diversity in cultivated crops indicates gene pool richness. It is the greatest resource for plant breeders to select lines that enhance food security. This study was conducted by Masinde Muliro University to evaluate genetic diversity in 19 cowpea accessions from Kenya national gene bank. Accessions clustered into two major groups. High divergence was observed between accessions from Ethiopia and Australia and those from Western Kenya. Upper Volta accessions were closely related to those from Western Kenya. Low variation was observed between accessions from Eastern and Rift Valley than those from Western and Coastal regions of Kenya. Diversity obtained in this study can further be exploited for the improvement of cowpea in Kenya as a measure of food security (Wamalwa *et al.,* 2016).

The study was undertaken on Thirty genotypes of cowpea [*Vigna unguiculata* (L.) Walp] were investigated to understand the extent of genetic diversity through sixteen traits. Mahalanobis's D^2 analysis established the presence of wide genetic diversity among these genotypes was grouped into six clusters. The cluster I was largest and consisted of 21 genotypes followed by cluster III of 5 genotypes and clusters II, IV,V and VI consisting of only one genotype each. Maximum inter cluster D^2 value was observed between VI (6987.85) and III (4806.87), indicating that the genotypes included in these clusters had maximum divergence. The diversity among the genotypes measured by inter-cluster distance was adequate for improvement of cowpea by hybridization and selection. The genotypes included in these diverse clusters may be used as promising parents for hybridization to obtain better segregants in cowpea (Srinivas *et al.,* 2016). A clear understanding of variability of various characters of the breeding materials is an asset to the plant breeder for selecting superior genotypes on the basis of their phenotypic expression. In this regards estimates of genotypic and phenotypic variance for various quantitative characters along with heritability and genetic advance expected by selection for yield and its components are useful in designing an effective breeding programme (Sarath and Reshma, 2017). The high degree of variability was observed for all the characters of different genotypes of cowpea under study in Konkan condition. The range of GCV and PCV was 3.18% to 36.45% and 3.56% to 36.60% respectively. High magnitude of the phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance was observed for plant height, grain yield per plant and length of the pods. Seeds per pod exhibited low PCV and GCV, but high heritability and low genetic gain. The phenotypic coefficient of variation and genotypic coefficient of variation were found maximum in number of pods per plant (GCV, 36.45% & PCV, 36.60%) followed by test weight (GCV, 29.37% & PCV, 29.49%). The genetic advance and genetic advance as per cent of mean (GAM) was ranged from 0.78% to 23.64% and 4.36% to 52.54% respectively. The high degree of variability was observed for all the characters studied since variety is the basis for any crop improvement program, so there is ample scope for improvement of all the characters studied through appropriate breeding programs. The estimates of phenotypic, genotypic and environmental variances revealed that phenotypic variances were higher in magnitude over the respective genotypic variances for all the characters. It is concluded that yield is controlled by both GCV and PCV also to use appropriate selection procedure for improvement of the characters. High genetic advance reveals the presence of lesser environmental influence and prevalence of additive gene action in their expression (Waghmare *et al.,* 2019).

Phenotypic analysis using qualitative and quantitative traits and genotyping using high density SNP markers revealed the presence of significant variation among 100 cowpea germplasm collections of southern Africa. Trait association analysis revealed significant correlation between NPP, NSP, PDL and GYD that could allow direct selection to improve grain yield. The SNP markers used in the study were able to deduce genetic variation among the tested cowpea populations. The largest proportion of variation was attributable to individual genotype differences that is essential for improving grain yield by crossing lines from different divergent populations. Test genotypes were classified in to four genetic groups irrespective of source of collection allowing selection for subsequent cross combinations to develop breeding populations for cultivar development. Genotypes Bubebe, CP411, CP421, CP645, Chimponogo and MS1–8–1-4 were identified being the most genetically divergent and high yielding making them ideal parental lines for breeding. This study provided a baseline genetic profile and identified promising cowpea genetic resources for effective breeding and systematic conservation (Nkhoma *et al.,* 2020). Studied cowpea accessions were morphologically distinct from each other and showed genetic diversity in many characters like growth habit, growth pattern, pod colour, pod curvature, pod length, seed colour, seeds per pod and 100 seed wt. Some accessions showed desirable characters like more pod/ inflorescence (CP-25, CP-23 CP-24 and CP-28) profuse branching (CP-31, CP-33 and CP-30); longer pods (CP-20, CP-15 and CP-18); seeds per pod (CP-31, CP-33 and CP-25). This diverse genepool could be further useful for plant breeder in developing cowpea variety with specific traits. Moreover, the findings of the study are useful for researchers in developing Distinctness, Uniformity and Stability (DUS) testing guideline for cowpea (Nalawade *et al.,* 2020). To determine phenotypic variation for yield and yield-related traits among cowpea genotypes and select best candidate genotypes for breeding hundred cowpea genotypes were evaluated across two environments using an alpha lattice design with two replications. The pooled data were subjected to analysis of variance, correlation and principal component analyses (PCA). Significant differences were observed among cowpea genotypes for assessed traits. PCA revealed three principal components contributing to 77.75% of the total variation. Grain yield was significantly correlated with most of the traits. The genotypic coefficient of variation was relatively higher, whereas the phenotypic coefficient of variation values were moderate for branch number, seed number per pod, and high for seed number per plant and pod weight per plant. Heritability and genetic advance values respectively ranged from 37.27% to 97.2% and 73.3% to 2242.6% for the studied traits. High direct path coefficient value of 0.71 for pod weight per plant with highly significant correlation with grain yield was observed. The study identified cowpea genotypes such as Glenda RV 465, RV 574, RV 115, RV 28, RV 419, RV 28, RV 419, RV 213, RV 550, RV 470, RV 111, RV 315 and RV 550 with better responses for yield and yield-related traits (Mofokeng *et al.,* 2020).

Phenotypic diversity analysis using morphological traits has been extensively used to establish genetic relatedness between and within species and for studying variability and correlated traits in cowpea. Phenotypic variation of cowpea germplasm collected from Botswana were assessed and reported phenotypic differences for agronomic traits such as peduncle length, seed width, seed thickness, pods per peduncle, and hundred seed weight (Mofokeng *et al*., 2020). In Goa, pole type cowpea with indeterminate growth habit producing long green fleshy pods are preferred and fetch premium price in the market throughout the year. There are many varieties released in case of bush type of cowpea but the availability of improved varieties in pole type vegetable cowpea is rather scanty. Not much work has been carried out on the genetic improvement of pole type vegetable cowpea. There is wide variability found for different morphological and other traits in the local types cultivated in the state of Goa. Exploration of genetic variability in the available germplasm is a prerequisite for initiation of any successful breeding programme. In spite of its popularity and importance very little effort has been made to upgrade the genetic makeup of this crop. Hence, the present investigation was carried out systematically to evaluate the local accessions to estimate the extent of genetic variability, heritability,genetic advance and genetic divergence in the locallycollected germplasm of vegetable cowpea (Thangam *et al.,* 2020). Twenty nine genotypes of vegetable cowpea including three improved varieties collected from different parts of Goa state were evaluated for twelve quantitative characters including yield. High variability was observed for pod yield/plant, number of pods/plant and pod length. The high variability for pod yield per plant is apparent as the pod yield ranged from 315.25 to 2070.45 g/plant with an average of 827.48 g per plant. Pod yield depends on number of pods per plant, pod length and pod weight. Number of pods per plant ranged from 36.65 to 147.80. Pod weight depends on pod length, number of seeds per pod and hundred seeds weight. Wide variation was observed for all these characters in the present study. The GCV value was maximum for pod yield per plant (g) followed by pod weight (g) and number of pods per plant. Low values of GCV were observed for days to first flowering, days to first harvest and number of seeds per pod. In the present study, the twenty nine genotypes could be grouped into fourteen clusters based on genetic distance. High coefficient of variation was observed for pod yield per plant, pod weight, number of pods per plant and pod length indicating their significant contribution in determining the inter cluster distances (Thangam *et al.,* 2020). Twenty eight cowpea entries of Agricultural Research Station, Virinjipuram were evaluated for yield and its components during two seasons Kharif 2014 and Rabi 2015. Wide range of variability was observed for various characters. Considerable amount of phenotypic and genotypic variability was observed for seed yield and component characters pods per plant and clusters per plant. The result indicated that the selected cowpea genotypes has shown mean value for 50% flowering was 45.00 days with total Days 7 4.50 for full maturity. The plant height was 73.27 cm with 16.77 no. of pods per plant. In addition 5.42 no. of cluster per plant with 13.50 seeds per pod, 5.84 g of 100 seed weight and 5.59 g of single plant yield. High heritability and low genetic advance as percentage of mean were recorded for days to 50% flowering, days to maturity and plant height suggesting that selection based on these characters could be effective. The character association studies indicated that selectionbased on days to 50% flowering, days to maturity, pods per plant, seeds per pod and 100 seed weight along with a medium plant height could useful for improving theyield in cowpea (Pandiyan *et al.*, 2020).

Flower bud thrips is one of the most destructive insect pests of cowpea in sub-SaharanAfrica. Information on genetic variability among cowpea germplasm and interrelationships among traits under thrips infestation would facilitate the development of resistant varieties. The objectives of the studywere to assess genetic variability for thrips resistance,estimate heritability of yield and other traits and investigate inter-trait relationships under thrips infestation. One hundred and fifty-six cowpea lines, including one resistant and one susceptible check,were screened for resistance under natural infestation at two locations in Nigeria, in 2016. Test lines were scored for thrips damage weekly for three consecutiveweeks, after removal of spreader plants, to obtaindamage scores (DS) 1, 2 and 3 while data were collected on agronomic traits. The data were subjected to analysis of variance from which genetic compo- nents of the phenotypic variance were computed. Interrelationships among traits were determined usingphenotypic and genotypic correlation, and sequential path analyses. Significant variability was observedamong test lines. Lines TVu 6824 and TVNu 1307 were identified as possessing thrips resistance. DS3 had significant genetic and phenotypic correlations with DS1, DS2 and yield-related traits. Number of pods per peduncle, number of peduncles per plant and DS3 were identified as first-order traits. Heritability estimates ranged from 0.55 to 0.73. Genetic variabilityamong the lines suggests the possibility of genetic control of thrips while number of pods per peduncle, number of peduncles per plant and Damage score 3 (DS3) would serve as useful selection criteria for thrips resistance (Toyinbo et al., 2021). In this study, the genetic diversity and population structure of 255 cowpea accessions collected from five administrative regions and the agricultural research institute of Togo were assessed using 4600 informative diversity array technology (DArT) markers. Among the regions, the polymorphic information content (PIC) ranged from 0.19 to 0.27 with a mean value of 0.25. The expected heterozygosity (He) varied from 0.22 to 0.34 with a mean value of 0.31, whilethe observed heterozygosity (Ho) varied from 0.03 to 0.07 with an average of 0.05. The average inbreeding coefficient (F_{IS}) varied from 0.78 to 0.89 with a mean value of 0.83, suggesting that most of the accessions are inbred. Cluster analysis and population structure identified four groups with each comprising accessions from the six different sources. Weak to moderate differentiation was observed among the populations with a genetic differentiation index varying from 0.014 to 0.117. Variation was highest (78%) among accessions within populations and lowest between populations (7%). These results revealed a moderate level of diversity among the Togo cowpea germplasm. The findings of this study constitute a foundation for genetic improvement of cowpea in Togo (Gbedevi et al., 2021). The knowledge on the nature and extent of genetic variability present in any crop species plays an important role in designing a suitable breeding method. Genetic diversity is the foremost basic requirement for a successful breeding programme. Heritability is a biostatistic commonly used in plant breeding and genetics works that estimates how much variation in a phenotypic trait in a population is due to genetic variation among individual plants in that population. Genetic advance is the improvement in the mean genotypic value of selected plant families over that of base population. It depends upon phenotypic variability, heritability and intensity of selection. The evaluation of cowpea germplasm, quantification of the magnitude of variability existing for different characters and classification into groups help in identifying potential distinct genotypes which are having contrasting characters, can be used to operate effective selection of genetically diverse genotypes for the improvement of yield (Panchta *et al.,* 2021).

