# Crop Protection Problems in Production of Maize and Guinea Corn in Northern Guinea Savanna of Nigeria and Control Measures

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**Abstract:** The cultivation of Maize and Guinea corn in the northern Guinea Savanna of Nigeria is faced with lots of Crop protection problems which hinder full scale production of these crops in that ecological zone. The problems range from biotic factors like vertebrate and invertebrate pests, disease pathogens, nematode and weeds, to abiotic factors such as nutrient deficiencies, environmental conditions (climatic, edaphic), and agronomic, logistic or social problems. Addressing the various problems militating against the production of maize and Guinea corn in this zone will further help strengthen the national food reserve base and alleviate the devastating effects of the global food crisis particularly in Nigeria. [Nature and Science. 2009;7(12):8-14]. (ISSN: 1545-0740) .

**Key words:** Maize, Guinea-corn, biotic, abiotic, problems, control.

## Introduction

Maize (*Zea mays* L.) and Guinea corn (*Sorghum bicolor* (L) Moench) are important food crops in Nigeria, widely grown in the savanna regions of the country. These crops form the staple foods for most of the population especially in areas adaptable for their production. Green maize (fresh grains) is eaten roasted or boiled on the cob. The ripe grains (of maize or sorghum) are cooked in combination with pulses or milled and boiled as porridge (Yoruba = Eko, Hausa = Kamu, Ibo = Akamu). Sorghum (Guinea Corn) uses vary from drinks to 'tuwo'. The stems are used for fuel and building of fences and local huts. Maize and guinea corn are used as basal ingredients of livestock feeds. They are rich in Carbohydrates. In spite of the importance of these cereals as sources of food for human consumption, their production is concentrated in the hands of peasant farmers whose average hectarage is very small, approximately 0.5 – 1.0 hectare per farmer. The technologies are basically traditional farming methods and systems.

An estimated one million hectares of land was planted to maize in the country in 1989/1990 and over 40% of this was cultivated in the northern states (NAERLS, 1982). This figure has been increasing steadily ever since, with the help of irrigation especially in the drier parts of the north (Sahel and Sudan). Average yield per hectare in the northern savannas on peasant farms is about 0.6 metric tonnes, while commercial farms average is about 2.0 metric tonnes/ha. Guinea corn, on the other hand, is grown in an estimated 300,000 hectares of land north of the Niger and Benue rivers, especially in areas generally too dry for consistent and reliable maize production. Average yield in both peasant farms and commercial setup is 0.40 metric tonnes/ha and 1.0 metric tonnes/ha respectively. Varieties of these cereals (maize and sorghum) planted in these areas are both local, improved local and hybrids. Plant breeders in I.A.R. (Institute for Agricultural Research, Ahmadu Bello University, Zaria) have produced suitable varieties adapted to different ecological zones of the savanna where the crops are grown. Suitable yields of the improved crops have also been packaged. However, a number of constraints (crop protection problems) militate against the production of those crops. These are discussed below and solutions proffered on identified problems.

## Crop Protection Problems

Crop protection problems refer to all the biotic and abiotic factors which impede our quest to achieve self sufficiency in food production. These problems are common to both maize and sorghum in the savanna areas even though their importance may vary greatly. Some problems are confined to a single zone, others are generalized.

### 1. Biotic Factors

About 6 percent of the total food currently produced in this country is lost to pests and diseases. Maize and Sorghum are susceptible to various pests (vertebrate and invertebrate) and diseases (bacterial, fungal, viral, nematode infections) in different ecological zones of the northern savanna.

### Pests

#### Vertebrate Pests

Samaru **(**Lat. $11^0$ $11^{11}$N, Long. $07^0 38^{11}$E) is in the Savanna region which consists of derived Savanna (referred to as northern and southern Guinea zones), Sudan and Sahel ecological zones. These zones are hosts to various species of monkeys, birds, rodents

and other wild animals which cause extensive damage to maize and sorghum fields.

