Review [Revisión]

INSECT PESTS PREFERENCE FOR COWPEA: THE DILEMMA OF FARMERS IN WEST AFRICA †

[PREFERENCIA DE LAS PLAGAS DE INSECTO POR EL COWPÍ: EL DILEMA DE LOS AGRICULTORES EN ÁFRICA OCCIDENTAL]

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SUMMARY

Background: Cowpea is a cosmopolitan crop cultivated in most of West Africa where the livelihood of people revolves around farming. It is a vital form of livelihood all through the value chain from seed production to farming, grain processing, distribution, and culinary purposes. **Main findings:** The high demographic growth, rapid urbanization, and burgeoning markets of West African countries are the key drivers for the intensification of cowpea production in these regions. Cowpea as a linkage crop connects agriculture to the prevalent local environments of West Africa; farmers to productive resources; and consumers to local healthy foods. As a choice crop among the resource-poor farmers, it is largely grown in intercrop with other food crops such as maize, sorghum, millet, sugar cane, cotton, and cassava. This is due to the ecosystem services and carbon credits derived from its cultivation. These ecosystem services and carbon credits are displayed through its nitrogen-fixing capability, drought-tolerant nature, and ground covering potential against erosion. **Implication:** Although benefits accrue from cultivating this crop, a major constraint to its production is its susceptibility to attack by an array of insect pests. These pests include the pod borer (*Maruca vitrata*), Flower thrips (*Megalurothrips* sjostedti), Spiny bugs (*Clavigralla spp.*), Other pod sucking bugs (*Aspavia armigera, Anoploclemis curvipes, Riptortus dentipe*), Whitefly (*Bemisia tabaci*), Aphids (*Aphis craccivora*), Leafhoppers (*Empoasca spp*), Foliage beetle(*Ootheca mutabilis*), Flower beetle (*Mylabris spp.*) *and* mites (*Tetranychus spp*). Their attack could be so severe that over 90% of harvestable yield may be lost and the farmer is left in a dilemma of fighting hunger and poverty. **Conclusion:** Despite the huge research collaborations in the management of insect pests of cowpea, this paper seeks to find out how much of these documented findings become transferred to resource-poor farmers in West Africa.
Keywords: Farmers; pest preference; production constraints; *Vigna unguiculata*; west africa

RESUMEN

Antecedentes: Cowpea es un cultivo cosmopolita cultivado en la mayor parte de África occidental, donde el sustento de las personas gira en torno a la agricultura. Es una forma vital de sustento a lo largo de la cadena de valor, desde la producción de semillas hasta la agricultura, el procesamiento de granos, la distribución y los propósitos culinarios. **Resultados:** El alto crecimiento demográfico, la rápida urbanización y el crecimiento de los mercados de los países de África Occidental son los principales impulsores de la intensificación de la producción de caupí en estas regiones. Cowpea como cultivo de vinculación conecta la agricultura con los entornos locales prevalentes de África Occidental; los agricultores con los recursos productivos; y los consumidores con los alimentos saludables locales. Como un cultivo bien escogido entre los agricultores con pocos recursos, se cultiva en gran parte en cultivos intercultivos con otros cultivos alimenticios como maíz, sorgo, mijo, caña de azúcar, algodón y mandioca. Esto se debe a los servicios ecosistémicos y a los créditos de carbono derivados de su cultivo. Estos servicios ecosistémicos y créditos de carbono se muestran a través de su capacidad de fijación de nitrógeno, su naturaleza tolerante a la sequía y su potencial de cobertura contra la erosión. **Implicación:** Aunque se obtienen beneficios del cultivo de este cultivo, una limitación importante para su producción es su susceptibilidad al ataque por una serie de plagas de insectos. Estas plagas incluyen el barrenador de la vaina (*Maruca vitrata*), trips de las flores (*Megalurothrips sjostedti*), insectos espinosos (*Clavigralla spp.*), Otros insectos chupadores de vaina (*Aspavia armigera, Anoploclemis curvipes, Riptortus dentipe*), mosca blanca (*Bemisia tabaci*), áfidos (*Aphis craccivora*), saltamontes