A field experiment was conducted with 60 genotypes of cowpea to study the diversity among the genotypes which were grouped in to 12 clusters revealing the presence of considerable diversityin the material. The clustering pattern of the varieties usually did not confirm to geographical distribution. Inter cluster distance and mean cluster character values indicated that hybridization of cluster-X variety (JCPL-134) with cluster-IV varieties (JCPL-1, JCPL-13 and JCPL-21) and cluster-V varieties (JCPL-50 and JCPL-133) with cluster-III varieties (JCPL-26 and JCPL-131) would exhibit high heterosis and also result in transgressive segregants with higher yield. It was also noted that genotypes of cluster-X which had higher cluster mean values for yield and other desired characters like leaf area, ten pods weight, number of pods per plant and green pod yield per plant etc. could be directly tested in multilocation trials for their suitability or could be used as a donor parent in breeding programme. The characters like plant height, green pod yield per plant, protein content and leaf area were found to contribute much to the total genetic divergence in cowpea (Dalsaniya *et al.*, 2023). The 33 indigenous and exotic accessions of cowpea were evaluated in a randomized complete block design with three replications during summer and kharif seasons of fragile climate of Rajasthan to estimate the presence of genetic variability, inter-characters associations, to identify a suitable short duration accession for cultivation during summer and to compare the relative performance of the genotypes in two seasons. The high degree of genetic variability was estimated during both seasons for seed yield per plant (g), 100-seed weight (g.), pod length, number of seeds per pod, number of pods per plant, number of pods per cluster, number of branches per plant, number of cluster per plant, plant height (cm.), number of days to 50% flowering and number of days to maturity. The moderate to high heritabilities coupled with moderateto high expected genetic advancewere observed for all studied traits. Number of seeds per pod, number of pods per plant, number of pods per cluster, number of cluster per plant, days to 50% flowering and days to maturity had positive and significant correlations with seed yield per plant. The accession C-720 had been identified to be of short duration of 62 days. The accessions C-791, C-896, C-721, C-1023, and C-727 during summer season and accessions C-791, C-731, C-875, C-720 and C-1023 during kharif season exhibited superiority in terms of seed yield per plant over best check (Vir and Singh, 2023). A high level of morphological diversity is found within the species with large variations in the size, shape, and structureof the plant. Cowpeas can be erect, semierect (trailing), or climbing. (Wikipedia, 2023)

BREEDING

Germplasm Collections: Cowpea germplasm is maintained in collections around the world with varying levels of accessibility and documentation. The largest collections are held by the IITA with more than 14,000 accessions. The collection can be accessed via an electronic database maintained through the CGIAR-SINGER system (http://singer.cgiar.org). The United States Department of Agriculture (USDA) maintains a collec-tion with ca. 8,000 accessions. Access to this collection is through the USDA Germplasm Resources In- formation Network or GRIN system (www.ars-grin.- gov). The University of California Riverside has a collection with ca. 5000 accessions accessible on a Microsoft Access database. There is also a large col- lection of Mediterranean and African landraces (ca.600 accessions) held at the Istituto di Genetica Ve- getale at Bari, Italy (www.ba.cnr.it). Other centers maintaining seed of wild and cultivated cowpeas include the following: Agricultural University Wageningen (Wageningen, The Netherlands), Botanical Research Institute (Pretoria, South Africa), Le Jardin Botanique National de Belgique (Meise, Belgium), International Plant Genetic Resources Institute (IPGRI) in Harare (Zimbabwe), Institut Français de la Recherché Scientifique pour le Développement en Coopération (ORSTOM; now IRD) in Montpellier (France), Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) in Goiana (Brazil), Zentralinstitut für Genetik und Kulturpflanzen forschung (GAT) in Gatersleben (Germany), and the National Bureau of Plant Genetic Resources in New Delhi (India) (Timko *et al.,* 2007). In addition to the centers and facilities mentioned above, many national cowpea breeding programs in Africa (including programs in Botswana, Burkina Faso, Ghana, Kenya, Nigeria, and Senegal) also have substantial germplasm collections. The condition of some of these collections, which are important reserves of local diversity, could be improved with funding for germplasm maintenance and facility repair (Timko *et al.*, 2007). Bayesian inference revealed the presence of two major gene pools in cultivated cowpea in Africa. Landraces from gene pool 1 are mostly distributed in western Africa whilethe majority of gene pool 2 are located in eastern Africa. Each gene pool is most closely related to wild cowpea in the same geographic region, indicating divergent domestication processes leading to the formation of two gene pools. The total genetic variation within landraces from countries outside Africa was slightly greater than within African landraces. Accessions from Asia and Europe were more related to those from western Africa while accessions from the Americas appeared more closely related to those from eastern Africa. This delineation of cowpea germplasm into groups of genetic relatedness will be valuable for guiding introgression efforts in breeding programs and for improving the efficiency of germplasm management (Huynh *et al.,* 2013.). The International Institute of Tropical Agriculture (IITA) maintains a collection of over 15,000 cowpea accessions of cultivated varieties from over 100 countries and 560 accessions of wild cowpeas. These have been characterized and evaluated for desirable traits and being preserved and used in the breeding program. Extreme cowpea genotypes have been observed with respect to many traits and genetic studies have identified several desirable genes which control plant pigmentation, plant type, plant height, leaf type, growth habit, photosensitivity and maturity, nitrogen fixation, fodder quality, heat and drought toler- ances, root architecture, resistance to major bacterial, fungal and viral diseases, resistance to root- knot nematodes, resistance to aphid, bruchid and thrips, and resistance to parasitic weeds such as Striga gesnerioides and Alectra vogelii. pod traits, seed traits and grain quality (Ferry and Singh, 1997; Singh, 2002). Limited studies have also been conducted on genetic maps including classical as well as DNA markers (Singh, 2015). Development of highly superior and high-performing genotypes can be achieved through exploitation of cowpea genetic resources to identify and select suitable genotypes with desirablephenotypic traits for use in improvement programmes (Mofokeng *et al.,* 2020).

Breeding Objectives

1. High green pod yield (vegetable type varieties); 2. High seed yield (dry-seed type varieties); 3. High fodder yield (fodder type varieties); 4. Dual purpose (seed and vegetable type and seed and fodder); 5. Earliness; 6. Appropriate plant type (erect, determinate for vegetable and seed type cultivars and spreading type for fodder type cultivars); 7. Wider adaptability; 8. Photo-insensitive; 9. Short tender pods for whole pod processing; 10. Long, tender and string-less pods for fresh consumption and 11. Varieties suitable for inter-cropping (Waqas, 2018; Gayatonde, 2018; Vidhi, 2023).

Cowpea is one of the least researched crops in South Africa until recently. There were no crop improvement activities until three years ago when cowpea breeding was included as one of ARC's research mandates. Considerable progress has been made in developing improved genotypes suitable for South African environment and market in the last three years in order to fill the gap and replace the old and pest-susceptible cultivars. The major breeding activities are to acquire more germplasm accessions in orderto increase genetic diversity of South Africa's cowpea genebank and develop more high-yielding genotypes with acceptable seed size and quality, develop cultivars tolerant to pests such as cowpea aphids, nematodes and virus as well as drought tolerance. Significant progress has been made in breeding cowpea cultivars with different maturity groups (early and medium maturity) dual-purpose and fodder types (Asiwe, 2007). One of the major goals of cowpea programs is to combine resistances to numerous pests and diseases and other desirable traits such as those governing maturity, photoperiod sensitivity, plant type, and seed quality. Parental lines with many desirable traits, such as resistance to cowpea weevil, cowpea aphid, and the parasitic weeds *Alectra vogeili* and *Striga gesnerioides*, along with resistancesto bacterial blight, CABMV, and other pathogens, exist in different advanced breeding lines developedby cowpea breeding programs around the world. One of the biggest current challenges is to incorporate all of these desirable traits into individual cultivars with acceptable grain quality and adaptation to targeted farming systems and environments. Marker Assisted Selection (MAS) could be an important tool to facilitate this effort. Cowpea remains to a large extent an under exploited crop where relatively large genetic gains can be made with only modest investments in both applied plant breeding and molecular genetics. Cowpea is grown mostly by poor farmers in developing countries and, as a consequence, has received relatively little attention from a research standpoint. Indeed, cowpea has been identified as an "orphan crop" that is recommended for increased public support for biotechnology research. A major challenge will be to apply the knowledge being gained from basic genomics research on "model species" such as Arabidopsis, rice (*Oryza sativa*), and *Medicago truncula*ta to cowpea (Timko *et a*l., 2007). Two superior lines with high seed yield and quality were selected through mutation breeding and released to farmers as new varieties under the names Kafr El Sheikh-1 and Kaha-1. Crosses were made between these two varieties to further improve cowpea to meet farmers' demand. Using the pedigree selection method, 13 new superior F_{10} lines were selected and evaluated over 2 years for seed yield and related traits, earliness, and protein content under low (16 plants/m^2) and high (24 plants/m^2) plant densities. The results showed that plants grown in narrower space produced significantly higher seed yield per unit area than the plants grown in wider space. All developed lines produced significantly higher seed yield than the two parental lines in the 2018 trial and Kaha-1 in the 2019 trial. Line number 6 proved to be the best genotype for earliness (73.5–73.9 days after sowing), seed yield (573–647 g/m^2), and crude protein content (22.7–24.3%) in both trials. In addition, line 4 with bushy determinate growth habit and high seed quality was recently released as a new variety (Sakha-1). Several other cowpea lines have clear potential for release as new high-yielding varieties with early maturity and high seed quality for farmers in Egypt. Seeds of selected lines are available from Kafrelsheikh University. This shows that mutation breeding and pedigree selection methods are among the most promising breeding methods for cowpea improvement (Metwally *et al.,* 2021). The drastic change in climate has compelled the plant breeders to develop climate-resilient cowpea, which can withstand abiotic stresses along with new emerging insect pests and pathogens. Unlocking the repository of genetic diversity of cowpea and its wild relatives and their efficient utilization in climate-resilient cowpea pre-breeding programs is imperative now. Recent advances in genomics along with high-throughput phenotyping and genotyping platforms have been exploited toward identifying underlying genes/QTLs for climate change relevant traits in cowpea. Genomics-assisted breeding approaches such as marker-assisted backcrossing (MABC), marker-assisted recurrent selection (MARS), and genomic selection (GS) have proven helpful in developing climate-resilient cowpea. Moreover, genome editing tools can further accelerate the improvement of cowpea for climate change adaptive traits (Sahay *et al.,* 2022). The genetic variation and the relationship between cowpea landraces collected in Portugal with those originated in Mozambique is reported. Despite the shared historical past, the Portuguese landraces did not share a common genetic background with those from Mozambique, and two different gene pools were revealed. Knowledge of the genetic structure of cowpea landraces offers an opportunity for individual selection within landraces adapted to particular eco-physiological conditions and suggests the existence of a valuable gene pool for exploitation in future Portugal-PALOP (Portuguese-speaking African countries) cowpea breeding programs (Guimarães *et al.,* 2023).

