EKITI STATE UNIVERSITY

JOURNAL OF RESEARCHES IN AGRICULTURAL SCIENCES

VOL 3 NO 1 & 2 2015

RAS Editorial Office
Faculty of Agricultural Sciences
Ekiti State University,
Ado-Ekiti, Nigeria.
E-mail: jras.foas@gmail.com
foas. jras@eksu.edu.ng

Website: www.foaseksujournal.org

ISSN: 2006-0041

Published by: EKSU Printing Press

EDITORIAL

This edition of the Journal of Researches in Agricultural Sciences is a reflection of two major changes that have taken place, since the last edition. First, three erstwhile universities in the state (University of Ado-Ekiti, University of Education, Ikere-Ekiti and University of Science and Technology, Ifaki-Ekiti) which had agriculture in their programmes were merged into one –Ekiti State University, Ado-Ekiti. Second, the Board of Editors of the Journal published by the Faculty of Agricultural Sciences was re-constituted with the mandate to revive the Journal and ensure the regular publication of pre-determined volumes per year. Thus, the Journal had been re-packaged to accommodate the ever-expanding curriculum in agriculture and the activities of researchers in meeting the current challenges encountered in the drive for food and nutrition security.

The articles in this edition have been blind peer-reviewed in line with the time-honoured tenets of international research journalism. It has become obvious that the desire to re-register the presence of the Journal in the academic community through online publication in response to the expansion in readership/referencing, subscription and submission of articles. The website being designed will offer the interested researchers the opportunity to visit the Journal online for needed information. This development would guarantee the regular publication of the Journal.

The Editorial Board appreciates the concern of the Dean and Board of the Faculty of Agricultural Sciences on the need to revive the Journal. The efforts of all contributors who promptly attended to comments made during the review process and the reviewers who took the time to add value to the quality of the papers submitted for publication are appreciated. It is our desire to get better with each edition.

Thank you.

Professor O. J. Ayodele
Editor-in-Chief.

AIMS AND SCOPE

The Journal of Researches in Agricultural Sciences publishes original articles and reviews in agriculture and related interdisciplinary studies that explore and exploit the production of food for mankind. It also publishes scientific works related to strategic and applied studies in all aspects of agricultural science.

The Journal publishes regular issues as well as special issues including symposia, conferences etc.

Instructions for authors.

Please note that these Instructions include guidelines that are specific to the Journal of Researches in Agricultural Sciences.

Author representations
Submission of a manuscript implies: that the work described has not been published before; that it is not under consideration for publication anywhere else; that its publication has been approved by all co-authors, if any, as well as by the responsible authorities at the institution where the work has been carried out.

Online submission
Authors must submit their manuscripts online via the Journal of Researches in Agricultural Sciences Editorial Manager at jras.foas@gmail.com, or foas. jras@eksu.edu.ng

Regular articles
Regular articles report original research on, or techniques for studying, the fundamental relationships between natural resources utilization and agricultural productivity.

Articles in special issues
Special issues are collections of themed articles, sometimes arising from conferences, symposia or other notable events. Only full papers of the same standard as regular articles will be considered for publication in special issues.
Articles submitted to the Journal for inclusion in special issues are subjected to the same editorial processes as regular articles.

Reviews
Review articles are intended to be comprehensive summaries of topical issues in particular aspects of agricultural science. Prospective authors of reviews should contact the Editor-in-Chief before preparing such articles.

Manuscript format
Cover letter
All submissions must include a cover letter that includes:

i. A confirmation of author representations that the work described has not been published before; it is not under consideration for publication anywhere else, and publication has been approved by all co-authors.
ii. A statement of the novelty and significance of the work and the relevance to the mission of the Journal of Researches in Agricultural Sciences.
iii. Names, affiliations and E-mail addresses of at least three suitable referees, together with a brief statement of why they are qualified to evaluate the manuscript. Referees should be selected from institutions other than those of the author(s).
iv. Approval from the ethics communities of the author(s) institution for the techniques / methodology and materials used.

Title page
The title page should include:

- The name(s) of the author(s), with symbols to link each name with that author's institutional affiliation and an asterisk to denote the corresponding author
- A concise and informative title
- The affiliation(s) and address(es) of the author(s)
- The E-mail address and the telephone number of the corresponding author

Abstract
.The abstract should be 150 to 250 words. The content should state the main purposes and research questions of the study, the methods used, the main results, and the key conclusions.

Keywords
Authors should provide 4 to 6 keywords, which can be used for indexing purposes.