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(*Empoasca spp*), escarabajo (*Ootheca mutabilis*), escarabajo flor (*Mylabris* spp.) y ácaros (*Tetranychus* spp). Su ataque podría ser tan severo que sobre el 90% de la producción cosechable se puede perder y el granjero se deja en un dilema de luchar el hambre y la pobreza. **Conclusión:** A pesar de las enormes colaboraciones de investigación en el manejo de plagas de insectos de caupí, este artículo busca averiguar cuánto de estos hallazgos documentados se transfieren a los agricultores con pocos recursos en África Occidental.
Palabras clave: Agricultores; preferencia de plagas; restricciones de producción; *Vigna unguiculata*; África occidental

INTRODUCTION

Cowpea (*Vigna unguiculata*) is an important leguminous crop postulated to have originated from West Africa (Ogunkanmi et al., 2006). It is an annual herbaceous crop with varying growth forms ranging from erect, prostrate, and bushy to climbing types with a well-developed taproot system and many spreading lateral roots in the soil surface (Rachie et al.,1975). Cowpea is cultivated for the seeds, pods or leaves that are consumed as green vegetables or for pastures and as green manure. The leaves are dark green and are varied in size and shape. Cowpea leaves are good sources of phosphorus, zinc, iron, and vitamins (ascorbic acid, B-carotene and folic acid (Neilsen et al., 1997). The stems are glabrous or slightly hairy with some purple shades. A distinguishing feature of cowpea is the peduncle which holds the flower and seed pods. A peduncle may hold four or more seed pods (Sheahan, 2012). A pod of cowpea has the capacity of carrying six to thirteen kidney-shaped seeds which tend to be more spherical with restriction within the pod. Cowpea seeds may be smooth, rough, speckled, mottled or blotchy in texture (IITA, 1975). The seed colours vary from white, cream, brown, and black, green, red to various combinations (Davis et al., 1991). Cowpea grain contains 23.4% protein, 1.8% fat and 60.3% carbohydrates and also a good source of vitamins and phosphorus (Adeyemi, et al., 2012). Cowpea grows well in soils of about 85% sand with less than 0.2 organic matter and low levels of phosphorus which makes it an important food crop in poor arid regions (Obatolu, 2003). On heavy fertile soils, they show vigorous vegetative growth but not necessarily good grain yield. They are generally drought tolerant but are very susceptible to a variety of insects and diseases. The optimum temperature for their growth and development is 20 to 35^0C (FAO, 1984). For optimum growth and development, cowpea performs well under rainfall ranging from 400 to 700 mm per annum (Wastphal, 1974). Cowpea seeds are often grown as intercrop with sorghum, maize or pearl millet at wide spacing (Blade et al.,1997). Sole-crops are becoming important as cowpea production is commercialized to meet the demands of a rapidly increasing urban population (Deresse, 2015).

DISTRIBUTION AND PRODUCTION POTENTIAL OF THE REGIONS IN WEST AFRICA

Cowpea production is widely distributed throughout West African countries with a higher concentration in Nigeria, Niger, Burkina Faso, Ghana, Senegal, and Mali. Cowpea is produced in almost all parts of Nigeria, but the bulk of its production comes from the semi-arid zone of Northern Nigeria (PetuIbikunle and Smith, 2008, Aluko et al., 2016). Kano State is one of the major high-producing areas, and it has the largest cowpea market in the world. Other high-cowpea producing states include Adamawa, Kaduna, Niger, Borno, Taraba, Katsina, and Gombe. The major production areas in Niger which account for about 80% cowpea production include Dosso(Sudano Savanna), Maradi and Zinder in the Sahel (TL II, 2013). In Burkina Faso, cowpea is grown across large parts of the country, especially in the drier regions where there is less parasite pressure. These regions include the Centre-North, North, the Bounce du Mouhon and the Centre-West regions (Dabat et al., 2012). Cowpea production in Ghana is majorly concentrated in the Upper West, Upper East, Northern Regions, and some districts in the Brong-Ahafo (Egbadzor et al., 2013). Cowpea production in Senegal exceptionally thrives in the dry steppe Northern and central savannah parts of the country. These areas receive irregular rainfalls of 100-300 mm and 400- 800 mm respectively in a year (Cissé and Hall, 2003). However, less than 10% of cowpea produced in Senegal comes from the Southern deciduous forest region of the country which receives 800-100 mm of rainfall per year. African continent produced a substantial seed yield of 5.4 million tonnes grown on a surface area of over 11 million hectares (IITA, 2015). Nigeria is Africa's largest producer and consumer of cowpea with an estimated production of 3.2 million tonnes out of the total 5.2 million tonnes produced in Africa (IITA, 2015). The Republic of Niger is the second-largest producer of cowpea in Africa. Estimated production of 764,000 metric tonnes on 4,132,000 hectares is produced annually (TL II, 2013). Burkina Faso is the third-largest producer of cowpea in the world, after Nigeria and Niger. A production of 589,000 tonnes was reported in Burkina Faso (FAOSTAT, 2013).