Breeding Methods

Pedigree breeding: Three principal methods are used in breeding self-pollinated crops like cowpea: pedigree, massselection, and single-seed descent. The pedigree method, often with slight modifications, is theone most frequently used. Segregating populations generated from crosses are selected at the F_2 and subsequent generations. Selections are based largely on the main character of interest, for example, resistance to the parasitic weed *Striga*. Detailed data on maturity, time to flower, growth habit, and grain and fodder yield are collectedand the most promising single plants selected for advancement. Other traits of interest are selected for, as well, including seed color, seed texture, seed size, and leaf yield. The relativeimportance of these traits varies with the particular breeding program. For example, leaf yield is more important in eastern and southern Africa while West and Central African breeding projects lay more emphasis on grain and fodder yield. When the pedigree breeding method is used, between 60 and 200 F_2 single plants are scored using a negative selection approach—those with undesirable traits, for example, black seeds, are discarded. Next, each of the selected F_2 plants is used to plant a progeny row. In the subsequentF_3 generation still more stringent selection criteria are used to reduce the population size further. Those F_3 families that breed true for the principal characters are advanced to the F_4 generation. At F_4 evidence of segregation for the principal characters is enough to prevent a family from being advanced to the succeeding filial generation. From F_5 and F_6 onwards, attention is placed mostly on quantitative traits such as seed size, generation, most of the families must have been fixed for not only the principal character of interestbut also for most of the secondary characters.Subsequent evaluations of the F_6 through F_8 families are conducted mainly to assess yield andmaturity performance. At each stage of selection, the breeder may save a portion of the seed of each family as insurance against crop failure. The fully characterized families are then grouped on the basis of maturity group into early,medium, and late; or by seed color into brown, white, or other colors. Each group is then subjectedto a preliminary yield trial (PYT). The trial is replicated at one or more locations. Locations are carefully selected to represent the typical production ecologies. The more promising entries,usually a maximum of 20, are pulled together from the various groups to form an advancedyield trial (AYT). The number of replications as well as test sites is greater for AYT compared to PYT. AYTs can require 2 or 3 years dependingon the breeder and the trait under consideration. The main aim of the AYT evaluation is to ensure rigorous evaluation of the genotypes under allpossible stressful conditions. This helps to ensurethat superior genotypes are selected. Eventually the AYT will have identified three or four most-promising lines; these are recommended forrelease. In some African programs national policy may require an additional on-farm evaluation by farmers to corroborate the breeder's claim about the superiority of the new lines over local commercial varieties. Some varieties developed using this approach are listed in Table 3. The pedigree method of breeding requires meticulous records on the characteristics of each F_2 plant and its subsequent progenies through to the F_6 or F_8 generation. This makes the method cumbersome and time consuming.

Table 3. Some cowpea varieties developed using the pedigree breeding method

Variety	Origin	Country of release
IT845-2246-4	IITA Ibadan(a)	Nigeria
IT89KD-245	IITA Ibadan	Nigeria
IAR-48	IAR2 Samaru(b)	Nigeria
IT90K-76	IITA Ibadan	Nigeria
IT89KD-374-57	IITA Ibadan	Nigeria
KVX-176B	INERA3, Ouagadougou(c)	Burkina Faso
IAR 355	IAR Samaru	Nigeria
IT90K-277-2	IAR Samaru	Nigeria

(a)IITA, International Institute of Tropical Agriculture
(b)IAR, Institute for Agricultural Research
(c)INERA, Institut National Environmental Recherche Agricole

However, it hasthe advantage of allowing the breeder to comparethe various families tracing their performance back to the antecedent F_2 plant. In addition, the genetic dynamics of several genes in the population can be studied. Therefore, despite its drawbacks when used with self-pollinating crops like cowpea, the pedigree method is best for most situations (Murdock *et al.,* 2008).

The pedigree system of breeding is the most common method used by cowpea breeders. This method has been successful in developing cowpea cultivars with new combinations of characteristics and resistance to diseases. Single plant selections are carried out within large F_2/F_3 populations. Individual plant progenies are planted in one or more rows, 4-6 m in length and 1.5 m apart (Vidhi, 2023).

Single-seed descent: To advance each selected F_2 plant derived from a cross or selfing program, a single representative seed from each plant is selected. This method has been adopted less widely in cowpea breeding. The few reported instances involve the development of pure lines from local landraces. Cowpea lines IT88DM- 345, IAR-1696, and possibly IT85ID-985 are examples. A single seed is selected from each selfed plant from the various landrace collections. After the plants are evaluated for genetic purity, a single seed is then selected from each of the plants having the desired trait. This process is repeated until substantial phenotypic homogeneity is attained. Finally at the F_{6-8} level, seeds from the most promising strains are multiplied for further field evaluation, if the objective is to develop a pure line cultivar or if the line is to be included in a hybridization program to produce further improvement (Murdock *et al.,* 2008).

Backcross breeding: As with other crops, the backcross breeding method seeks to improve the genetic value of a locally adapted cultivar that has a few genetic defects such as susceptibility to diseases, low oil or sugar content, etc. In practice, the hybrid between the adapted variety receiving the gene for further improvement—known as the recurrent parent—and the source of the gene of interest—the donor parent—are backcrossed again or several times, preferably as the male parent to the recurrent parent. With each backcrossing, in addition to acquiring the gene of interest, 50% of the genome of the recurrent parent is transferred into the backcross hybrid. For example, BC_1, BC_2, BC_3, and BC_4 are 50%, 75%, 87.5%, and 93.75% recurrent parent genome, respectively. Some of the varieties developed using this method include IT89KD-245, IT89KD-260, and IT90K-277-2. Seed size and general adaptation are the most common target traits for improvement using this approach (Murdock et al., 2008). The backcross breeding procedure has been found efficient for transferring single-gene resistance to specific diseases into cowpea cultivars. For example, this procedure has been used to transfer the Cls gene, which provides resistance to *Cercospora* leaf spot into the susceptible cultivar Colossus in USA (Vidhi, 2023).

A combination backcross-pedigree breeding procedure has also been used successfully to transfer a desired trait from a relatively un-adapted genetic background into a well-adapted commercial cultivar which is lacking in a particular trait. In this approach only one or two and rarely three backcrosses are made and after that the material is handled as per conventional breeding procedure. This method has been found successful by the author himself at Pantnagar in transferring resistance to yellow mosaic virus from a wild soybean, Glycine soja to cultivated soybeans (Vidhi, 2023).

Mutation breeding: Mutation breeding in cowpea has been utilized on a limited scale through irradiation (9-40 kR) by gamma rays to isolate mutants with increased yield and earliness. Mutants with resistance to cowpea aphids (ICV 11 and ICV 12) have been obtained from ICV 1 seeds irradiated with 20k rad of gamma rays. Surprisingly the mutants differed from ICV 1 in several traits, including having semi-erect rather than spreading growth habit, and longer pods with 19 seeds compared with only 13 seeds/pod for ICV 1 and aphid resistance of ICV 11 was shown to be conferred by a dominant gene (Vidhi, 2023).

Selection techniques: The overall success of a cowpea breeding program depends largely on the effectiveness of the selection tools used to identify desirable genotypes through their phenotypes. If the precision of the tools is low, improvement of the population for the trait will be small. Even when there is an effective tool for selection, the genetic variation in the genome must be sufficient to warrant exploitation—as is often not the case for major insect pests of cowpea. Barriers to genetic recombination between genotypes must also be surmounted to facilitate introgression of desirable genes into different backgrounds (Murdock *et al.,* 2008)

Pollination: Cowpea flowers are large and showy. Flowers open only once between 7 and 9 am. On cloudy days the flowers may open even in the afternoon. Though the flowers open late in the morning, the dehiscence of the anthers is much earlier. It may vary from 10 pm to 0.45 am. The dehiscence is influenced by environmental factors like presence of moonlight, a clear sky and a dry warm atmosphere. During dark nights the dehiscence tends to be delayed. Due to dehiscence taking place before the opening of flowers, the cowpea is strictly self-pollinated in nature. Since the dehiscence of anthers is much in advance of the blooming, the emasculation needs to be carried out in mature flower buds in the preceding evening. The flower buds likely to bloom the next day (recognised by large size, the yellowish colour of the back of the standard petal) is selected for emasculation. The bud is held between the thumb and the fore-finger with the keel side uppermost. A needle is run along the ridge where the two edges of the standard unite. One side of the standard is brought down and secured in position with thumb. Same thing is done with one of the wings. After this the exposed keel is slit on the exposed side, about 1/16 inch from the stigma. A section of keel is also brought down and secured in position under the end of thumb. Now 10 stamens are seen. They are removed with pointed forceps. Afterwards, the disturbed parts of standard, wing and keel are brought in original position as far as possible. To prevent drying out of the emasculated bud, a leaflet may be folded and pinned around the bud. A tissue paper can be used to cover and protect the bud. Pollination is done next morning from a freshly opened flower. The standard and wings of male flower are removed. By slight depression of the keel, stigma covered with pollen grains protrudes out. This itself can be used as a brush for pollination. Cowpea flowers are highly sensitive and drop off easily with slight mechanical disturbance or injury. Therefore, much labour and time is devoted to get enough crossed seed. For pollination next morning, freshly opened flower from male parent is taken. The portion of keel containing anthers and style with stigma is taken out from the freshly opened flower. Anthers and style from this keel cap are removed. The keel cap is put on the stigma of emasculated flower bud. The pollen mass collected inside the keel cap pollinates the emasculated flower bud (Vidhi, 2023).

Floral biology of cowpea, selfing and crossing technique are depicted as follows (Fig. 9) (Gayatonde, 2018; Waqas, 2018):

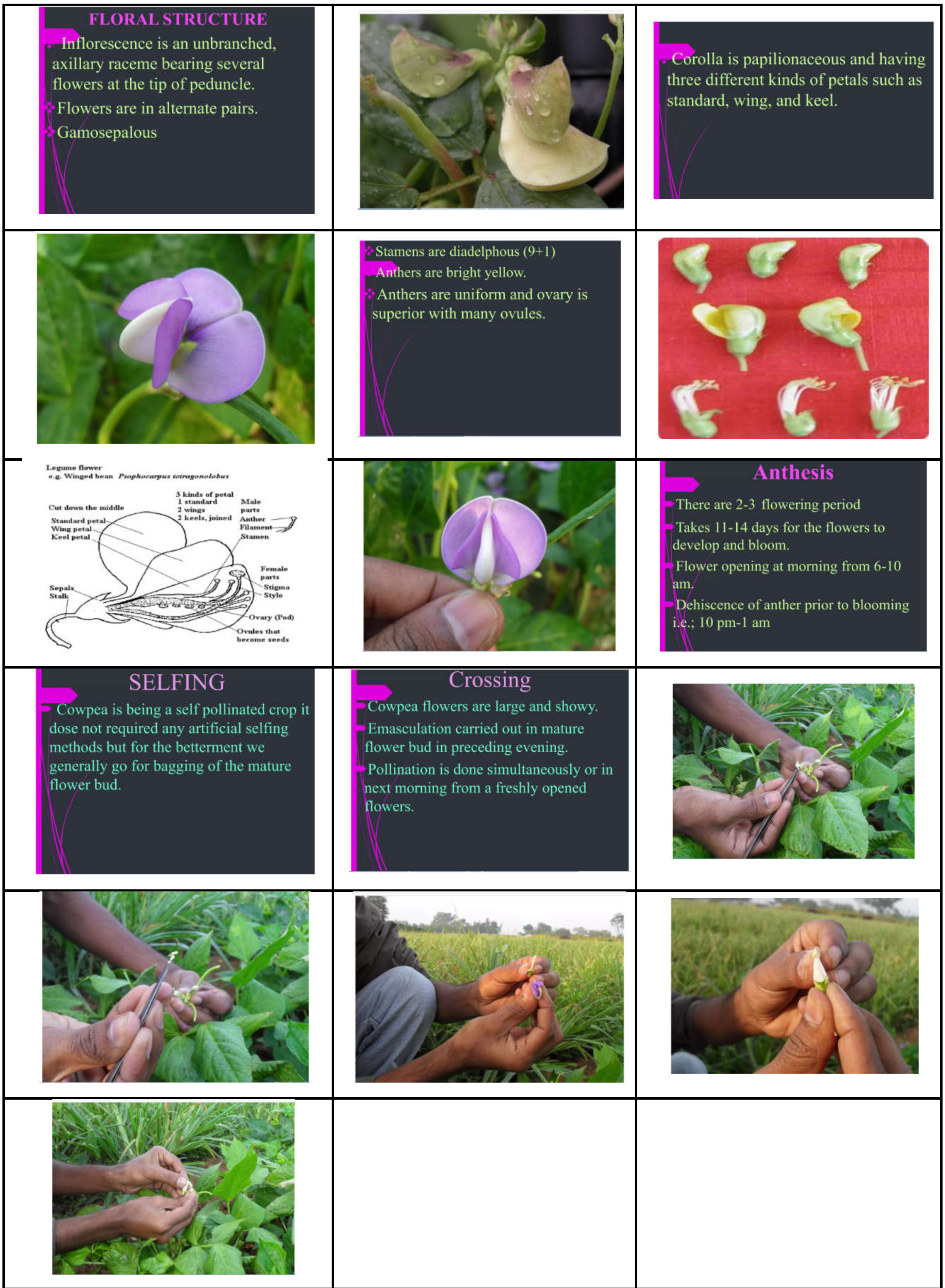


Fig. 9: Floral biology of cowpea, selfing and crossing technique (Gayatonde, 2018; Waqas, 2018)

Breeding For Resistance to Diseases in Cowpea: The success of a resistance breeding programme depends on identification of stable sources of resistance, their use in large number of crosses and handling of segregating generations in a disease condusive environment, preferably a disease sick plot/hot spot location. Anthracnose, Cercospora leaf spot, Ascochyta blight and mosaics are serious diseases of cowpea. The major work on disease resistance breeding on cowpea is being carried out at International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Sources of resistance to different diseases in cowpea are given in Table4 (Vidhi, 2023).