Monkeys moving in groups can cause up to 70% loss in peasant's maize fields and about 30% loss in commercial farms if their activities are not checked (Amadi, 1988 personal communication). Damage is done early in the morning between 6.00 am and 9.00 am; and between 4.30 pm and 6.30 pm. Succulent maize cobs are removed from the stalks and eaten up while excess harvest are littered on the fields and along bush paths. Monkeys menace on the farms can be checked by trapping and employment of hunters to track down the animals. Widening of farm paths to allow for regular traffic and placement of scare-crows in strategic areas in the farm may also be helpful.

Birds especially *Quelea quelea* and Doves cause great damage to Sorghum heads. Adult Quelea birds may not be as destructive as the young ones newly weaned. The adults feed on wild seeds of grasses until exhausted before raiding cereal fields. Damage done by the newly independent young Quelea (from 3 weeks of age) arises from extreme hunger, since their parents no longer feed them. The young Queleas are extremely persistent in their attack and may continue feeding even when the Sorghum stem they are on is shaken by hand. They may also pay a deaf ear to shouts or sounds produced by farmers to scare them away. Quelea birds can be controlled by using flame-throwers, explosives or aerial spraying of organo-phosphorus pesticides. The use of resistant varieties of Sorghum (those with hard kernels and more tannin content e.g. red types) may prove helpful in some localities.

Rodents particularly rats and grass cutters cause extensive damage to both maize and sorghum in the northern and southern Guinea Savannas. Rats and bush fowls attack newly sown seeds and young germinating seedlings causing wide gaps in crop rows. These gaps when extensive cause severe yield reduction and necessitate supplying to fill the gaps at extra costs. Seed dressing chemicals such as Apron Star, Apron plus etc, should be used to treat seeds before sowing to control these pests. Rats and grass cutters may cause damage on maize grains on the field. Rats climb up the stalk, reaching the cobs and feed on the grains while grass cutters cut the stem a few centimeters from the ground, subjecting the stalk to lodging. They later feed on the falling immature cobs. Rats also feed on stored grains of maize and sorghum thereby reducing its quality and quantity. Control of rats is by using bait poisons (both in the field and store) and by fumigation with phostoxin tablets during storage.

**Invertebrate Pests**

These include all arthropod insects, molluscs, etc. which attack maize and sorghum plants inflicting heavy losses to the farmers. Different stages of the plant growth (e.g. seedling, vegetative, flowering and heading) are susceptible and various parts (e.g. roots, stems, leaves, flowers and grains) are attacked resulting in colossal losses. Termites and mole crickets destroy seeds in the soil causing wide gaps within the crop rows and poor crop establishment. The roots of seedlings and mature plants may be attacked by termites resulting in extensive damage to the cereals. Control is by seed dressing chemicals and use of Dieldren sprayers on the habitat of termites.

The major insect pest problems on cereals in the field are the stem borers, (*Busseola fusca* and *Sesemia calamistis*); shoot flies (*Atherigona* spp); grasshoppers (*Zonocerus variegatus*) and army worms (*Spodoptera exempta* and *Helicoverpa armigera*). The stem borer attack is usually more serious in late maize than the early ones. These borers feed inside the plant stems and are well protected from both their natural parasites and insecticides. They cause two types of damage to the plants. First, is mechanical damage due to consistent feeding in the stem, weakening it, and thus rendering the stems susceptible to lodging (stem breaking or falling down) and withering (dead heart). Secondly, stem borers may cause characteristic perforations or windows on leaves called 'fenestrations' seen when the sheath opens exposing the perforations (NAERLS, 1982). This type of damage reduces the photosynthetic area of the leaves resulting in poor cereal yield, especially during high infestation. Stem borers can be controlled economically by cultural methods. This involves removal and destruction of infested plants and plant residues. Pesticides with contact and systemic action are very effective at the initial stage of infestation to get rid of the larvae before burrowing into the stems.