Cowpea is the second most important food legume in Ghana, and an annual production of 219,300 metric tonnes was reported harvested from 163,700 hectares in 2010 (MORA, SRD, 2011). In Senegal, about 35,000 metric tonnes of cowpea are produced annually on 0.13 hectares of land.

UTILIZATION OF COWPEA IN WESTERN AFRICA

Cowpea is consumed at different stages of its development in various forms. The different stages are as fresh green leaves, dry leaves, green pods, and green beans or as dry grain. Traditional West African culinary has diversified the utilization of this crop. Nigeria has a large market for processed cowpea which is peeled, made into paste and deep-fried to form a staple food known as "akara". A lot of women and entrepreneurs have developed large business ventures through the sale of this staple food (IITA, 2011). In Ghana, women as caregivers regard cowpea as an essential diet needed by young infants for proper growth, and prevention of iron deficiency. They cook the leaves in stews and use it as a weaning food or porridge. (Quaye et al., 2009a , Abizari et al., 2013). The rural women process the crop through soaking and milling into flour. Water is added to the flour to make balls which are deep-fried to make a dish called Koosai or koos (Otoo et al., 2011). Cowpea is also prepared and consumed in different dishes which include; "Waakye " - whole with cereals like rice in a dish called, "Apprepensa " - a combination of roasted maize and cowpea flour, and as " tubani or gablee" – prepared from cowpea flour alone (Quaye et al., 2009a, Quaye et al., 2011). Cowpea leaves are also added in the preparations of some dishes like "nyombeica" – a mixture of cowpea leaves and whole maize or cowpea flour which is subjected to steaming and "goara" – boiled cowpea leaves usually eaten with spicy bean cake (Quaye et al., 2011). In Niger, cowpea has turned out to be more of a national food crop than an income generation crop. This is because it has significantly enhanced the food security of over 66% of the country's resource-poor farmers (IT II, 2013). The grain is either cooked alone or missed with rice and consumed as the main meal. It is also processed into flour, which is used for a variety of recipes such as "Kossai" a popular breakfast meal in Niger (Ibro et al., 2006). Cowpea haulms are also used as animal feed which helps to increase livestock productivity (Singh et al., 2003). In Burkina Faso, cowpea is grown mostly as a secondary crop, mostly for subsistence purposes. It is usually intercropped with other cereals such as millet and sorghum (Dabat et al., 2012a). This intercropping system promotes the distribution of cowpea for dual purposes as a grain and fodder crop. These by-products are crucial part of the value of the crop. Farmers in Burkina Faso place higher premium on cowpea haulms since its sales yield greater economic returns than the sale of grain especially in areas where animal feed are scarce (Dabat et al., 2012a).