Table 4. Sources of resistance to different diseases in cowpea

Disease	Resistance sources
Anthracnose, rust, cercospora, bacterial pustule cowpea yellow mosaic virus,	TVu 310, 345, 347, 410, 645, Iron
Cowpea yellow mosaic, cowpea mottle, cowpea aphid-borne mosaic, southern bean mosaic, golden mosaic	TVu 393, 493, 1185, 2755, Iron
Fusarium wilt	TVu 109-2, 347, 984, 1000, Iron
Bacterial blight	TVu 347, 410, 483-2, VITA-3
Scab	TVu 853, 1404, 1433, VITA-4
Septoria	TVu 456, 483-2, 486, 1433, VITA-4
Brown blotch	VITA-1
Root knot	VITA-1, VITA-4
Phytophthora stem rot	Ku-235

Several improved breeding lines have been developed at IITA which have resistance to bacterial blight and bacterial pustules, e.g., TV_X 1850-01 E, IT 90 K-284-2, IT 90 K- 277-2, IT 86 D-719 and IT 8ID-1228-11. TV_X 3236 is highly resistant to anthracnose and brown blotch. Breeding line H 8-8-27 developed by University of California has resistance to race 4 of fusarium wilt. Cowpea cultivars IT 82 D-889, IT 835-818, IT 83 D-442 and IT 85 F- 867-5 are reported to be resistant to CPMV, CABMV, CGMV, CMV and SBMV (Vidhi, 2023).

Breeding For Resistance to Insect Pests in Cowpea: Aphids are a serious problem in dry regions, reducing yield not only directly but also indirectly by transmitting viral diseases. Resistant varieties (based on antibiosis) have been developed. Inheritance studies have shown the involvement of a single dominant gene for resistance. Thrips can cause yield losses up to 100 per cent. The sources are available. Resistance is controlled by two recessive gene pairs. Similarly, donors for bruchid have been identified and inheritance studies have revealed that bruchid resistance is controlled by two recessive gene pairs. Resistance to pod borer (*Maruca testulalis*) is dominant and the trait is probably controlled by several genes. The sources of resistance to different insect pests in cowpea are given in Table 5. These have been identified by systematic screening of 6000 lines at IITA (Vidhi, 2023).

Table 5. Sources of resistance to different insect pests in cowpea

Insect pest	Sources of resistance
Leafhoppers	TVu 59, 123, 662, VITA 3
Aphids	TVu 36, 62, 408, 410, 801, 2896, 3000
Thrips	TVu 1509
Bruchids	TVu 2027, 11952, 11953

Cowpea Breeding at IITA: The International Institute of Tropical Agriculture (IITA) has a global mandate for cowpea improvement and therefore, it develops and distributes improved cowpea varieties to over 65 national programs. To meet the regional preferences for specific seed types and adaptability to different environments, IITA's general strategy is to develop a range of breeding lines with diverse maturity, plant type and seed type with combined resistance to major diseases, insect-pests, Striga, Alectra and broad based adaptability (Singh, 2015).

Breeding for grain type and dual-purpose cowpea varieties: Combining erect plant type with early maturity and resistance to major pests new extra-early cowpea varieties have been developed which yield from 1.5 to 2.5 tons/ha within 60 days compared to less than 1ton/ha of the local varieties which mature in 100 to 140 days. Similarly, a number of medium maturing dual purpose cowpea varieties have been developed which yield over 2.5 t/ha grain and over 3t/ha fodder in 75-80 days. These varieties have been tested and released in 65 countries covering Africa, Asia and Central and South America (Singh, 2015).

Breeding for resistance to biotic stresses: Using a combination of field and laboratory screening, a number of cowpea breeding lines have been developed with combined resistance to cowpea yellow mosaic, blackeye cowpea mosaic and many strains of cowpea aphid borne mosaic, Cercospora, smut, rust, Septoria, scab, Ascochyta blight, bacterial blight, anthracnose, nematodes, Striga, Alectra, ahpid, thrips and bruchid (Singh, 2015).

Breeding for tolerance to abiotic stresses: Using simple screening methods for heat and drought tolerance and root architecture, major varietal differences for all the three traits have been identified and incorporated into improved lines (Singh & Matsui, 2002). Significant progress has also been made in developing cowpea breeding lines with enhanced nitrogen fixation and tolerance to low phosphorus (Singh, 2015).

Breeding for improved nutritional quality: A systematic breeding program to develop improved cowpea varieties with enhanced levels of protein and micronutrient contents was initiated in 2003 and considerable progress has been made. A total of 2000 germplasm and breeding lines have been evaluated. The analytical results showed signifi-cant genetic variability for all the attributes and the values ranged between 21 to 30.7% for protein, 545 to 1300 ppm for calcium, 48 to 79 ppm for iron, 23 to 48 ppm for zinc, and 12750 to 16150 ppm for potassium (Singh, 2015).

Global impact of cowpea research: The release of about 40 new improved cowpea varieties in over 60 countries has led to a quiet revolution in cowpea cultivation throughout the tropics. From about 6.3 million ha and 1.1 million tons production in 1974, the global area and production under cowpea in 2004 was about 14.5 million ha and 4.5 million tons respectively. The new cowpea varieties developed have been given special names like'Victory' and 'Breeze' in Sri Lanka, 'Light' and 'Sky' in Nepal, 'Big Buff' in Australia, 'Hope' and 'Pride' in Tanzania, 'Gold from the Sand' in Sudan, 'Son of IITA' in Nigeria, 'Korobalen' in Mali, Ayiyti, Asontemand Bengpla in Ghana, and 'Titan' and 'Cubinata' in Cuba etc. Millions of small holder farmers in the tropics are benefiting from the new improved cowpea varieties (Singh, 2015).

Drought tolerant lines: Increasing the level of drought tolerance in existing cowpea varieties grown by farmers would enable them to obtain more and stable yield from their cowpea fields. As a first step towards enhancing drought tolerance in existing cowpea varieties, 1288 lines were selected randomly from cowpea germplasm collections maintained at the International Institute of Tropical Agriculture (IITA)and evaluated for their drought tolerance at Ibadan. Drought was imposed by withdrawal of irrigation from 5 weeks after sowing. On average, drought reduced the number of days to flower by 12 d, and the mean grain yield per plantwas also reduced by 67.28%. A few of the cowpea lines stayed green for up to 6 weeks after irrigation was stopped, even though some of these produced no pods when the study was terminated. Further evaluation in the screenhouse of 142 selected drought-tolerant lines helped to identify six lines that could be potential parents for developing breeding lines with enhanced drought tolerance (Fatokun *et al*., 2012).

Bush Varieties: Bush-type vegetable varieties with 30-cm long succulent pods have been developed, such as IT81D-1228-10, IT81D-1228-14, IT81D-1228-15, and IT86D-880, which yield up to 18 t/ha green pods with 3-4 pickings starting at 45 days after planting. These varieties have semi-erect growth habit with extra-long peduncles (40-50 cm long), protruding well over the canopy and holding the pods above the ground. Picking green pods periodically reduces the weight on peduncles and they remain upright all the time. Frequent picking also stimulates further flowering and podding on the same peduncles, which ensures a continuous supply of green pods for a 6-7 week period after the start of picking, provided soil moisture is not limiting. These varieties have been distributed to several national programs. Some of these varieties have been found promising in China, Nepal, Sri Lanka, Philippines, the West Indies, and Nigeria (Singh *et al*., 1957)

Recommended Varieties for different zones of India: A number of improved varieties have been developed to fit in cowpea in intensive cropping systems under varying situations in different states of the country (Table 6) (Pallavi, 2023).

Table 6. Cowpea varieties recommended for different zones of India

States/UTs	Recommended varieties
Bihar	Pusa Sampada (V 585), Pusa Rashmai (V 576), V 240, Pusa 152.
Delhi	Pusa 578, Safed (V 130), Amba (V 16), V 585.
Gujarat	Pusa Sampada (V 585), GC 5, GC 4, V 240, GC 3, GC 2.
Haryana	Pusa 578, Safed (V 130), UPC 9202, UPC 8705, V 585.
Karnataka	Subhadra, KBC 2, S 488.
Kerala	Krishnamani, Kanakamani.
Madhya Pradesh	Pusa Sampada (V 585), Pusa Rashmai (V 576), V 585, UPC 9202, UPC 8705, GC 3, Pusa 152.
Maharashtra	Durga Kranti, V 240, Pusa 152, V 585.
Orissa	V 240, Durga Kranti, Pusa Swarna.
Punjab	Pusa 578, Safed (V 130), Pusa Swarna (V 38), V 585.
Rajasthan	Pusa Sampada (V 585), Pusa Rashmai (V 576), Rambha V 240), UPC 9202, UPC 8705, UPC 607, Shubra, RC 101, V 240, RC 19, RC 101.
Tamil Nadu	Co 6, Vamban 1, Co 5, Paiyur 1, CoVu 702.
Uttar Pradesh	Pusa Sampada (V 585), Pusa Rashmai (V 576), Rambha V 240), Shalimar cowpea 1, UPC 9202, UPC 8705, UPC 607, UPC 4200, Shubra.
West Bengal	Pusa 152, Pusa 578, Safed (V 130), Durga Kranti, UPC 9202, UPC 8705, UPC 607, V240.

Several early- and medium-maturing varieties such as 'Amba', 'Rambha', and 'Shveta' have been developed, and are used for both green pods and dry grains. The cowpea variety development programs in India aimed at transferring disease resistance, better grain quality, or earliness but paid less attention to developing an efficient plant type for intensive cultivation. Some varieties, such as V 16 (Amba) and V 38, were semi-spreading. V 38 has long peduncles and the pods are held above the crop canopy. The truly upright nontrailing varieties are still not available in Southeast Asia. However, a number of extra-early maturing varieties from IITA have shown great promise (Singh *et al.,* 1957). Several countries in Asia have identified promising grain-type varieties from IITA and released them for general cultivation: VITA-4 (Yezin 1) in India, Myanmar, and Pakistan; IT82D-889 (Prakash) and IT82D-752 (Aakash) in Nepal; IT82D-889 in Philippines and Thailand; and IT82D-789 (Wijaya) and IT82D-889 (Waruni) in Sri Lanka. Vegetable cowpeas, both yardlong and bush types, are most important in China, Indonesia, Korea, and the Philippines and several new varieties have been developed (Singh *et al.,* 1957). Genotypes PI339600, PI527263, PI527302, PI582793, PI582867 and SARI-6-2-6 produced high grain yields under both drought stress and non-stress conditions. These genotypes could be exploited for future breeding programs for developing drought tolerant cowpea varieties for the savannah ecology and other areas with similar environmental conditions such as semi-arid tropics, including the Sahelian and Guinea Savannah regions in West Africa (Singh, 2014). Cowpea is predominantly grown as rainfed crop during kharif both as intercrop and sole crop. Optimum sowing time is first fortnight of June. However, depending on the receipt of monsoon rains, it can be sown up to middle of July. In southern states, short duration cowpea is grown during rabi after kharif rice as an irrigated crop if irrigation water is inadequate for more remunerative crops. Optimum sowing time is February first week. In north India, it is grown during summer as an irrigated- crop after rabi wheat. April first fortnight is the optimum time of sowing. Generally, short duration varieties are grown during summer (Pallavi, 2023).