Similarly, *Sessemia calamistis* a polyphagous insect most associated with young seedlings can cause extensive tunneling of adult plants stems resulting in 'dead' heart and chaffy heads in sorghum. Control is similar to *B. fusca. Zonocerus variegatus* when occurring gregariously causes extensive defoliation of cereals. Spraying with Fernithrothion 50 EC, Endosulfan (granules) or Trichlorphon (granules) can effectively check its menace on the field. Other grasshoppers attacking maize and sorghum albeit sporadically include *Locusta migratoria* L., *Schistocerca gregaria* L. (desert locust) and *Oedaleus* spp. All these are gregarious pests which can stripe the plants of their vegetation leaving the stalk bare. Control is similar to that of *Zonocerus* spp.

Army worms, *Spodoptera* spp and *Helicoverpa armigera* occur sporadically but may destroy the crops completely. The larvae are gregarious during outbreak and they feed for about three weeks. Outbreak is associated with alternating wet and dry spells (Misari, 1993 personal communication). These worms cause severe yield reduction on cereals by feeding on developing grains cutting them into smaller bits. Deep ploughing immediately after the season's harvest exposes the pupae to direct sun-rays resulting in desiccation of the pupae. Chemical control using Uppercott ® (Cypermethrin + Dimethoate) gives a good control.

Sorghum shoot fly, *Atherigona socata* Rondani attacks young seedlings as soon as the plants emerge from the soil and can last for about six weeks. The larvae feed on the central bud of young shoot, causing the death of the growing points ('dead heart' effect). Fenithrothion 50 EC at the rate of two litres per hectare can be applied for control. Sorghum midge, *Contarina sorghicola* lays its eggs on flowering heads and on hatching, the larvae feed on developing ovaries. Control can be achieved by prompt spraying of the sorghum heads as soon as the pests are detected with a good insecticide.

Beside field pests, maize and sorghum are seriously attacked by storage pests. The most important storage pests include grain weevils (*Sitophilus zeamays*) and *Rhizopertha dominica* for maize crops; *Tribolium casteanum* or *T. confucium*, *Trogoderma* spp, *Sitotroga cerealella* and *Sitophilus* spp for sorghum. In some cases, infestation takes place on the field and continues in the store. Some others are confined to the store while infestation may be by insects already present where the cereal grains had previously been stored or by crops infestation between granaries during storage.

For control of storage pests, strict adherence to hygiene in the store as well as provision of air-tight cover is essential. Mixing or storing old grains with new ones during storage should be discouraged. Cereals stored for seed or consumption beyond one month should be fumigated with phostoxin or treated with Actellic e.c.

**Diseases**

Diseases play an important role in the reduction of the potential yield of cereal crops. Agents causing diseases include bacteria, fungi, viruses, nematodes, weeds and nutrient deficiencies. The geographical distribution of cereal diseases in the savanna ecological zones is influenced by temperatures (high/low), moisture (humidity), cultural practices and the type and diversity of germplasm used.

**i) Pathogen Problems**

In a survey for incidence and severity of diseases in both the northern and southern guinea savanna of Nigeria, Adeoti (1992) reported the occurrence of the common foliar diseases such as the rust, *Turcicum* blight, *Curvularia* leaf spot and *Maydis* blight induced by *Puccinia* spp; *Helminthosporium turcicum*; *Curvularia* spp and *H. maydis* in the order of severity. The 'Pokkha boeng' disease induced by *Fusarium moniliforme* was also found to be severe in many areas where it occurs (Adeoti, 1992) and the percentage yield loss ranges between 5 and 30%. Other important maize diseases occurring in the savanna ecological zones include smut (*Ustilago maydis*), Downy mildews, Maize leaf fleck and Maize streak. Similarly, some rusts, smuts and blight diseases have been recorded on Sorghum plants. These include common rust (*Puccinia graminis*) f.sp. *Sorghii*, loose smut (*Sphacelotheca cruenta*), Cover smut (*Sphacelotheca sorghii)* and Head smut (*Sporisorium reiliana*) (Adeoti, personal communication).