Main body
Manuscripts describing original research will typically include the following sections: *Introduction*: a concise, up-to-date description of the background to provide a general reader of the Journal with enough context to understand the research being presented and its significance, as well as providing a clear statement of the research question and any hypotheses being explored. Materials and methods: techniques, materials, and equipment described in sufficient detail for another trained researcher to be able to reproduce the experimental work reported. Methods that are identical to published procedures should be summarized and include a citation to the original work.
Data Analysis: in submissions that have a significant theoretical or mathematical component, a description of the analytical procedures may be required.
Results: a description of the analyses and measurements related to answering the central research questions.
Discussion: the interpretation of the results, considering their significance, and putting them into a wider context through comparison with previously published research. The use of a combined "Results and Discussion" section is preferred as the format for the journal.
Conclusions: a concise statement of the main conclusions drawn from the research reported in the manuscript.
Acknowledgments: a list of people who contributed to the work in the manuscript but who are not named in the author list, and a list of funding sources that supported the research presented.

Text
Text formatting
Manuscripts should be submitted in Microsoft Word.
Use a normal, plain font (e.g., 12-point Times New Roman) for text.
Use italics for scientific names.
Use the automatic page numbering function to number the pages.
Do not use field functions.
Use tab stops or other commands for indents, not the space bar.
Use the table function, not spreadsheets, to make tables.
Use the equation editor or Math-Type for equations.
Save your file in docx format (Word 2007 or higher) or doc format (older Word versions).

Headings
No more than three levels of displayed headings should be used.

Abbreviations
Abbreviations should be defined at the point of first use and be used consistently thereafter.
Abbreviations defined in the abstract should be redefined in the main body of the submission.

Scientific style
Internationally-accepted signs and symbols for units (SI units) should be used throughout. Negative exponents should be used instead of a slash, e.g., m s–2 rather than m/s2. *Nomenclature*: In so far as possible, authors should use systematic names similar to those used by Chemical Abstracts Service or IUPAC.

References

The list of references should only include works that are cited in the text and that have been published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text.

Reference should be arranged in alphabetical order (APA format) of authors' names at the end of the paper. Each should be given in the following form: authors' names, year of publication, the title of paper, the title of the journal in full and italicized , volume number, first and last page e.g.

Braimah, A. K. (2000). Land evaluation for sorghum. Nigerian Journal of Soil Science 12:4-11.

Kilmer V. J. (1990). Handbook of Soils and Climate in Agriculture. CRC Press, Boca Ratio. In the text, reference should be given by the name of the author, followed by the year of publication in brackets. The letters, a, b, etc. should be used to distinguish between papers published by the same author in a single year.

Callosobruchus maculatus: A Silent Cowpea and Human Plant Protein Terrorist.

O. O. Longe
Department of Crop, Soil and Environmental Sciences,
Ekiti State University, Ado-Ekiti. Nigeria.
longesola@yahoo.com

Abstract: Since the September 11, 2001 terrorist attacks on the World Trade Center in the United States of America, terrorism has become a global issue of serious concern. Today, Al-Qaeda, ISIS, Boko-haram and several groups have become dreaded names noted for terror and wanton destruction of peoples' lives and properties for no just cause. *Callosobruchus maculatus*, on the other hand, is a small cowpea beetle or weevil (2.0-3.5 mm in length) and capable of destroying millions of tons of stored cowpea grains through their silent grubs thereby causing very heavy losses of highly digestible dietary plant protein. In Nigeria, cowpea occupies a prominent place in human nutrition as the edible grains form a cheap and rich source of plant protein. Cowpea sale is also an important local trade and a good source of employment and income. The cowpea bruchid has been responsible for 10-25% loss of stored cowpea grains but enormous losses, up to 100%, have been observed in unprotected seeds after about 5 months in store. The attack not only reduces seed weight but also affects the aesthetic and nutritional quality, viability and market value of the seeds. In Nigeria, annual losses to this pest amount to about ? 15billion. This paper, therefore, examined the life cycle of the cowpea bruchid and proffered strategies for mitigating its activities to ensure proper cowpea storage and increase the upply of cowpea seeds.

Keywords: *Callosobruchus maculatus*,cowpea seeds, mitigation.

Introduction

Grain legumes and cereals form major staple food crops and sources of subsistence and livelihood for millions of people in many countries, especially in sub-Saharan Africa. In Nigeria, food grain legumes occupy a prominent place in human nutrition as the edible grains are a source of cheap and rich plant protein. Out of the food grain legumes grown, cowpea is the most widespread and commonly consumed in Nigeria (Ofuya, 2003).