Vegetable type cowpea varieties (Vidhi, 2023; IIHR, 2023; IIVR, 2023):

Pusa Phalguni: It is a selection from a promising introduction Dolique Du Tonkin (ex Canada). The plants are dwarf with bushy habit. It gives two flushes of dark green erect pods of 10-12 cm length with small cylindrical white seeds. Pods get ready for harvesting in about 60 days. Yield potential of green pods is 75 q/ha. It is best suited for February-March sowing.

Pusa Barsati: It is a selection from exotic materials from Philippines. It is an early cultivar (45 days to first green pod picking) suitable for growing during the rainy season. It gives 2-3 flushes of light green pendent pods. The pods are 25-28 cm long and contain large green seeds. Green pod yield potential is about 75 q/ha.

Pusa Do Fasali: It is bushy type. It has been developed from cross of Pusa Phalguni and a long podded introduction from Philippines. It flowers in 35-40 days after sowing. Pods are light green, erect, about 18 cm long. Plants are bushy. It is photo-insensitive and is suitable for sowing in spring- summer and rainy seasons. Green pod yields are lower in summer plantings than those in the rainy season. The green pod yield potential is about 80 q/ha.

Yard Long Bean (*V.u. sesquipedalis*): It is commonly grown in home gardens in Uttar-Pradesh. It is not suitable for transportation as pods break easily. Pods are about 50 cm long. The plants are viny type and mature late (100 days). Green pod yield potential is 100 q/ha.

Pusa Komal (Sel. 1552): It has been bred at IARI, New Delhi. It has been recommended for release by the all India coordinated vegetable improvement workshop, 1983. It is a dwarf and bushy cultivar suitable for planting in spring-summer and rainy seasons. Pods are light green, 25-30 cm long. It flowers in 45 days and gives 2-3 flushes. It is resistant to bacterial blight. The green pod yield potential is 100 q/ha.

Pusa Rituraj: This is a selection in germplasm by National Bureau of Plant Genetic Resources, New Delhi. This is photo-insensitive and can be grown in summer and rainy seasons. First picking is possible in 40-50 days. The plant is bushy. Pods virtually cover the foliage. Pods are 20-25 cm long. It is a dual purpose variety as pods and seeds (brown) both can be consumed. Green pod yield potential is 80 q/ha.

Bhagya Lakshmi: It has been developed at KAU, Vellanikara. Pods are light green, 30 cm long, borne in cluster of 2-4, resistant to anthracnose, 65 q/ha.

Narendra Lobia 1: This variety was evolved at NDUAT, Narendranagar, Faizabad from a cross of L 1552 (now released as Pusa Komal) X Varanasi Local following pedigree method of breeding. It has been released by the U.P. State Variety Release Committee meeting on 7.4.1995. It has determinate plant habit. Plant height is 40-45 cm. Foliage is green with large leaves. Green pods are 28-32 cm long with purple terminal end. Each pod contains 10-12 seeds. Seeds are bold (18 g/100 seeds) with black hilum. Edible pod maturity is 45-48 days and seed maturity 75-80 days. It is photo- insensitive and can be grown in summer and rainy both the seasons. Green pod yield potential is 90 q/ha.

Arka Samrudhi: Plants erect, bushy and photo-insensitive. Pods green, medium thick, medium long round, tender, fleshy without parchment with good cooking qualities. Pod Yield: 19 t/ha in 70-75 days.

Arka Mangala: Plants tall (3-4 m), pods are very long (80 cm), light green, stringless, round, tender with crisp texture and matures in 60 days. Suitable for kharif and rabi. Pod yield: 25 t/ha in 100 days.

Arka Suman: Plants erect, bushy and photo-insensitive. Pods medium long, tender, fleshy, crisp, without parchment with good cooking qualities. Pod Yield: 18 t/ha in 70-75 days.

Arka Garima: Plants tall, photo-insensitive. Pods light green, long, thick, round, fleshy and stringless. Suitable for vegetable purpose. Tolerant to heat and low moisture stress. Pod Yield: 18 t/ha in 70-75 days.

Kashi Nidhi: Plants are dwarf, erect and bushy, with 20-25 peduncle per plant. Fruits are green, 25-30 cm long. Seed colour is reddish brown. Golden mosaic virus and Pseudocercospora cruenta tolerant with an average pod yield of 140-150 q/ha. Better yield and keeping quality suitable for distant marketing. Recommended for release and cultivation in the states of Uttar Pradesh, Bihar, Haryana, Punjab and Jharkhand. Vide gazette notification number S.O. 2363(E), 04.10.2012

Kashi Sudha: Golden mosaic virus and Pseudocercospora cruenta tolerant, Identified for UP, Bihar, Jharkhand, Bihar, Andhra Pradesh, Orissa, Chattisgarh, Madhya Pradesh and Maharastra by AICRP-VC.

Kashi Kanchan: This is dwarf and bush type (height 50-60 cm), photo-insensitive, early flowering (40-45 days after sowing) and early picking (50-55 days after sowing) variety suitable for growing in both spring-summer and rainy seasons. Pods are about 30-35 cm long, dark green, soft, fleshy and free from parchment. The cultivar gives green pod yield of about 150-175 q/ ha and is resistant to golden mosaic virus and Pseudocercospora cruenta.

Kashi Unnati: This is a photo-insensitive variety. Plants of this variety are dwarf and bushy, height 40-50 cm, branches 4-5 per plant, early flowering (30-35 days after sowing), first harvesting at 40-45 days after sowing, produces 40-45 pods per plant. Pods are 30-35 cm long, light green, soft, fleshy and free from parchment. The cultivar is resistant to golden mosaic virus and Pseudocercospora cruenta, and gives green pod yield of about 125-150 q/ ha.

Cowpea-74: the variety was developed by pau, ludhiana by hybridization (FS 68 × Strain No. 102) followed by selection. It has been released for cultivation in Punjab in 1975. (CVRC- notification no. 13 dated 19th December 1978).

Kohinoor: this variety was developed by IGFRI, Jhansi through single plant selection from material from itan (IL-68-786) and released for parts of Haryana, Punjab, Gujarat and UP. The plant height is 55-70 cm, stem green in colour, pods are green with a smooth surface and horizontally dispositioned with tendency to droop. The seeds are bold and red. Average green fodder yield is 40-45 t /ha and average dry fodder yield 50-60 t/ha. The mvariety has excellent growth in summer. (CVRC- notification no. 441(e) dated 21st August 1975).

Graintype cowpea varieties (NPRC, 2023):

Varieties	Parentage	Duration (days)	Grain yield (kg/ha)		Special features
			Rainfed	Irrigated	
CO 1	Pureline selection from Coimbatore local	135	750	---	Long duration type and suitable for rainfed condition.
CO 2	C521xC49	90	11.0 tons green pods	1375 Vegetable yield 9.4 t/ha	Vegetable type.Seeds reddish brown with irregular patches S.O. 13 / 19.12.1978
KM 1	JC5xDufasli	65	-	1000	Seeds white with prominent black hilum. Small seeded (100 seed weightt.7.0 grams) and early. S.O. 661 (E) / 17.09.1997
CO 3	Pureline from AC152	80	830	1085	Suited to rainfed & irrigated situation S.O. 661 (E) / 17.09.1997
CO 4	Selection from Russian giant	85	960	1570	Clusters are projected above canopy. Suited to rainfed & irrigated conditions. Slate coloured seeds. S.O. 596 (E) / 13.08.1984
Paiyur 1	Selection from VM 16	90	750	---	Suited for rainfed tracts of Dharmapuri, Madurai, Ramnad, Tirunelveli and Periyar Districts. S.O. 258 (E) / 14.05.1986
CO 5	Gamma ray mutant of CO 1	55-60 (fodder) 100-105 (seed)		Fodder: 25 t/ha Seed : 600 kg/ha	Fodder Cowpea S.O. 867 (E) / 26.11.1986
CO 6	Ms 9804xC152	65-70	700	---	Dwarf and suited to rainfed conditions S.O. 92 (E) / 02.02.2001
Vamban 1	Pureline selection from IT 85-F2020	55-65	950	---	White grain type and suited to rainfed condition thorughout Tamil Nadu S.O. 647 (E) / 09.09.1997
Vamban 2	Selection from IT-81-D-1228-10 (culture VCP 6)	75-85	10581 green pods	---	Vegetable type, Ivory coloured seeds and suited for all seasons.
CO(CP) 7	Mutant of CO 4(20 kR)	70-75	1000	1600	Square, dull brown seeds S.O. 1177 (E) / 25.08.2005
CO(FC) 8	CO 5 / N331	60-70 (Fodder) 100-105 (Seeds)	-	Fodder: 30 t/ha	High green fodder, Indeterminate type of growth, Resistant to cowpea yellow mosaic virus and root rot S.O. 1177(E)/ 25.08.2005
CO 9	CO 5 / Bundel Lobia 2	Green fodder: 50 – 55 days Seed production: 90 – 95 days	-	Fodder: 23 t/ha	Higher protein content (21.56 %); Reduced fibre portions confer increased digestibility, palatability and intake rate; MR to YMV and resistant to major pests S.O_1379(E)_2018 dated 27.03.2018
VBN 3	TLS 38 x VCP 16-1 (Culture: VCP 09-013)	75-80	1013	-	Suitable for cultivation in Adi pattam (August - September) and Purattasi Pattam (September – October). Determinate plant type, synchronized maturity, multiple resistance to Bean Common Mosaic Virus, rust and anthracnose diseases. S.O.6318(E) dated 26.12.2018

Fodder type cowpea varieties (LCA, 2023):

HFC-42-1 (Hara Lobia): this is an erect variety with dark green foliage and is suitable for mixed cropping. The variety has been developed by ccs hau, hisar and is suitable for cultivation in Haryana and Punjab. It gives green fodder yield of 262 t/ha. (CVRC notification no. 786 dated 2nd February 1976).

Cowpea-74: this is a variety from PAU, Ludhiana developed from irradiation of F1 of cowpea-74 × H2 for Punjab state. (CVRC- notification no. 13 dated 19th december 1978). EC 4216: the variety was developed by IARI, New Delhi through selection from exotic material. The plants are erect to semi-erect, 140-150 cm long and climbing type. The, green fodder yield is 30 t/ha and dry matter yield is 5.5 t/ha. (CVRC-notification no. 13 (e) 19th December 1978).

Type-21: the variety was developed by IGFRI, Jhansi through single plant selection from the local material and is recommended for cultivation all over the country. The plants have dark green leaves and provides 33 t/ha green fodder and 5 t/ha dry fodder. (CVRC notification no. 13 (e) 19th December 1978).

GFC-1 (**Gujarat Forage Cowpea**-1): the variety was developed by selection from local collection from Chharodi area of Gujrat by GAU Banaskantha. The plant has a trailing habit with a height of 125 cm. It takes 65–70 days for 50% flowering and has dark green pods. It is recommended for kharif sowing in Gujrat and provides 25–30 t/ha green fodder. (CVRC- notification no. 2103 dated 21st August 1980).

GFC-2 (**Gujarat Forage Cowpea**-2): this is a variety developed by GAU, Banaskantha through selection of local material collected from Chharodi area of Gujrat. It performs well during summer season with trailing type plants with dark green pods. The variety gives 20 t/ha green fodder and 3–4 t/ha dry fodder. The protein content is 14–19%. (CVRC notification no. 2103 dated 21st August 1980).