Control of most fungal, viral and bacterial diseases of maize and sorghum can be by the use of resistant varieties, seed dressing with Furadan or Apron plus; elimination of alternate host (for rusts); crop rotation, removal and burning of infected plants and spraying with systemic fungicides such as a mixture of Benomyl and Dithane M45, Delsene, Rovrus (for 'Pokkha Boeng' disease) and so on.

**ii) Nematode Problems**

Several species of nematode have been reportedly associated with both soil and root of sorghum and maize in the savanna ecological zones. These species include *Pratylenchus* spp, *Aphelenchoides* spp, *Tylenchus* spp, *Helicotylenchus* spp, *Ditylenchus* spp and *Scutellonema* spp (Chindo, 1991 personal communication). Infected plants fall down from the root level and on examination, the plant roots are shortened, tiller profusely with round stubs at the tips. Control of nematodes is achieved by the use of Furadan 3G and other fumigant nematicides e.g. Ethylene Di-bromide (EDB), Dichloropropenes (Telone) and Dichromochloropropane (Nemagon). Manufacturer's recommendations should be adhered to for effectiveness.

**iii) Weeds**

Weeds constitute a special class of pests which seriously limit the production of the major crops on any scale. They compete with the crops for nutrients, air, light and moisture. The most noxious of these weeds are the parasitic ones particularly striga

spp (known as witch weed and "wuta wuta" or "kuduji" in Hausa). There is still no "universally applicable" and most effective control for striga despite several years of research in Nigeria. However, some inexpensive control measures including crop rotation, the use of tolerant varieties, generous fertilizer application and hand pulling before flowering can be applied to ensure satisfactory crop yield.

Other 'stubborn' weeds which also reduce cereals yield in the savanna include *Rottboellia* spp, *Pennisetum purpureum*, *Cyperus* spp, *Dactylon* spp and some broad leaved plants (compositae). Stomp, Round up, Fusilade and 2, 4-D respectively offer good control of these weeds. Hand weeding is effective but must be timely and repeated thrice before the crops mature to ensure economic yield. Since most cereals are shallow-rooted, it is essential to ensure that no mechanical damage is done to the crops roots during hand weeding. In erosion prone sites, earthing up or remolding of ridges may be required to prevent excessive exposure of the roots to the sun.

**iv Nutrient Deficiencies**

Maize and sorghum are high nutrients demanding crops than other cereals (rice, millet and wheat). These crops require both the major nutrients (N, P and K) and the secondary nutrients (S, Mg, Ca, B, Fe, Cl, Cu etc.) in adequate amount to ensure good root establishment, vigorous and healthy growth and increased yields. Healthy seedlings and plants are less susceptible to pests and disease attack. Deficiencies of vital nutrients cause yield reductions through poor plant development and growth, thereby, predisposing the plants to pests and disease attack.

Plant nutrients are supplied as fertilizer formulations. The demand for fertilizers in Nigeria has increased in recent years forcing the Federal Government to remove fertilizer subsidies to the Nigerian farmers. The result is escalating prices of the product making it difficult for peasant farmers to purchase enough for their crop needs. Consequently, most field crops especially maize and sorghum planted all over the savanna ecological zones exhibit symptoms of nutrient deficiencies such as chlorosis, stunted growth, poor root development, early leaf fall, delayed flower opening, hasty maturity, improper setting of grains, poor resistance to disease agents and low yield. Since the prices of different brands are prohibitive, the Federal government may reconsider its stand on fertilizer subsidy in order to encourage farmers to produce more food crops. Availability of these fertilizers at the right time is also essential.

**2. Abiotic Factors**

Crop protection problems in the savannas can be precipitated by various abiotic factors including climatic, edaphic, agronomic, logistic and social contributors.

