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Cowpea Production Challenges and Contribution to Livelihood in Sub-Saharan Region

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Abstract

Cowpea [Vigna unguiculata (L.) Walp.] is an important grain legume mainly grown in tropical and subtropical regions for vegetables, grains, and fodder. The crop is grown predominantly in the dry savannahs to the Sahel in the fringes of the Sahara Desert where the annual rainfall is around 300 mm or less. Cowpea provides shelter as a cover crop and improves soil fertility by fixing atmospheric nitrogen. Its grain is preferred for high levels of protein, energy, micro-and macronutrients. Cowpea belongs to the family Fabaceae and sub-family Faboidea, and it is a self-pollinating crop with low and narrow genetic diversity, making it susceptible to various environmental factors. Various research projects have been established on cowpea, and as a result, various cowpea germplasm is stored at Africa International Institute of Tropical Agriculture (IITA)—Nigeria, the USDA repository in Griffin, GA (USA), the University of California, Riverside, CA (USA), and at the National Bureau of Plant Genetic Resources (NBPGR) in New Delhi, India. Despite the available germplasms, cowpea productivity remains very low in many countries due to a wide array of abiotic and biotic stresses and socio-economic constraints. This review summarizes some aspects of cowpea, including origin and history, challenges, economic importance, and constraints to production, providing possible useful information for cowpea researchers, agronomists, and producers in SSA.

Keywords

Breeding, Genetic Variation, Cowpea, Productivity, Constraints

1. Introduction

Cowpea (*Vigna unguiculata* (L.) Walp.; 2n = 2x = 22) is an annual self-pollinated diploid and has been ranked as the most economically important indigenous African legume crop [1] [2]. Cowpea belongs to the family Fabaceae and sub-family Faboideae [3]. Other commonly used names of cowpea include southern pea, black eye pea, crowder pea, labia, niece, coupe, or frijole [4]. Various types of cowpea are cultivated for different purposes. The most cultivated cowpea is in subspecies *unguiculata* and is divided into five cultivar groups, *i.e. unguiculata*, *sesquipedalis*, also known as yard-long-bean, Textiles, Biflora, and Melanophthalmus [5]. [6] reported about diverse cowpea germplasm at Africa International Institute of Tropical Agriculture (IITA), Nigeria, the USDA repository in Griffin, GA (USA), the University of California, Riverside, CA (USA), and at National Bureau of Plant Genetic Resources (NBPGR) in New Delhi, India. There are various cultivars suitable and used in various parts of the world. According to [5], among the cowpea cultivar group, *unguiculata* is the most cultivated cowpea, while members of the cultivar group Textiles, which are grown in some parts of Nigeria and favored for their long peduncles, are cultivated for fiber production. About 6.5 million metric tons of cowpea were reported produced annually on about 14.5 million hectares worldwide [5]. In Sub-Saharan Africa (SSA), West Africa is regarded as the major cowpea producing region with 80% of the total regional production reported for Nigeria and Niger at first and second positions respectively for 14 years in a row [6] [7]. In addition, Nigeria has been the leading producer and consumer of cowpea globally with an approximately 2.4 million tonnes annual production produced on five million hectares in 2010, followed by Niger, Brazil, and the USA [8]. Cowpea plays a major among the livelihoods of millions of smaller holder farmers who depend on it as a source of economic livelihood and nutritional well-being [9]. Cowpea is mainly grown for food, fodder, vegetable, green manure, and cover crop. [5] reported that cowpea grains contain protein (20% - 32%) with high amounts of essential amino acids (lysine and tryptophan), minerals (zinc, iron, Ca), vitamins (thiamine, folic acid, and riboflavin) and fibres (6%). The high nutritional value of the cowpea grain makes it suitable for infant food and is widely used as weaning food in many African countries [10].

2. Origin and History

The cowpea crop has originated and was domesticated in Southern Africa; later, it was spread to East and West Africa and Asia [3] [11]. The crop belongs to the family Fabaceae and sub-family Faboideae. Cowpea is also known as southern pea, black eye pea, crowder pea, lubia, niebe, coupe or frijole. The southern African region (Namibia, Botswana, Zambia, Zimbabwe, Mozambique and South Africa) and the semi-arid West and Central Africa are reportedly considered the center of diversity of *Vigna. Unguiculata* [8] [11]. People in these areas (centre of diversity) consume cowpea and other pulses as supplements to their daily diet.

3. Biological and Ecological Description

According to [5], cowpea is grown predominantly in the dry savannahs to the Sahel in the fringes of the Sahara Desert, where the annual rainfall is around 300 mm or less annually. Cowpea can grow under harsh environmental conditions where other major crops fail to grow [12]. In addition, one of the significant importance to the ecology is the ability to fix atmospheric nitrogen in marginal soils where farmers have no access to agricultural inputs such as fertilizers or manure [8] [13].