GFC-3 (Gujarat Forage Cowpea-3): the variety is developed by GAU, Banaskantha, Gujrat through selection of local material collected from chharodi area of gujrat followed by pure line selection. The variety has been recommended for cultivation in Gujrat state. The plants are trailing type and are 196 cm long. It provides 20 t/ha green fodder and 3–4 t/ ha dry fodder. The protein content is 17.5–19.5%. (CVRC- notification no. 2103 dated 21st August 1980).

GFC-4 (Gujarat Forage Cowpea-4): this is a variety developed by GAU, Banaskantha through selection from Chharodi area of Gujrat and it performs well during summer season. The variety gives 20 t/ha green fodder and 3.0–3.5 t/ha dry fodder. (CVRC- notification no. 2103 dated 21st August 1980).

UPC-5286: the variety was developed by gbpua&t, pantnagar through single plant selection. The variety matures in 140–150 days with green fodder yield of 35 t/ha. (CVRC notification no. 19(e) dated 14th April 1982).

CO-5: this variety was developed by TNAU, Coimbatore and is a gamma irradiated mutant of CO- 1. It has been recommended for cultivation in south zone of the country. It produces 30 t/ha of green fodder. (CVRC- notification no. 867 dated 26th November 1986).

UPC-5287: the variety has been developed by GBPUA&T, Pantnagar from single plant selection from CK-74-5287 followed by selection on single pod basis and bulking on plant basis. The variety matures in 155–170 days with green fodder yield of 26 t/ha. (CVRC notification no. 258(e) dated 14th May 1986).

UPC – 287: the variety has been developed by gbpua&t, pantnagar using single plant selection from germplasm line CK-72-287. The variety has been notified for cultivation in the entire country. It provides green fodder yield of 17 t/ha. The variety takes 135–140 days for 50% flowering and 135–145 days for maturity. The green fodder yield is 30–35 t/ ha. (CVRC- notification no. 471(e) dated 5th May 1988).

Sweta (No. 998): this is a variety developed by MPKV, Rahuri. (CVRC- notification no. 915(e) dated 5th May 1988).

Charodi: this variety has been developed at GAU, Anand and has been notified for cultivation in Gujrat state. (CVRC- notification no. 471(e) dated 5th May 1988).

Cowpea-88: this variety was developed by PAU, Ludhiana from irradiation of F1 of intervarietal cross (Cowpea-74 × H2) and has been notified for cultivation in Punjab state. (CVRC- notification no. 860(e) dated 25th November 1992).

UPC-4200: this variety was developed by GBPUA&T, Pantnagar by pure line selection from CK-76-4200. The variety has been recommended for cultivation in north east zone of the country. The plant is erect during early stages of growth and later on becomes trailing/ climbing with profuse branching; foliage is dark green with broad globose leaflets. The flower colour is light violet. The pod colour is straw brown. The seeds are kidney shaped, medium sized and testa colour is black mottled. It is suitable for humid/wet regions. The variety yields 30.0–32.5 t/ha green forage and is resistant to collar rot, wilt and pod borer. (CVRC- notification no. 793(e) dated 22nd November 1991).

Bundel Lobia-1 (IFC – 8401): the variety was developed by IGFRI, Jhansi through single plant selection from IL-515. It is recommended for all India cultivation. It grows up to 120– 130 cm with 5–7 branches, which are basal and sub-basal. The plant growth habit is decumbent, semi-tendrillar at late stage of growth. It possess medium to broad leaves with light green colour, seed shape is rectangular to round, tapering towards the distal end. Seed colour has yellowish back ground with gray dotting covering the entire seed coat surface. It is suited to drier areas of the country with moderate rainfall. It is ready for green fodder harvest in 60– 65 days. The green fodder yield, dry-matter yield and crude protein are 30–35, 4–5 and 0.60 t/ha respectively. (CVRC- notification no. 814(e) dated 4th November 1992).

Bundel Lobia-2 (IFC – 8503): the variety was developed by IGFRI, Jhansi through single plant selection from IL-978. It is recommended for cultivation in north-west zone mainly Punjab and Rajasthan. The plant height is 140–150 cm with 4–5 branches. The growth habit is erect to semi-erect with tendrils. The leaves are medium to broad and light green in color, peduncle length is 15–20 cm. The number of pods per peduncle is 2–4, pod disposition drooping with tough and leathery surface at maturity. Seed colour is fawn white with variable pinkish shade. The variety is suited to drier areas of the country with moderate rainfall. The fodder yield (t/ha) is 30–35 green and 3.5–4.0 dry with 63.8% ivdmd and 17% crude protein. (CVRC- notification no. 636(e) dated 2nd September 1994).

UPC- 8705: the variety was developed by GBPUA&T, Pantnagar and is a derivative of the cross (N-425 × H-288). It provides green fodder yield of 35–40 t/ha and dry fodder yield of 5.3 t/ha. The variety takes 80–90 days for 50% flowering and 140–145 days for seed maturity. (CVRC- notification no. 349(e) dated 20th May 1996).

CS – 88 (Haryana Lobia – 88): the variety has been developed by ccshau, hisar by hybridization of C-28 AND HFC- 42-1 followed by pedigree selection. This is suited for cultivation in summer and rainy season providing 31 t/ha green fodder with erect growth nature, good early vigour, having long and broad leaves, it is suitable for mixed cropping.

Konkan Fodder Cowpea-1: (DFC-1): the variety has been developed by KKV, dapoli through selection from local germplasm material of Ratnagiri district. It comes to 50% flowering in 60–65 days. It takes 100 days for seed to seed maturity. It provides 23–25 t/ha green fodder during kharif and 20–22 t/ha during rabi. The dry matter yield is 5 t/ha. The seed yield is 7–8 q/ha. (CVRC- notification no. 360(e) dated 1st May 1997).

UPC- 9202: the variety has been developed by GBPUA&T, Pantnagar by pedigree selection from intervarietal cross (V-260 × UPC 9805-7-2-4). The variety has been notified for cultivation in sub-tropical to tropical regions of central zone of the country comprising of MP, Gujrat and Maharashtra. It is a medium late variety which matures in 80–85 days. It provides 35–40 t/ha green fodder. (CVRC- notification no. 5425(e) dated 9th June 1999).

UPC 607: the variety has been developed by gbpua&t, pantnagar by selection from intervarietal cross (L-212 × Singapore) – 48-2-9. The variety matures in 140–150 days. The variety has been notified for cultivation in subtropical to tropical plains of North-West Zone comprising Uttaranchal, Northern Uttar Pradesh, Tarai belt, Punjab, Haryana and Rajasthan. It provides 35–40 t/ha green fodder and 4.5–5.0 t/ha dry matter.

Fodder Cowpea-CO (FC)-8: this variety is developed by TNAU, Coimbatore. It is resistant to yellow mosaic virus, root rot and moderately resistant to leaf hoppers, beetles and bacterial leaf blight. It is suitable for intercropping with sorghum and maize. Green fodder has high protein (20.67 per cent), fat (2.72 per cent), calcium (1.49 per cent) and phosphorus (1.37 per cent), and high palatability. It is a hybrid derivative of the cross (CO- 5 × n- 331). It is semi-spreading, erect in early stages of growth and later on becomes creeping. It can be grown all over Tamil Nadu except Villupuram, Cuddalore, Tiruvarur and Kancheepuram districts as irrigated crop, it can be raised throughout the year, and the Rainfed crop is cultivated in kharif and rabi seasons. The plant grows to a height of 100 to 120 cm, and green fodder can be harvested in 60 to 70 days when fifty per cent flowering is recorded. When allowed to set seeds, the crop matures in 100 to 105 days.

CL-367: the variety has been developed by PAU, Ludhiana (Cowpea 74 × Strain No. 90) and bulked in f6 generation. It has been recommended for irrigated areas of Punjab. This is an early short duration variety which provides 27 t/ha green fodder and 12.3 q/ha seed yield. (CVRC-notification no. 599(e) dated 25th April 2006).

UPC – 618: the variety has been developed by GBPUA&T, Pantnagar from cross (UPC-8703 × IT-84 e-124 -2-5-1). The variety has been notified for cultivation in Uttranchal, UP, Punjab, Haryana, Rajasthan, Jharkhand, West Bengal, Orissa, Assam, MP, Gujrat and Maharashtra. It is medium late variety which matures in 140–150 days. It provides 30 t/ha green fodder and 4.5–5.0 t/ha dry matter. (CVRC- notification no. 599(e) dated 25th April 2006).

UPC-622: the variety has been developed by GBPUA&T, Pantnagar through single plant selection. The variety is recommended for cultivation in North-West, North–East and hill zone of the country. (CVRC- notification no. 1178(e) dated 20th July 2007).

UPC- 621: the variety is developed by GBPUA&T, Pantnagar. This variety is released for cultivation in the lower hills and plains of Uttrakhand. The green fodder yield is 32.5– 35.0 t/ha and dry fodder yield is 50–55 q/ha at 50% flowering stage in 85–90 days. The seed yield is 6-8 q/ha in uncut crop. DM digestibility is 60–65% with 16-17% cp besides lower adf and ndf. Slight twining tendency character is suitable for mixed/intercropping with sorghum, maize, bajra and other cereal forages during summer and kharif season.

UPC- 625: the variety was developed by GBPUA&T, Pantnagar. It is a white seeded variety released for all India cultivation and can be used as dual purpose crop due to its stay green biomass at pod maturity and creamy white seeds with rough wrinkled testa which is most preferred for human consumption. It provides 35–40 t green and 45–5.0 t dry fodder per hectare at 50% flowering stage in 80–85 days. Seed yield is 6-8 q/ha in uncut crop. Dry matter digestibility is 65–70% with 15–17% crude protein and has higher leaf stem ratio besides lower adf and ndf. Slight twining tendency character is suitable for mixed intercropping with sorghum, maize, bajra. (CVRC- notification no. 449(e) dated 11th February 2009).

Development of Transgenic Cowpeas: As mentioned earlier, cowpeas are a good source of protein and highly digestible energy but its yields remain critically low, largely because of insect pests. Cowpea germplasm contains little or no resistance to these major insect pests and a gene technology approach for adding insect-protection traits has been a high priority for many years (Ehlers and Hall, 1997). The first reported transformation experiments with cowpeas were conducted by Garcia *et al.* (1986, 1987) and although kanamycin-resistant callus was obtained, no plants were regenerated. Later, Penza *et al.* (1991) and Muthukumar *et al.* (1996) used longitudinal mature embryo slices and mature de-embryonated cotyledons, respectively, as target tissues. Although Penza and colleagues could not demonstrate stable integration of the transgenes, Muthukumar *et al.* (1996) obtained transgenic plants after selection on hygromycin. However, transmission of the transgenes to the next generation could not be demonstrated. Similarly, Ikea *et al.* (2003), using the particle gun method for cowpea transformation, found that the transgenes were transmitted to only a small proportion of the progeny and that there was no evidence for stable integration of the transgenes. A very promising regeneration and transformation system was described by Kononowicz *et al.* (1997) and although not pursued at the time, it did form the basis of a system that is reproducible and that obeys Mendelian rules of inheritance (Popelka *et al.*, 2006). This is the first cowpea transformation system capable of producing transformants on a field scale. Critical features of this system include suitable explants from cotyledonary nodes or embryonic axes and a tissue culture regime without auxins in the early stages, but which includes the cytokinin, 6-benzylaminopurine (BAP), at low levels during shoot initiation.