The cowpea plant *Vigna unguiculata* (Linnaeus) Walpers belongs to the family *Fabaceae* (Verdcourt, 1990). The plant probably originated from the southernmost region of Africa and has domestication and concentration in West Africa (Padulosi and Ng, 1997). Today, almost 12.5million hectares of cowpea are cultivated in Nigeria to produce some 5 million tonnes of grains (bean) annually (Singh *et al*., 1997).

Cowpea has been described as the 'wonder' crop of Nigerian agriculture (Ofuya, 2003) from the standpoint of the roles in human and animal nutrition, soil improvement and protection, crop protection, internal trade and poverty alleviation. People who consume cowpea have variously described it as protein-and blood-giving, body-building, strength-giving and an adequate substitute for meat (Nnanyelugo *et al*., 1997). Some people relish the young leaves which are eaten as salad while the immature pods or immature seeds are used as a vegetable. The mature seeds can be made into various local dishes such as porridge, cakes, and other snacks. The dry seeds can also be boiled with yam, rice, and maize, with condiments, to provide a sort of balanced diet, for human consumption. It can also be used in soup preparation (Longe, 2012).

The sale of beans is a booming business in Nigeria and a good source of income and employment for rural dwellers. Large quantities of beans worth several millions of naira are regularly transported from the production centres in the northern states to the southern parts for sale and consumption. Men and women, boys and girls obtain their livelihoods from trade in beans either as wholesalers or retailers in market centres throughout the country thereby helping to alleviate poverty (Ofuya and Longe, 2009).

Cowpea at the vegetative growth phase is important in animal nutrition as livestock fodder. The haulms or husks left over as chaff after threshing the harvested pods are also good livestock feeds. The nutritional value of dry cowpea haulms compares very well with other forage legumes. The crude protein, digestibility

and mineral contents are high but the fibre content is low (Tarawali *et al*., 1997).
The entire cowpea plant is also important in crop production systems as a cover crop that checks both water and wind erosion and suppresses weeds. The roots harbour some bacteria *(Rhizobium leguminosarum)* in the nodules which fix atmospheric nitrogen (N) symbiotically into the soil. Research has shown that soil N levels increase following a cowpea crop (Miller and Fernandez, 1986). Some varieties of cowpea also help in weed control by causing suicidal germination of the seeds of *Striga hermonthica*, a parasitic plant that infests cereals (Quin, 1997).

Damage Done by *Callosobruchus maculatus* to Cowpea Seeds.

Despite the values of cowpea, its availability and utilization in Nigeria have been impaired by the damage to the seeds caused by the larvae of the cowpea seed beetle *(Callosobruchus maculatus)* Fabricius during storage which is usually the longest post-harvest phase of the crop (Okigbo, 1986). The pest is responsible for over 90% of the damage done to cowpea seeds by insects in the tropics (Caswell, 1982). Up to 100% losses have been frequently observed in unprotected seeds after about 5 months in store due to the beetles' attack (Singh and Van Emden, 1979).

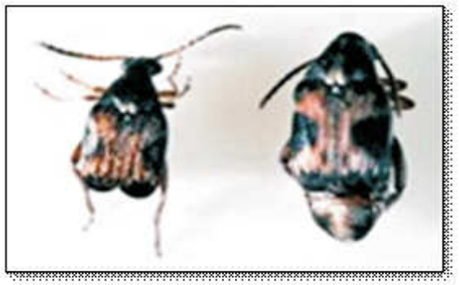
The attack begins in the field and continues in storage, causing substantial damage as the pest population rapidly increases (Ofuya, 2003). The severe damage lowers the quality and quantity of the cowpea available for consumption. Germination is adversely affected when three or more emergence holes appear on a seed (Singh and Van Emden, 1979). The larvae make holes in the seeds and partly emptying them of their contents leaving a fine, white powder which accumulates at the bottom of the containers.

In addition to the physical damage caused, the fatty acid content of infested seeds is increased and the protein content slightly denatured. There is also a loss of thiamine from infested seeds (Southgate, 1978). Loss of seed quality is manifested through changes in texture, taste, appearance, reduced nutritional values and the overall marketability. The annual losses to this pest alone in Nigeria amount to at least 15 billion Naira (Lale and Okunade, 2000).
This paper, therefore, examined the life cycle of the cowpea beetle, *Callosobruchus maculatus* and proffered ways of subjugating the pest's activities for sustainable cowpea storage in order to ensure availability of the seeds as alternative protein sources for human and livestock.