**Climatic Problems**

The areas north of Niger and Benue rivers can be classified as mainly savannas. The savanna consists of the southern and northern Guinea zones, Sudan and Sahel zones. The main characteristics of these ecological zones include poor rainfall (distribution and quantity), high temperatures, humidity, drought, high wind velocity and harmattan, etc. In the last ten years, the onset, distribution and even total amount of rainfall in the savanna zones have been erratic, resulting in crops failure (NAERLS, 1982). Maize crop is more water demanding than sorghum and the uncertainty in rainfall pattern and distribution affected the crop severely. If drought occurs at the time of silking, the result is poor pollination and serious loss of grain, even when the plants look well grown and healthy.

The Sahel zone (Katsina, Sokoto, Maiduguri, Kano, Potiskum, Nguru etc.) are particularly vulnerable to this problem where average maize yield on rainfed crop is below 400kg/ha as compared to national average ranging between 1000kg/ha and 2500kg/ha. Similarly, sorghum crop though tolerant to drought may be susceptible to drought during the reproductive growth stage. Late season drought causes sorghum midge and head bug outbreak.

Rainfall shortages and drought can be solved by constructing more dams for irrigation. Breeding of drought tolerant /resistant varieties of maize and sorghum as well as closer rows may reduce soil moisture loss at the end of the season. High humidity, day length and high wind velocity affect maize and sorghum yields. High humidity encourages pests and diseases attack; short day-length affects the photoperiod requirement of maize (usually about 12 hours) for high yield; while heavy wind causes lodging especially on tall local varieties as well as facilitating pests and diseases movement.

These problems can be ameliorated by planting resistant varieties and adopting relevant agronomic practices. Wind breaks/shelter belts may be established in strategic locations to check wind movement.

**Edaphic Factors**

Soils in the savanna parts of the country consist of sandy loam, clayey-loam and loess (wind deposited sand). Organic matter contents are generally low (< 0.5%) and plant nutrients are

critically low. In some places, soil water availability is very critical and in some others water logging is common-place (e.g. Fadama). Soils of the savanna are generally alkaline in nature but in some cases, soils with low pH values have been reported (UAC Agro, 1989 unpublished). Erosion due to wind and running water also create problems in some localities. These edaphic factors constitute an impediment to crop production in the savannas and can be remedied by various soil amelioration processes. These include application of cow dung, poultry droppings, farm yard manure, and leaf dropping of shelter trees (to improve the organic matter content and improve the physical properties of soil). Wind erosion can be checked by establishment of shelter belts in wind prone areas (Kano, Sokoto, Daura, etc.). Erosion due to running water (flood) can be checked through construction of water channels (gutters); embankments and levees; encouraging vegetation cover in susceptible areas. Soils with low pH can be reclaimed through liming to improve its nutrient availability to the crops.

**Agronomic Factors**

Various agronomic or cultural practices may predispose crops to attack by pests and diseases, in the following ways:

**i)** Sowing dates influence grain yield through number, head weight and length of total growth cycle. Ogunlela (1985) reported a marked reduction in grain yield when sowing of photosensitive variety of sorghum (L.187) was delayed beyond June at Samaru than at Mokwa. A major cause for sorghum failure under delayed sowing was shoot fly (*A. soccata* ) attack. Adapted sorghum varieties should not be sown later than late June in the northern Guinea savanna to ensure good yield; and a little later in the southern Guinea savanna (Ogunlela, 1985). However, early sowing for early maturing grain varieties causes crop to mature during the rains leading to the problem of grain mould. Similarly, late sowing for late maturing varieties runs the risk of drought or early cessation of rains (Ogunlela, 1985).

**ii)** Planting depth also affects incidence of pests and diseases. Deep planting causes the seed to rot while shallow planting subjects the seed to predation by birds, rodents, termites; and may weaken the roots of seedlings. Solution to this problem is to plant at the recommended depth, usually between 2.5cm and 4.5cm on ridges or flat.

**iii)**

**iii).** Crops grown by hand labour and using wider row spacing encourage pests and diseases attack. High nitrogen predisposes crop to disease and lodging. Continuous cropping (monoculture) of these cereals throughout the year permits the maintenance of a high inoculum potential. Similarly, the practice of leaving maize in the field long after maturity tends to increase losses from ear rots, stalk rots and even pilfering.