DNA Markers and Transgenic Plants of Cowpea: Indirect marker-assisted selection can be useful for applying selection pressure in early generations for traits that are difficult to select directly or for shuttle breeding, where it is not possible to directly screen for resistance to a pest due to quarantine restrictions. Isozymes have not been useful for indirect selection in cowpea due to extremely low levels of polymorphisms in cultivated cowpea. DNA markers should be more effective for developing a linkage map for cowpea. A cowpea linkage map has been developed from a cross between an improved cultivar and a wild subspecies (Vigna unguiculata ssp. dekindtiana). This map consists of 87 random genomic and 5 cDNA RFLPs, 5 random amplified arranged in 10 linkage groups. Also, a genetic linkage map has been constructed within the cultivated gene pool of cowpea. A cross was made between inbred breeding lines from IITA (IT 84S-2049) and UCR (524B a stable line from 'CB5' X 'CB3'), and the map is based on an F_8 recombinant inbred population (94 individuals). The map consists of 180 loci, comprising 133 RAPDs, 19 RFLPs, 25 AFLPs, and 3 morphological markers. The markers identify 12 linkage groups spanning 932 cM with an average distance of 6.2 cM between markers. Linkage groups ranged from 4 to 268 cM in length and from 2 to 41 markers, respectively. This DNA-linkage map could be useful for indirect marker-assisted selection. Genetic engineering has considerable potential for making possible unique types of progress in cowpea breeding. For cowpea, it will not replace traditional breeding methods but could provide genes from other species that confer useful resistance to insects and some other traits to cowpea. Genes coding for resistance to insect pests of cowpea need to be identified, cloned, and transmitted into cowpea, such that the toxic proteins are expressed in the right place, at the right time, and at the right concentration to confer effective resistance. In addition, it is necessary to develop bioassays to test the effectiveness of specific proteins, such as through the rearing of target insect pests on artificial diets. Some proteins have the potential to confer insect resistance, including the *Bacillus thuringiensis* dendotoxin, and various protease inhibitors and lectins. In collaboration with L. E. N. Jackai of IITA, his research group has developed and used bioassay systems to test the effects of these proteins on several insect pests. They have demonstrated that two *B. thuringiensis* gene products [cry IA(b) and cry II(a)] are effective against *Maruca testulalis*, that the cysteine proteinase inhibitor E-64 and a lectin from wheat are effective against *Clavigralla tomentosicollis*, and that an α-amylase inhibitor can control *Callosobruchus maculatus*. Unfortunately, an effective system for the genetic transformation of cowpea has not yet been developed to permit the exploitation of these genes. Progress is being made in the development of genetic transformation systems for cowpea using an *in vivo* system involving DNA electroporation into axillary buds and systems involving micro projectile bombardment or co-cultivation with *Agrobacterium tumefaciens* (Vidhi, 2023).

International Program: Cowpea improvement program forms a major part of research programs of International Institute of Tropical Agriculture (IITA) located at Ibadan, Nigeria. IITA came into existence in the year 1967. Cowpea improvement program at IITA in the initial stages concentrated primarily on germplasm collection, evaluation, maintenance, and breeding for disease resistance. Later on, the emphasis shifted on breeding for insect resistance, early maturity, improved plant types and desired seed quality. There are about 12,000 accessions of cowpea and about 200 accessions of wild Vigna at IITA. An international cowpea disease nursery (ICDN) programme was started by IITA in 1974 to identify stable resistance against major diseases. The promising lines coming out of this program were VITA 1, 3, 4 and 5. Breeding efforts in 1980s aimed at developing extra-early cowpea varieties and bush type varieties, combined with resistance to diseases and insects in focus. This gave rise to development of IT 82E-16, -18, IT 82D-807, -828, -889, and -950 having resistance to six major viral diseases (CYMV, CAbMV, CuMV, CMeV, SBMV, CGM). Extra early varieties (60 days maturity) developed in this programme are IT 82E-32, -9, -56, -5, -60 and bush type varieties are IT 81D-1228-13, -14 and -15. From 1988, the main breeding objectives have been improved drought and heat tolerance and multiple pest and disease resistance. At IITA, every year four generations of breeding lines are advanced and within two years F_6/F_7 lines combining major attributes are developed (Vidhi, 2023).

USES: Cowpea can be used in the form of dry seeds, fodder, green pod, green manure, and cover crops. It is mainly cultivated in Africa, including Egypt, for its dry seeds and/or green pods before maturity as a vegetable. Cultivated cowpea is a valuable source of protein, micronutrients, and vitamins. In fresh form, the young leaves, immature pods, and peas are used as vegetables, while several snacks and main meal dishes are prepared from the grain (Brader, 1957). The aboveground plant parts of cowpea, excepting pods, are harvested for fodder. In some areas, trading is these residues (haulms) can be highly remunerative. In West and Central Africa, farmers who cut and store cowpea fodder, for subsequent sale at the peak of the dry season, have been found to obtain as much as 25% of their annual income by this means. Fodder yields of 0.5 t/ha (air dry haulms) are commonly obtained in northern Nigeria. Yields as high as 2-4 t/ha can be obtained (Quin, 1957). Going beyond its importance for food and feed, cowpea can arguably be regarded as the fulcrum of sustainable farming in semiarid lands. This is especially so for West and Central Africa. In this region, the area of cowpea production extends westerly from Cameroon through to Senegal, lying mainly between IO 0N and 15 °N, covering the dry savanna (northern Guinea and Sudan savannas) and Sahelian zones. There are a few additional pockets of production at more southerly latitudes, where the dry savanna agroecology penetrates closer to the West African coast, as in Ghana and Benin (Quin, 1957). Cowpea can be used at all stages ofgrowth as a vegetable crop, and the leaves contain significant nutritional value (Ahenkora *et al.,* 1998; Nielson *et al.,* 1993). The tender green leaves are an important food source in Africa and are prepared as a pot herb, like spinach. Immature green pods are used in the same way as snap beans, often being mixed with cooked dry cowpeas or with other foods. Nearly mature "fresh-shelled" cowpea grains are boiled as a fresh vegetable or may be canned or frozen. Dry mature seeds are also suitable for boiling and canning. In many areas of the world, cowpea foliage is an important source of high-quality hay for livestock feed (Tarawali *et al.,* 2002).

Varieties of cowpea with a "persistent green" grain have been developed by breeding programs in the USA that are a versatile product for frozen vegetable applications (Ehlers *et al.,* 2002 a). Persistent green cowpea grains are green colored when dry but when soaked in water for several hours closely resemble fresh shelled cowpea that can be used in frozen vegetable products to add color and variety. Because persistent green cowpea grain canbe harvested and stored dry until rehydration and freezing, it is a quite convenient and economical frozen vegetable compared to other frozen vegetable crops that require highly coordinated harvesting and processing operations and expensive long term frozen storage. The crop is mainly grown for its seeds, which are high in protein, although the leaves and immature seed pods can also be consumed. The seeds are usually cooked and made into stews and curries, or ground into flour or paste (Wikipedia, 2023). Cowpeas are grown mostly for their edible beans, although the leaves, green seeds and pods can also be consumed, meaning the cowpea can be used as a food source before the dried peas are harvested. Like other legumes, cowpeas are cooked to make them edible, usually by boiling. Cowpeas can be prepared in stews, soups, purees, casseroles and curries. They can also be processed into a paste or flour. Chinese long beans can be eaten raw or cooked, but as they easily become waterlogged are usually sautéed, stir-fried, or deep-fried. A common snack in Africa is *koki* or *moin-moin*, where the cowpeas are mashed into a paste, mixed with spices and steamed in banana leaves. They also use the cowpea paste as a supplement in infant formula when weaning babies off milk. Slaves brought to America and the West Indies cooked cowpeas much the same way as they did in Africa, although many people in the American South considered cowpeas not suitable for human consumption. A popular dish was Hoppin' John, which contained black-eyed peas cooked with rice and seasoned with pork. Over time, cowpeas became more universally accepted and now Hoppin' John is seen as a traditional Southern dish ritually served on New Year's Day. (Wikipedia, 2023). In addition to their use as a protein-rich food crop, cowpeas are extensively grown as a hay crop and as a green manure or cover crop (Britannica, 2023). It is an important source of dietary protein in developing countries of Asia and Africa. It is used as fodder, vegetable, pulse and green manure crop. The economic importance of cowpea is difficult to ascertain, since production statistics no longer kept separate from those of other pulses (Pallavi, 2023). Cowpea is primarily used in the form of dry seeds, fodder, green pod, green manure, and cover crops (Vidhi, 2023). Roots are consumed roasted. Green leaves are boiled or fried. Immature pods are boiled or steamed. Seeds are consumed directly. Green seeds are roasted and consumed. Steam or cook the soaked cowpeas. It is also added to various recipes. Onions, tomatoes and chilies could be added to enhance the taste the peas (Healthbenefits, 2023). Cowpeas could be cooked or either steamed after soaking in the water whole night. It is added to the various recipes as well. The diet professional should be consulted before consuming the cowpeas to avoid any health conditions (Vegetables, 2023).

Traditional uses are as follows (Vegetables, 2023):

Leaf: Leaves and seeds are used as a bandage in order to treat skin swellings and infections. It is also applied to treat burns. Leaves are chewed to treat tooth disorders.

Root: The root acts as an antidote for snakebites. The infusion of seeds treats amenorrhea and the use of crushed roots with porridge cure the chest pain, epilepsy, painful menstruation and dysmenorrhea.
Seed: The powder made from the seeds is used to treat insect stings. The liquor of cowpea which is cooked with spices is effective for common cold. The worms in the stomach could be eliminated with the boiled cowpea. The roots of other plant if cooked with the seeds, is effective in treating the bilharzias and blood in urine.

Plant: The plant is used to make emetics which treats fever and heals urinary schistosomiasis caused due to Schistosoma haematobium.

Traditional uses of cowpea are as follows (Healthbenefits, 2023): The daily intake of cowpeas emphasizes the spleen, with the improvement in the cell manufacture which promotes immune system. Seeds are used to treat common cold, worms in the stomach, blood in urine. Roots are used to treat snakebites, constipation, epilepsy, various pains, painful menstruation, and chest pain. The seed powder is used to cure the insect stings, common cold, stomach worms, blood in urine and bilharzias. The emetic which is made with the use of plant cures the urinary schistosomiasis and fever.

NUTRITIVE VALUE

All the plant parts that are used for food are nutritious, providing protein, vitamins, and minerals. Cowpea grain contains, on average, 23-25% protein and 50-67% starch. Petty trading of fresh produce and processed foods provides both rural and urban opportunities for earning cash, particularly by women (Brader, 1957). The nutritional content of cowpea grain is important because it is eaten in quantity by millions of people who otherwise have diets lacking in protein, minerals, and vitamins. The nutritional profile of cowpea grain is similar to that of other pulses, witha relatively low fat content and a total protein content that is two to four times greater than cereal and tuber crops. Like other pulses, the protein in cowpea grain is rich in the amino acids lysine and tryptophan, compared to cereal grains. However, it is deficient in methionine and cystine when compared to animal proteins. In a study of 100 cowpea breeding lines in the IITA collection, seed protein content ranged from 23 to 32% of seed weight (Nielson *et al.,* 1993). Similarly, protein content of 12 West African and US cultivars ranged from 22 to 29%, with most accessions having protein con- tent values between 22 and 24% (Hall *et al.,* 2003). These results suggest that sufficient genetic variation exists to develop new cowpea cultivars with protein content of at least 30%. Cowpea grain is also a rich source of minerals and vitamins (Hall *etal.,* 2003) and it has one of the highest levels of any food of folic acid, a crucial B vitamin that helpsprevent spinal tube defects in unborn children. In developed countries, cowpea is expected to become increasingly important as consumers seek interesting and healthy "new" foods and rediscover"traditional" foods that are low in fat, high in fiber, and that have other health benefits. Fat contents of 100 advanced breeding lines from IITA showed a range in fat contents from 1.4 to 2.7% (Nielson *etal.,* 1993), while fiber content is about 6% (Bressani 1985). Besides being low in fat and high in fiber, the protein in grain legumes like cowpea has been shown to reduce low density lipoproteins that are implicated in heart disease (Phillips *et al.,* 2003). In addition, because grain legume starch is digested more slowly than starch from cereals and tubers, their consumption produces fewer abrupt changes in blood glucose levels following consumption (Phillips et al. 2003). Innovative and appealing processed food products using dry cowpea grain, such as cowpea-fortified baked goods, extruded snack foods, and weaning foods, have been developed (Phillips *et al.,* 2003). Protein isolates from cowpea grains have good functional properties, including solubility emulsifying and foaming activities (Rangel *et al.,* 2004), and could be a substitute for soy protein isolates for persons (especially infants) with soy protein allergies.