Baseline Studies of the Cowpea Bean Beetle *(Callosobruchus maculatus)* Fabricius

The bean beetle, *Callosobruchus maculatus* (Coleoptera: Chrysomelidae: Bruchidae), is also called cowpea weevil or cowpea seed beetle. The larva is a herbivore that specializes on leguminous seeds' consumption. Unlike the maize weevil, *Sitophilus zeamais*, the cowpea beetle is not a true weevil as it lacks the "snout". It is a member of the Order Coleoptera (meaning “sheath-winged” referring to the stiff outer, first pair of the insects' wings called elytra that protect the membranous second pair of flight wings). The larvae of this species feed and develop exclusively on the seed of legumes particularly cowpeas, hence the name bean beetle.

Description and Identification of Sexes*:* The adult *C. maculatus* is small, compact brownish beetle, 2.0 -3.5 mm long and characterized by serrated and clubbed antennae, relatively long legs, a pair of distinct ridges on the ventral side of each hind femur which bears a tooth near the apical end. The body is clothed in short hairs and the elytra. The elytra is longer than the width and has four round dark patches. The elytra markings or dorsal spots are stronger and more pronounced in females than males while the last abdominal segmented tergum (known as pygidium) in both sexes, is not covered by the elytra. In the non-flying females, the pygidium is black with a medium line of white hairs. The female beetles generally have larger body size than the males (Adedire, 2001; Ofuya, 2001; Lale, 2002). The adult of *C. maculatus* exhibits polymorphism (Taylor and Agbaje, 1974). The beetle is sexually dimorphic and males are easily distinguished from females. Females are darker overall, while males are brown. The plate covering the end of the abdomen is large and dark in color along the sides in females and smaller without the dark areas in males. Two primary morphs called the 'sedentary' (normal or storage) and 'active' flight forms may be produced in infested stores. Active morphs appear when the food quality is poor and when the temperature and humidity rise during severe infestations (Messina and Renwick, 1985). Active morphs fly readily and are smaller, have larger fat reserves, live longer and lay fewer eggs later in life. They are very important in the dispersal of the beetle. The sedentary forms may be able to fly well enough to invade field crops from nearby stores. Intermediate morphs which exhibit variable take off ability may also appear.



""Flight" form Male (L) / Female (R).
Fig 1: *C. maculatus* Sexes in pix

Sedentary" form Male (L) / Female ®

Origin, Distribution and Host Range.
C. maculatus originated in Africa where it is still the dominant species of the genus *Callosobruchus.* It is now distributed throughout the tropics and sub-tropics as the most important field-to-store and cosmopolitan pest of cowpea Odeyemi and Daramola, 2000). In Nigeria, it also infests pigeon pea, lima bean, African yam bean, soya bean and Bambara groundnut *(*Dobie *et al*., 1984).

Infestation and Ecology of *C. maculatus*
C. maculatus occurs everywhere cowpea is grown. Individuals, which invade field crops may come from infested stores in the vicinity (Taylor and Agbaje, 1974) or from wild cowpeas and other legumes. Infestation normally starts with the females laying eggs on ripening cowpea pods in the field or enters the cowpea pods through holes made by other pests and lay eggs directly on the seeds (Singh *et al*., 1998). As the pods dry, the pest's ability to infest the seeds decreases. Dry seeds stored in their pods are sometimes resistant to attack whereas the threshed seeds are susceptible to attack throughout storage (Odeyemi and Daramola, 2000). A bean that is too dry will be impossible for the larva to bore into while wet beans may have fungal growth. Store infestation is frequently derived from harvested field-infested pods or seeds but may also come from a hidden infestation in the store (Ofuya, 2001). Irrespective of the source of the initial infestation, the founder population consists of relatively few individuals that can breed and proliferate to pest proportions in a relatively short time (Messina, 1989).

Biology and Behaviour of *C. maculatus*
The growth, development, and reproduction of *C. maculatus* have been extensively studied. The developmental time varies with factors such as humidity, temperature, legume type, crowding and inbreeding levels in the population (Fox and Reed, 2011). The optimum conditions for these developmental processes in the beetle are 30-35°C and 70-90% relative humidity. The pest has little resistance to cold as development ceases below 17°C but occasionally can tolerate 10% relative humidity (Odeyemi and Daramola, 2000; Ofuya, 2001; Lale, 2002).