**iv).** Seed Bed Preparation - Poorly prepared seed bed encourages shallow rooting, poor seed establishment, lodging and wilt due to soil water unavailability to plants. Good seed bed preparation is therefore essential to ensure good crop establishment and high yield. Deep plowing, harrowing and ridging facilitate water penetration, exposes eggs and diapausing pupae of pests to desiccation by the sun and ensures weed and erosion control in the field.

**v).** Removal of crop residue - Maize and sorghum stalks left over on the farm after harvest is a source of pest and disease attack next planting season. Their removal and burning will ensure protection of crops from this source of infestation. Guinea corn stalk used for fencing or building should be properly dried in the sun before use.

**vi).** Crop density and close spacing-This may be used to reduce pest infestation on the field by denying insect pests the opportunity to make soil contact during their life cycles due to extensive canopy cover.

**vii).** Farming systems - In some areas, farmers plant sorghum, groundnut and okra; maize, cowpea and pepper; or maize-soyabean in the same parcel of land in a single growing season. Each crop combination requires different agronomic practices, nutrients, sowing and harvesting periods. For a successful handling of a combination of crops, understanding of the farming systems is very essential. Invariably, this becomes a source of worry to the farmer due to poor planning and execution of work plans for each crop in the combination to ensure good yield. Crops with similar pests and diseases (e.g. sorghum and maize) should not be planted in a crop combination in order to avoid the perpetuation of their common pests.

**viii).** Timeliness is very important in crop protection programmes; a little delay can jeopardize efforts and render completely unprofitable all that have been incorporated into the farming enterprise. For instance, stem borer is an insect pest of economic importance on cereal crops. Larvae of these insects are found in the whorls feeding on the young unexpanded leaves and later bore into the stem. Control programme for these insect pests should be

directed at the larvae while feeding in the whorls. If spraying is delayed and the larvae have bored into the stem, the use of contact insecticides to control the insects at this stage is no longer feasible (Amatobi *et al*., 1988).

Similarly, some insect pests that attack produce in storage usually commence infestation while still in the field. These fields to storage pests (e.g. *Sitophilus* spp on maize and sorghum) may cause extensive damage to stored produce if harvesting is delayed on the field. Timely harvesting of these crops is recommended to avoid further yield losses during storage.

**ix).** Pesticides are chemical formulations for the prevention and control of crop pests and diseases. Pesticides include herbicides, insecticides, fungicides, bactericides, nematicides, various protectants and growth regulators. A clear understanding of the mode of action is essential to ensure effective use. However, most Nigerian farmers seldom understand what pesticides to apply or look for to solve a specific field problem. Invariably, these farmers fall easy prey to Agro-chemical hawkers who are more interested in making money than solving the farmers' problems. Even when the correct pesticide is purchased by the farmer, the pesticide may not be effective due to staleness, late application after significant damage has been done to the crop; poor follow up of the recommended application schedule, incorrect method of application, sole reliance on pesticides in situations where other methods are more effective and fear of toxic effects on crops and man (Srivastava, 1974). Another constraint to pesticide use in the northern savanna is the lack of large amount of water required for conventional application. Even when water is available, cost of labour in carrying and applying large quantities of water can be quite high. The above problems can be solved by training and posting more extension workers to the villages to assist farmers solve their crop protection problems. Water shortages can be checked by digging wells or sinking bore-holes in the farms and by formulation of more ultra low volume (ULV) pesticides with hand sprayers.