WEST AFRICAN COWPEA FARMERS STATUS AND PREFERENCE

Cowpea production in Nigeria is labour intensive with smallholder farmers cultivating about 2 hectares of land (Wakili, 2013). Farmers' preferences due to the morphological diversity of the crop vary from one region to another (Padulosil and Ng, 1997). Nigerian farmers especially in the North-east where the bulk of cowpea is produced, prefer to grow the predominant local varieties to the improved varieties largely because it has proven suitability for relay intercropping and potential to smother weeds (Kamara et al., 2012). Cowpea is generally intercropped with other main cereal crops and mostly grown by smallholder farmers on less than 3 hectares of land in Burkina Faso (Statistika, 2003). However, cowpea is cultivated as a monoculture crop in the high production areas of the country but not so much in the dominant production regions (Dabat et al., 2012). The two most popularly grown varieties are the white and red cowpea. While the white variety is the most preferred, the red is also appreciated for its sweetness (Dabat et al., 2012). In Ghana, cowpea is majorly cultivated by adult illiterate men and women. The men are largely involved in farming while the women engage in the processing of the food crop (Quaye et al., 2009b). Most Ghanian farmers prefer to grow the early maturing variety, milk-coated and easy to cook cowpea, as this has shown some levels of tolerance to insects and relatively better yields with little chemical applications (Quaye et al., 2009b, Egbadzor et al., 2012). Cowpea is grown as a monoculture crop in most parts of Ghana or as an intercrop with maize, sorghum, millet, and cassava (Rose and Adiku, 2001).

INSECT PESTS CONSTRAINT

Nigerian farmers in the south-western part of the country have identified the incidence of insect pests as one of the most prevalent constraints limiting cowpea production (Sangoyomi and Alabi, 2016, Saka et al., 2018). In the drier savannah agro-ecology of the north, the incidence of pests and disease was also reported as the most serious constraint faced by cowpea farmers (Mohammed and Mohammed, 2014). Different insect pests specialize on every

cowpea plant parts and in worst cases these pest overlap in their incidence and damage (Singh and Jackai, 1985). *Aphis craccivora* has preference for cowpea leaves, pods, seeds and other aerial parts of the plants where if feeds by sucking the sap causing damage to the plant and yield reduction. In a trial on effect of pod growth stages on aphid reproduction and damage by cowpea aphid, Ofuya (1989) reported that infestation with *A. craccivora* caused significant reductions in seed yield of cowpea. An infestation of A. craccivora on cowpea was also reported to cause reduction in growth and losses in yield (Annan et al., 1995). *A. craccivora* is also an important vector of plant viral disease (Wightman and Wightman, 1994). The most damaging of all pests are the ones attacking the crop at flowering and podding stages. They include flower thrips, dominated by *M. sjostedti*, the legume pod borer, *M. vitrata, C. tomentosicollis*, and a complex of pod sucking bugs (Oso and Falade, 2010). Raheja (1976) reported a cowpea grain yield loss of 45-52% in Northern Nigeria during flowering stages, followed by 21-26% loss during pod formation. The legume pod borer has preference for tender stems, flower buds, flowers, peduncle, pods and leaves and in the absence of adequate control, flower infestation rates of 80% and seed damage rates of 50% have been reported. (Afun et al., 1991; Dreyer et al.,1994). The flower thrips preference is more for the inflorescence and leaves. They begin feeding before the opening of the flower damaging various parts of the plant especially the flower. In Nigeria, Alghali (1992) reported yield loss of up to 75% from the attack by this pest on cowpea.

Cowpea is the second most important legume crop in Ghana, and its production is concentrated in the Northern Savannah zone of the country. Among the major constraints to cowpea production in Ghana, insect pests and Striga infestation are responsible for 15% to 100% yield losses based on the level of infestation and the relative susceptibility of the crop variety. The main target insect pests of cowpea reported in Ghana are *Aphis craccivora* (aphids), *Ephestia cantella and Corcyra cephabonica* (Storage moths), *Callosobruchus maculatus* (storage weevils) and a complex of sucking bugs (PPRSD, 2015, Pest List of Ghana (unpublished)). The aphids show preference for the young succulent green parts (leaves, stem and green pods) of the plant. The preference of both the moths and storage weevils is for seeds in storage. The caterpillars and adults of the moths and weevils feed on the grain causing extensive damage, thereby reducing its quality. These complex of bugs including *Riptortus dentipes, Nezaria viridula, Anoploclemis curvipes, Clavigralla spp* among others attack the pods of the plant. They suck the contents of pods and inject poison into the pods causing necrosis. At two locations, Googo and Tingoli in the Upper East and Northern regions of Ghana, Kusi et al., (2019) reported that thrips, legume pod borer and a complex of pod sucking bugs (including *Clavigralla tomentosicollis, Anoploclemis curvipes, Riptortus dentipes*) are the economically important pests of these two ecological zones.