In Vegetable cowpea, among the different parts analyzed shells were rich in dietary fiber. Seeds were nutrient dense as compared to podsand shells, but more in anti- nutrients (Tiwari *et al.,* 2019). Black-eyed peas are incredibly nutrient-dense, packing plenty of fiber and protein into each serving. They're also a good source of several important micronutrients, including folate, copper, thiamine, and iron. One cup (170 grams) of cooked black-eyed peas contains the following nutrients: Calories: 194, Protein**:** 13 grams, Fat: 0.9 grams, Carbs: 35 grams, Fiber: 11 grams, Folate: 88% of the DV, Copper**:** 50% of the DV, Thiamine**:** 28% of the DV, Iron**:** 23% of the DV, Phosphorus**:** 21% of the DV, Magnesium**:** 21% of the DV, Zinc**:** 20% of the DV, Potassium**:** 10% of the DV, Vitamin B6: 10% of the DV, Selenium**:** 8% of the DV and Riboflavin**:** 7% of the DV. In addition to the nutrients listed above, black-eyed peas are high in polyphenols, which are compounds that act as antioxidants in the body to prevent cell damage and protect against disease (Ajmera, 2020). Cowpea seeds provide a rich source of proteins and food energy, as well as minerals and vitamins. This complements the mainly cereal diet in countries that grow cowpeas as a major food crop. A seed can consist of 25% protein and has very low fat content. Cowpea starch is digested more slowly than the starch from cereals, which is more beneficial to human health. The grain is a rich sourceof folic acid, an important vitamin that helps prevent neural tube defects in unborn babies. The cowpea has often been referred to as "poor man's meat" due to thehigh levels of protein found in the seeds and leaves. However, it does contain some antinutritional elements, notable phytic acid and protease inhibitors, which reduce the nutritional value of the crop. Methods such as fermentation, soaking, germination, debranning, and autoclaving are used to combat the antinutritional properties of the cowpea by increasing the bioavailability of nutrients within the crop. Although little research has been conducted on the nutritional value of the leaves and immature pods, what is available suggests that the leaves have a similar nutritional value to black nightshade and sweet potato leaves, while the green pods have less antinutritional factors than the dried seeds (Wikipedia, 2023). Vitamin B9 (Folate, Folic acid) 356 µg 89.00%; Iron, Fe 4.29 mg 53.63%; Copper, Cu 0.458 mg 50.89%; Phosphorus, P 267 mg 38.14%; Tryptophan 0.162 g 36.82%; Manganese, Mn 0.812 mg 35.30%; Histidine 0.41 g 33.28%; Isoleucine 0.537 g 32.12%; Valine 0.629 g 29.78%; Total dietary Fiber 11.1 g 29.21%; Vitamin B1 (Thiamin) 0.345 mg 28.75%; Threonine 0.503 g 28.58%; Leucine 1.012 g 27.38%; Carbohydrate 35.5 g 27.31% and Lysine 0.894 g 26.73% (Healthbenefits, 2023). Cowpea is loaded with various types of nutrients. It is rich in fiber, protein, iron, potassium, low in fat and calories. The cup of cowpea possesses 11.1 g fiber, 13.22 g protein, 4.29 mg iron, 475 mg potassium, 0.91 g fat and 198 calories. Along with that, various amino acids such as 0.612 g of tryptophan, 0.41 g of histidine, 0.188 g of Methionine and 0.894 g of lysine is contained in this seed (Vegetables, 2023).

HEALTH BENEFITS

Cowpea (*Vigna unguiculata*) is a legume consumed as a high-quality plant protein source in many parts of the world. High protein and carbohydrate contents with a relatively low fat content and a complementary amino acid pattern to that of cereal grains make cowpea an important nutritional food in the human diet. Cowpea has gained more attention recently from consumers and researchers worldwide as a result of its exerted health beneficial properties, including anti-diabetic, anti-cancer, anti-hyperlipidemic, anti-inflammatory and anti-hypertensive properties. Among the mechanisms that have been proposed in the prevention of chronic diseases, the most proven are attributed to the presence of compounds such as soluble and insoluble dietary fiber, phytochemicals, and proteins and peptides in cowpea. However, studies on the anti-cancer and anti-inflammatory properties of cowpea have produced conflicting results. Some studies support a protective effect of cowpea on the progression of cancer and inflammation, whereas others did not reveal any (Jayathilake *et al.,* 2018). Black-eyed peas have been associated with a number of powerful health benefits (Ajmera, 2020) as follows:

Support weight loss: Due to their content of protein and soluble fiber, adding black-eyed peas to your diet is a great way to boost weight loss. Protein, in particular, has been shown to reduce levels of ghrelin, a hormone that's responsible for stimulating feelings of hunger. Meanwhile, soluble fiber is a type of fiber that forms a gel-like consistency and moves through your digestive tract slowly to help keep you feeling full between meals. ccording to one study in 1,475 people, those who ate beans regularly had a 23% lower risk of increased belly fat and a 22% lower risk of obesity, compared with non-consumers. Another review of 21 studies concluded that including pulses, such as black-eyed peas, in your diet could be an effective weight loss strategy and may help reduce body fat percentage.

***Promote digestive health*:** Black-eyed peas are a great source of soluble fiber, which is a key nutrient when it comes to digestive health. In fact, studies show that increasing your intake of soluble fiber can help promote regularity and increase stool frequency in those with constipation. Other research indicates that fiber could help prevent digestive disorders, such as acid reflux, hemorrhoids, and stomach ulcers. The soluble fiber found in black-eyed peas and other plants can also act as a prebiotic, stimulating the growth of the beneficial bacteria in your gut to help foster a healthy microbiome. These beneficial bacteria not only support digestive health but also have been shown to reduce inflammation, enhance immune function, and reduce cholesterol levels.

***Enhance heart health*:** Enjoying black-eyed peas as part of a balanced diet is an excellent way to help keep your heart healthy and strong, as they may help reduce several risk factors for heart disease. In one review of 10 studies, regular intake of legumes was linked to lower levels of total and LDL (bad) cholesterol, both of which can contribute to heart disease. Another study in 42 women showed that following a low calorie diet enriched with 1 cup of legumes per day for 6 weeks significantly reduced waist circumference and triglyceride and blood pressue levels, compared with a control group. Regularly eating legumes has also been tied to lower markers of inflammation, which may also help reduce your risk of heart disease.

***Precautions*:** Black-eyed peas are high in antinutrients and may cause digestive issues in some people. However, soaking and cooking them can help minimize side effects.

Cowpea prevents cancer, prevents anemia, supports healthy metabolism, maintains strong bones, encourages mental well-being, helps heal and repair muscle tissue, helps maintain bowel health, supports a healthy cardiovascular system, supports immune system, prevents cold sores, prevents depression and prevents diabetes (Healthbenefits, 2023).

Following health benefits of cowpea are reported (Waqas, 2018; Vegetables, 2023):

***Prevent cancer*:** Cowpea possesses folate (Vitamin B9) which assists in lowering the chances of neural tube defects like anencephaly or spina bifida. The deficiency of folate leads to the birth defects such as malformations of limb and heart. Folate is also essential for the replication of DNA because the fetus cells could not grow without the presence of folate. This is an essential vitamin that is necessary for having a healthy pregnancy. The pregnant women should consume the prenatal vitamin so that they would consume the adequate amount of folate. Cowpea possesses Vitamin B9 by 356 µg which provides the eighty nine percentage of the daily recommended value.

***Prevents anemia*:** Cowpeas possess the mineral (Iron) in high amount which eliminates the anemia. Iron assist in the protein metabolism which is essential for the RBCs and hemoglobin production and also inhibits anemia. Anemia is the result of the low hemoglobin and red blood cells. Anemia affects the body parts and also reduces the energy levels. It leads to the poor functioning of the brain and reduction in immunity. World Health Organization surveys that the half of the anemia cases are caused due to the deficiency of iron and other are caused due to the genetic factors.

Supports a healthy metabolism: Potassium, copper, various antioxidants and folate assist to maintain the metabolism health in the people who intake the cowpeas daily. Copper acts as an essential part in functioning 50 different reactions of metabolic enzymes in the body. The reactions of enzymes are vital to maintain the smooth functioning of metabolism. 0.458 mg of copper is present in the cowpeas.

***Helps maintain strong bones*:** Cowpeas possess the calcium and phosphorus which is a vital mineral to maintain the strength and structure of bones. Manganese assists in the formation of bones by regulating the enzymes and hormones which is involved in the process of bone metabolism. Phosphorus assists in the mineral density of bones that forbids the bone break, fracture and osteoporosis. To have the healthy bones, it is a must to balance the calcium and phosphorus levels. Cowpeas contains 4% calcium, 38% phosphorus and 35% manganese. The osteoporosis in women is helped with the presence of vitamin D, zinc, magnesium, calcium, copper and boron in cowpea.

***Encourages mental well-being*:** Cowpea possesses tryptophan which is effective for treating disorders of social anxiety, insomnia and provides a sound sleep. It assists the neurotransmitters which maintain the level of energy, control mood and appetite. The cowpeas can enhance the level of histidine as it possesses histidine in 0.41 mg which provides thirty three percent of the daily recommended value.

***Helps heal and repair muscle tissue*:** Cowpeas contain isoleucine which assist to raise the endurance and also fixes the tissue in the muscles and promotes the clotting of the injury. The presences of amino acids enhance the energy. Valine, isoleucine and leucine are three chain of amino acid which enhances the recovery of muscles. It also stabilizes the blood sugar. 053 grams Isoleucine, 1.01 grams leucine and 0.63 grams Valine is obtained in one cup of cooked cowpeas.

***Helps maintain bowel health*:** The cowpeas possess dietary fibers which promote and softens the stool. It reduces the constipation with the easy flow of bulky stool. The bulk is added to the stool because the fiber helps to absorb the water. The diet rich in fiber reduces the chances of small pouches in the colon and hemorrhoids.

***Supports a healthy cardiovascular system*:** The presence of Vitamin B1 is a must for the production of neurotransmitter which is also known to be acetylcholine which passes messages between the muscles and nerves. The recent studies summarizes that thiamine counteracts with the heart diseases and maintains the healthy function of ventricles which cures the heart failure. Adding vitamin B1 rich food Cowpeas to your diet may help to prevent cardiovascular diseases.

***Supports immune system*:** Cowpeas possess threonine which may assists the immune system by promoting the antibodies production. The threonine produces the serine and glycine which is essential for the collage, muscle tissue and elastin production. It maintains the healthy and strong connective muscles and tissues. Cowpeas which are rich in threonine may help to boost your Immune system.

***Prevent cold sores*:** The lysine in the cowpea reduces the genital herpes or cold sores and also speeds up the healing process. The daily intake of the cowpeas reduces the chances of recurrence of cold sores. One cup of cowpea provides 0.90 g of lysine which means 27% of DV.

Prevent depression: The amino acid phenylalanine in Cowpeas may help to prevent depression. The studies have shown that the phenylalanine is effective for the therapy of depression. The mood of the people was improved as they took phenylalanine because the raise in the production of chemicals such as norepinephrine and dopamine. Hence depression and other health conditions such as migraines and insomnia may prevent by adding phenylalanine rich food Cowpeas to your diet.

***Prevent diabetes*:** Cowpea possess high amount of magnesium which is essential for the metabolism of glucose and carbohydrate. The research summarizes that the intake of the food rich in magnesium reduces the chances of the type 2 diabetes by 15% in approx. The clinical studies show that the intake of magnesium improves the insulin sensitivity. The researchers have shown that the low presence in the level of magnesium leads to the defect in the secretion of insulin and also reduces the sensitivity of insulin. It inhibits diabetes but does not cure it. As it possess the carbohydrate by 27%, it stimulates the level of glucose so the patients of chronic diabetes must consult with medical professional before consume it.

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