4. Importance of Cowpea

Cowpea is consumed either as a vegetable for the leaves, fresh pods, or grain. Cowpea is regarded as a cheap source of protein to poor resource farmers whose diet largely depends on starchy foods such as millet, sorghum, maize, and cassava, making it a potential crop to contribute to the alleviation of malnutrition [14]. The protein content in cowpea varieties ranges between 17 and 32% on a dry weight basis [10] and about 64% of carbohydrates, vitamins, and fiber [15]. The amino acid and vitamin profiles of cowpea grain make it an essential complement to cereals. Its leaves, green pods, and grains are consumed as a dietary source of protein among many households in African countries [16]. Apart from its nutritional component, the crop has multiple advantages to farmers, including its ability to grow and produce high yields on poor, sandy soils unsuitable for the production of other crops, high rates of symbiotic nitrogen fixation, and lower fertilizer requirements [13].

5. Constraints to Cowpea Production

According to [17], about 6,991,174 tonnes of dry cowpea grains are produced annually worldwide on about 12,316,878 ha. Despite the importance of cowpea, its productivity in typical Sub Sahara Africa farmers' fields is very low, at less than 600 kg/ha compared with a potential grain yield of over 2000 kg/ha [5]. This is partly due to the use of unimproved varieties, inadequate application of inputs, and poor agronomic practices during crop production. Furthermore, cowpea production is constrained by many biotic and abiotic factors, including low soil fertility and a wide range of factors such as insects, diseases, parasitic weeds, and unavailability of improved seeds [6] [9] [18]. According to [19] drought and soil salinity are major abiotic stress factors affecting crop production and food safety. In addition, drought and high temperatures are identified as key stress factors that the researcher should emphasize more about the effects of climate change on plants. Plant breeders and biotechnologists have been studying and trying to acquire knowledge and tools, to tackle challenges posed by climate change. The challenge in many is to produce sufficient food for the escalating population growth with limited water supplies and breeding for drought tolerance and water use efficiency [6] [20].

Water scarcity causes a significant reduction in agricultural productivity and can lead to total crop failure or reduce yield below 360 kg·ha^{-1}. In addition, water deficit reduces leaf area index, chlorophyll content, number of pods per plant, and seed yield in cowpea [21]. Even though cowpea is regarded as a drought-tolerant crop and can grow under harsh climatic conditions with limited water, it is also affected by various climatic factors and often lead to low yields [22]. According to [23], cowpea's growth period can range between 90 to 240 days, but this varies from variety to variety and climatic conditions. [24] reported that well-watered cowpea plants could produce more than 1000 kg grain ha^{-1}, while in Ghana, an average yield of 1.25 metric tons per hectare was observed in farmers' fields [22].

Insect pests are the most important yield-reducing biotic factors in cowpea production worldwide [2] [25]. The major insect pests of cowpea include aphids (*Aphis craccivora Koch*), flower bud thrips (*Megalourethras spotted* Trybom), pod borer (*Maruca vitrata* Fabricius), and pod sucking bugs (especially *Clavigra llatomentoscollis* Stal, *Riptortus identifies* Fabricius, *Anoplocnemis curvipes* Fabricius, and *Nezara viridula* Linnaeus) [5]. Most of the insect pests affect the crop in the field except storage pests such as weevils that destroy seeds in storage facilities, although infestation may occur while the crop is in the field [10].

Significant losses due to *Striga gesnerioides* have been reported to range between 83% and 100%, especially in Sub-Saharan Africa [26]. In some parts of Sub-Saharan Africa, such as the northern Guinea savanna of Nigeria and northern Namibia, 100% yield losses on farmer's fields were recorded mainly when susceptible local varieties were used [20] [26].

Cowpea Genetics and Breeding Progress

Like most self-pollinating crops, the genetic diversity of cowpea is regarded as very low and narrow, which makes the crop susceptible to various environmental factors [2]. Cowpea breeding programs have contacted various research activities, including intensive qualitative and quantitative genetics studies of the crop to enhance its improvement [5]. It is suggested that the use of naturally resistant varieties against biotic and abiotic stresses could be the most environmentally protective approach in improving yields and adaptation due to recurrent climatic change [27].

The International Institute of Tropical Agriculture (IITA) has been involved in developing improved cowpea varieties globally. As a result, the nematode-resistant (e.g. varieties CE-31, Frade Preto, CE-28, CE-01, CE-315 and CE-237) [28], *Striga gesnerioides* and *Alectra vogelii* tolerant varieties (genotypes 16A, 19B, 35, 155A2, and 191 were identified in Uganda) were developed and released [29] [30]. In a variety screening experiment conducted by [31] two cowpea varieties (Mkanakaufiti and IT99K-7-21-2-2XIT82E-16) were observed with no and few Alectra shoots infestation, respectively. Furthermore, the IITA and the Agricultural Research Institute of Senegal (ISRA) have developed early maturing, high-yielding and pest-resistant cultivars. The IITA varieties are now reported and grown widely in Nigeria, Niger, and Senegal in Africa. In Namibia, the Ministry of Agriculture Water and Forestry, through cooperation with the Joint FAO/IAEA programs has released cowpea mutant varieties regarded as high yielding and resistant to harsh climatic conditions during 2017-2018 [2] [32].

6. Conclusion

Researchers worldwide have been working tirelessly on finding varieties of various crops, including cowpea, which can withstand harsh climatic conditions. In Namibia, for example, new and improved varieties of crops were introduced during the early 1990 [33]. Since then, not much effort has been invested in new varieties improvement of development until recent research activities reported by [20] [34].

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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