Among the major identified constraints to cowpea production in Niger, infestation by insect pests such as aphid, flower thrips, pod sucking bugs, legume pod borer and weevils play prominent roles. The legume pod borer is a recalcitrant pest of cowpea, causing up to significant yield losses in the country (Margam et al., 2010).

DOCUMENTED RESEARCH COLLABORATIONS

Research collaborations have reported on several management options that have been tested and proven to be effective against the broad-spectrum of insect pests attacking cowpea. These management options include the use of synthetic insecticides, botanicals, resistant cultivars, biological agents, and manipulation of the crop's environment (cultural).

***Synthetic Insecticides*.** This is the dominant insect pest control practice in all West Africa countries especially as a result of the spectacular outcome associated with its use. Despite being the most efficient and effective pest control option for the management of cowpea pests (Edema and Adipala, 1996), the synthetic pesticides must be used judiciously (Omongo et al., 1997). In a study to identify appropriate combinations of cultivar and insecticide spraying times for effective management of cowpea insect pests in Ghana. Kusi et al., (2019) reported that the farmer's cultivar used for the study was susceptible to pest attack while the improved cultivar showed varying degrees of tolerance to the different pest categories. They opined that for increase in grain yield, farmers should combine at least two rounds of insecticide sprays with any of the improved varieties. In an investigation, on the combination of four different spraying regimes and four different cowpea cultivars against the pod borer. Oso (2012) reported that the cultivars that received a weekly spray produced significantly highest grain yield. Hence, the combination of improved cultivar of cowpea and a weekly spray interval was recommended for effective control of *M.vitrata.* Monitored sprays which is referred to as application of insecticide for pest control based on monitoring of crop damage or level of pest infestation was

compared with calendar sprays (application of insecticide at specific dates without any consideration for presence or absence of pest). It was reported that although the calendar schedules recorded lower damage by aphids, flower thrips, and pod borer, grain yield did not differ between the two spraying schedules. Hence, monitored spraying was recommended for overall management of cowpea pests because of the reduced cost of purchasing insecticide (Afun et al., 1991, Egho, 2011).

Use of Resistant Cultivars. Through conventional breeding methods, significant success has been reported in the manipulation of cowpea germplasm to develop varieties that are resistant and tolerant to diseases (Singh and Awika, 2010). With the inception of application of biotechnology in agriculture, scientists have concurred to exploit the conventional and modern crop improvement approaches to develop insect-resistant varieties. The African Agricultural Technology Foundation (AATF) co-ordinated a public-private partnership to develop improved varieties of cowpea that will be resistant to attack by legume pod borer, *Maruca vitrata*. The project focused on accessing and inserting the cry1Ab gene (Bt-gene) into selected cowpea varieties to protect the crop against *Maruca vitrata* (AATF, 2015b). However, one of the limitations of this control option is that no single cultivar has been developed with the innate resistance to the array of insect pests attacking cowpea (Dzemo et al., 2010). Also, most developed resistant cultivars are only resistant against one or few insect pests which cannot provide satisfactory control (Kusi et al.,2019).

Cultural Control. This method of control includes all forms of manipulation of crop's environment to create an unconducive space for insect pests multiplication. Abudulai et al., (2017) reported that manipulation of planting time such that the vulnerable stage of cowpea does not coincide with the period of pests' population was effective in controlling pests. Intercropping of cowpea with other crops especially cereals has been reported to play a major role in the management of cowpea pests. However, pest management through intercrop is variable and dependent on some factors. Agboh-Noameshie et al., (1997) reported that the micro-environment created through the intercrop of cowpea with cassava was effective against the *M. sjostedti* and pod sucking bugs but not against the pod borer. In another intercrop mixture of one row of sorghum with two rows of cowpea, Mensah (1997) reported a low population of *M. vitrata* and sucking bugs but a high population of *M. sjostedti*. Two intercropping systems (1:1 and 2:3 maize/cowpea intercrop) were investigated to compare the response of two cultivars (Ife brown and Tvu13076) of cowpea to insect pest infestation and yield. Lower population density of *M. vitrata* was observed in the two intercrops when compared with the population of *M. sjostedti*, and the incidence of the two pests was significant in the late reproductive phase for cultivar Ife brown. Despite its (Ife brown) vulnerability, significantly higher grain yield was produced in the plot-mix of 2:3 maize/ cowpea intercrop and cultivar Ife brown. This suggests that intercropping may not be a determinant factor for any observed reduction in pest load, but such reduction can be crop and pest dependent (Jackai and Adalla, 1997, Oso and Faade, 2010).