**x).** Use of Resistant varieties - Farmers in the northern savanna seldom plant improved resistant varieties of maize and sorghum due to its high demand for fertilizers and good management practices before high yield is guaranteed. Again, local preferences (for example use of tall sorghum variety stems for fencing/building; or preference for red coloured to white sorghum) may restrict the adoption of resistant varieties in spite of its attendant benefits. Solution to this problem lies in effective extension services and mass literacy campaign to change farmer's orientation. Cost of purchase of resistant crop varieties must be farmer pocket- friendly

**Logistic Problems in Crop Protection**

Farmers in northern Nigeria seldom plan for their crop protection needs. Their pre-occupation is to clear and till the land, plant the seeds, apply fertilizers, remove unwanted vegetation and harvest the crop. This sequence has exposed a major problem inherent in our farm management system, at least, at the peasant farmer's level. It is only when crop protection problems surface (albeit when much harm have been done to the crop) that a 'fire brigade approach' to control pest is initiated. Crop protection problems such as pests, diseases and early cessation of rains should be anticipated and planned for, to ensure success.

Logistic problems have been recognized as a major hindrance to a virile and effective crop protection programme. For instance, farmers may recognize a problem situation in the field but may not understand its causes. This calls for training of more extension workers and sending them to the rural suburbs to assist farmers. Difficult field problems should be communicated to the research scientists for solution. Unfortunately, the number of trained extension workers is inadequate and ill-equipped. Most extension workers prefer living in the urban areas than staying in the rural areas where pipe-borne water and electricity are lacking. This situation can be reversed by training two extension workers from each village in northern Nigeria who will live among the rural people to render extension services to them.

Another logistic problem in crop protection is lack of monitoring group and ineffectiveness of plant quarantine and sanitation programmes in the country. To this end, it is suggested that the state governments in the northern savanna should as a matter of necessity establish pests and disease monitoring groups as well as effective plant quarantine laboratory in each state capital. At the national level, a system of quick response (within 48 hours) to a reported case of outbreak of pests and diseases should be adopted to salvage crops and prevent total failure and great loss to farmers.

**Social Problem**

Plant protection problems have its social aspect. For instance, an individual farmer cannot take effective measures against pests which ravage over a large territory; in which case a joint action with his neighbours is necessary. An example is illustrated with grass hopper (*Z. variegatus*) infestation. Preventive measures should be taken in the locations where the eggs are laid, such as burning old tree stumps, heaps of uprooted weeds and avoiding damp

places in general. Eggs are most effectively destroyed by raking them out so that they dry in the sun. Nest sites are comparatively rare, usually one or two per hectare (Amatobi, 1984). For effective control, the destruction of all nest sites over a large area by all farmers is necessary. One farmer acting alone has little effect, whereas joint action can reduce the succeeding population of grasshoppers by 70 – 80% (Amatobi, 1984).

Another social problem in crop protection is inadequate price incentives to farmers particularly when inclement weather strikes. Price incentive is necessary to guarantee farmers good reward for their efforts. Also, excess produce should be purchased by the state governments and stored as strategic grain reserves. All these would encourage farmers to produce more to feed the teeming population in the country.

## CONCLUSION

Plant protection is currently considered as being synonymous with the use of pesticides whose utilization is the only barometer for ascertaining achievement in this respect. Other control methods which are relatively easy to adopt should be explored and exploited. A number of pests can effectively be checked by manipulation of cultural practices, for example, depth of planting, soil and water management, soil amendments (for nematodes), and dry season deep plowing for killing insects and pathogens in the soil. Growing maize and sorghum in areas where the environment is unsuitable for pests and diseases attack and where the crops have relative advantage for high yield potential is essential for good economic returns from the farm.

Besides, since the savanna ecological zones have diverse weather conditions and varied farming systems, pest and disease problems, the severity of their occurrence and control strategies differ according to conditions. By studying the occurrence and spread of pests and diseases in these agro-ecological zones for more than 3 years, a fairly good idea of the pest and disease situation can be worked out for that particular area.

Establishment of plant clinics at district or local government level, staffed with competent pathologists and an entomologists will ensure sound surveillance service with the aim of supplying technical assistance to the farmers and village extension workers in terms of diagnosis, control, correct use of pesticides and use of disease free planting materials.

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Date: 10/10/2009