Botanical Control. Botanical pesticides are biologically active compounds derived from plants and are used in the management of pests. The global crusade for the development of environmentally sound strategies in the control of pests has renewed interests on plant products as a viable alternative to synthetic pesticides (Dubey et al., 2010). Botanical pesticides with potentials against pests are currently being explored for possible production of commercially available natural products that can be effective on certain pests, selective in crops, non-toxic for the user, easily biodegradable, and that can be locally and easily produced, especially by farmers who usually cannot afford expensive synthetic pesticides (Damalas, 2011). Plant extracts (aqueous or oil) with lethal activities against insect pests may be applied sole or in mixtures with less toxic plants, which have different activity to ascertain their synergistic attributes in the management of crop pests (Opareke et al.,2006). In Ghana, Abatania et al., (2010) reported the use of some botanical insecticides for protection of cowpea. Longe and Oso (2017), also tested ash from bulbs of garlic (*Allium sativum* L.) and onion (*Allium cepa* L.) for fumigant action against adult emergence of *Callosobruchus maculatus*, a major pest of stored cowpea. Ash of onion (*Allium cepa* L.), was generally less effective in the control of *Callosobruchus maculatus* compared with that of garlic (*Allium sativum* L.).

Biological Control. The recalcitrant nature of the most important economic insect pests of cowpea if not nipped in the bud, could result into an estimated average production loss of about 3.8 million tons/year (IITA, 2016). Long-term management strategy of cowpea insect pests may not be sustainable using insecticide pesticides for obvious reasons which include, human and environmental safety (Tamò et al., 2012). Similarly, the novelty of Bt-toxin cowpea has its limitations because the myriads of pests attacking cowpea cannot all be

controlled by the Bt-cowpea. Hence, the development of biological-based-intervention with the use of fungal-based (endophytic strains of *Beauveria bassiana*) bio-pesticides which offer profitable and efficient control (Sokame et al., 2015). The efficacy of *Metarhizium anisopliae* and *Beauveria bassiana* in the reduction of aphid population on cowpea leaves suggests that these isolates had the potential for development as microbial pesticides for the management of *Aphis craccivora* (Daoust and Pereira, 1986; Shrestha et al., 2015). The origin of *Maruva vitrata* has also been traced to Asia, where more efficient natural enemies have been discovered and currently being tested to curtail the menace of the old enemy of cowpea (Arodokun et al.,2006, Tamò et al., 2012).

FARMERS COPING STRATEGY

An investigation on cowpea insect pests' management practices among cowpea farmers in some parts of Northern Nigeria revealed that awareness on the use of insecticides and its adoption was higher compared to that of the use of resistant varieties and bio-pesticides. Similarly, farmers testified to the effectiveness of insecticides, certified seeds and spraying methods and regime against the effectiveness of resistant varieties and bio-pesticides (Sabo, 2015). She opined that expensive inorganic insecticides, health hazards, farm size, high cost of control methods and illiteracy limit effective use of integrated pest management technologies among the farmers. Misuse of synthetic pesticides was reported to be prevalent among most cowpea farmers in Mubi zone of Northern Nigeria. The high adoption rates as found for the use of inorganic insecticides and spraying regime, as well as indiscriminate use, were traceable to awareness amongst the farmers that non-use of insecticides at the appropriate time would account for low seed yield and crop failure Sabo et al., 2014). In Ghana, the list of registered pesticides are regularly updated to improve their quality, but dismally, farmers use unapproved pesticides. The farmers are of the opinions that such unapproved pesticides are sold at reduced price, easily sold on local market, and that proximity to approved pesticides remains difficult (Williamson, 2003). Cowpea farmers interviewed in Ghana, described their common use of ten different insecticides to combat field pests of cowpea. They attested to the fact that these insecticides are mostly sprayed on improved varieties of cowpea, which are very susceptible to attack by pests in the field and storage. Ghanaian pest management experts identified price, indirect subsidies and preferential pesticide distribution programmes as the three most important factors influencing the country's levels of pesticide use (Gerken et al., 2000). They think that pesticide donations and direct subsidies are responsible for the excessive pesticide use amongst farmers. The use of synthetic chemicals in pest control raises concern for human health and environmental safety, and as such, technologies are being transferred to farmers guard against this menace. An investigation on the factors affecting the adoption of botanical extracts as pesticides in cowpea production in Northern Ghana revealed that the level of education of the household head, size of farm and access to labour were the three principal determinants of adoption of botanical pesticides (Abatania et al, 2009). They suggested that increased adoption of the technology can be fostered by targeting education toward farmers who have had some formal education, and with smaller farm sizes. It was also suggested that industrial production of botanical extracts, to reduce the drudgery of its production and use by individual farmers, could speed up adoption. In another survey on the adoption of improved variety of cowpea carried out in Northern Ghana. Wahaga (2019) reported that the farmers have a typical gradual adoption attitude which is dependent upon yield, amount of pesticides needed, and the incidence of insect pest and diseases. Hence, as a result of pest and diseases persistence, degrading soil fertility, drought-related problems, dwindling farmland and low yield, cowpea farmers in northern Ghana now grow improved varieties which are mainly high yielding, insect/ disease resistant and drought tolerant. The continued provision of free pesticides at farmers' disposal in Senegal has been accompanied by a surge in pesticide diversion, inequitable distribution, food safety hazards and accumulation of highly hazardous chemicals (Williamson, 2003). This liberalization is responsible for the erroneous desirability and indispensability of pesticides among the small-holders farmers. Research efforts in Institu National de la Recherche Agronomique du Niger (INRAN) among other priorities, has been directed at developing cowpea varieties that are resistant to insect pests (especially aphids legume pod borer and thrips). In Niger, neem products have been reported to show some effectiveness against the legume pod borer. Ostermann and Dreyer (1995) reported that weekly applications of an aqueous neem extract proved to be more effective than neem oil at 12l/ha.

FUTURE PROSPECTS

Cowpea can be regarded as the fulcrum for leveling West Africa's basic nutrition. The grain is not only rich in protein but in digestible carbohydrate bridging the gap of hunger and malnutrition among millions of

Africans. Cowpea species are exceptionally rich in useful genetic diversity and a crop for high potential of rural development. It is appalling that the average yield of the crop despite its nutritional benefits still lies low at <500 kg/ha (Abudulai et al., 2017). The reason being that most of the resource-poor farmers of West Africa practice subsistence farming, grow their traditional cowpea varieties in mixed cropping with other cereals and are misinformed on the best approach to tackle the problems of insect pests on their farms. These traditional varieties though with little resistance to insect pest attack (Asante et al., 2001), have very low productivity potential. The indiscriminate use of inorganic insecticides further compounds the problems by posing a threat to life generally because they end up in the food chain. The increasing industrialization, the prevalence informal economy, and adulteration of synthetic insecticides which are prevalent in West Africa economy are drivers which support the misuse and overuse of chemical pesticides. In most West African farming communities, farmers adopt technologies when such technology impacts positively on their production, livelihood, and profitability. Hence, extension systems in this region should be built around dissemination of information on efficient Integrated Pest Management (IPM) Approaches. Enlightenment about these IPM approaches should be enhanced through training (farm field schools) in cowpea production value chain. There should also be a promotion of global collaborative efforts to develop genetic combinations suited for Africa and supported by appropriate educational deployment strategies that will enlighten the farmers' on the economic potentials of such newly bred cultivars. However, adopting this proposed genetically combined cultivars and crusading for a monocropping system may be seen by these farmers as a threat to being food secured and sufficient. There is a general assumption that their most dependable cereals (sorghum and millet) are about to be knocked down. A way out of this notion would be for the government and private sectors to provide supports to farmers. Funds and other forms of subsidies should be provided to help build farmers' momentum for a positive change.

CONCLUSION

Whatever the climate, location, or cultivation practices, insect pests are major constraint to cowpea production in West Africa. Overcoming this menace is never an easy task but could be surmounted if the opinions and experiences of smallholders farmers could be transmitted into the improved packaging by policymakers and other donor agencies.

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