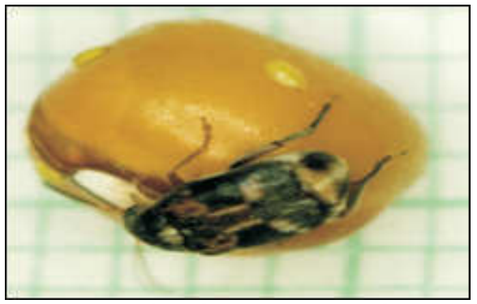
Mating starts shortly after adults emerge from seeds and probably several times during adult life (Fox, 1993). Females release a pheromone that attracts the males for mating (Qi and Burkholder, 1992). Freshly emerged adults may take 24 to 36 hours to mature completely and have a life span of 10-15 days while unmated females tend to live much longer (Ofuya, 2001). Adults are basically semeparous (require neither food nor water) but spend their limited lifespan mating and laying eggs on bean seeds. It may consume water, sugared water or yeast, it offered. A female given nutrients may lay more eggs (Raina, (1990).

Oviposition starts soon after mating and within 24 hours of adult life, with the majority of the eggs laid within three days (Credland and Wright, 1989). Unmated females do not lay eggs. Females lay between 60-115 eggs before they die and the eggs are usually laid only on the smooth parts of cowpea seeds (Odeyemi and Daramola, 2000). Females prefer to lay eggs on large, whole, smooth and pristine seeds (seeds that are egg-free or containing no developing larvae or emergence holes) (Ofuya and Agele, 1990).

Fecundity of females is variable and influenced by the kind of host infested, host availability, the reproductive experience of males and other

factors, including the environment (Ofuya, 2003). The age of the female at oviposition affects the development and survival of the offsprings. The eggs of older females are less likely to hatch and the larvae take longer to develop and fewer larvae survive to adulthood (Fox and Reed, 2010).

Eggs of *C. maculatus* on cowpea seeds



C. maculatus laying eggs on seeds

Generation Time
Once mated, adult females will oviposit single fertilized eggs. Individual eggs (0.75 mm long) are oval or spindle-shaped, clear, shiny and firmly glued to the bean surface as white crystalline distinct structures. Under optimum conditions of 30-35°C and 70-90% relative humidity, the eggs hatch in about 4-6 days after oviposition. The emerging scarabaei-form larvae bore through the chorion of the eggs directly into the pod wall and then into the cotyledons of the seeds where they feed and pupate. Larvae development takes 16-20 days. Larval crowding can occur when up to 8 or 10 larvae feed and grow within one seed. This limits the resources for each individual and leads to longer development time, higher mortality, smaller adult size, and lower fecundity. As the larva feeds, it prepares a chamber covered with a flap of testa known as 'window' before pupation. The window is a hole (1-2 mm) with a thin membrane of testa covering it. The hole excavated by the larva serves as an exit for the eventual emergence of the adult bruchid.

Pupation takes place in this chamber and the pupal period is about 7 days (Lale, 2002). There are a 2-day pre-pupal and a 5-day pupal stage. Adults emerge, through exit or emergence holes, from about 28-36 days after the eggs have been laid. During eclosion, 3-4 beetles may emerge from a single seed (Odeyemi and Daramola, 2000; Ofuya, 2001; Lale, 2002).

The elapsed time from newly laid eggs to the emergence of adult beetles varies between bean beetle strains and environmental conditions. Previous studies indicate that temperature and relative humidity are the most important variables influencing generation time (egg to adult) when beetles are raised on preferred host beans. Within a limited range, increasing temperature will decrease the generation time. Laboratory studies have shown observed generation times as short as 3-4 weeks at 30°C and ambient humidity (ranging from 20-40%). Cultures raised in a 25°C incubator and ambient humidity (ranging from 40-60%) had generation times of 4-5 weeks while cultures maintained on a laboratory bench at room temperature (22°C) and ambient humidity (40-60%) had a generation time of a full 7 weeks. Generation time also depends on the host species of bean used. At 30°C, it took seven weeks for emergence from adzuki beans, pigeon pea, and hyacinth beans compared to 3-4 weeks from mung beans.(Devereau, *et al*, 2003; Fox *et al*, 2004; Chi *et al*, 2011).

Measures of Prevention and Control of *Callosobruchis maculatus*
In the control of bruchids, preventive and curative measures complement each other and this is necessary for the long-term efficacy of the control measures adopted. The degree of success observed in cowpea production is a function of the level of pest control, both in the field of planting and in the store. To achieve an effective pest management in cowpea production status, therefore, several measures have been put in place or adopted by grain farmers both on the field and in store, such as proper sanitation, use of conventional insecticides, physical control practices, good cultural measures, the use of natural enemies such as predators, planting of resistant crop varieties, the use of plant materials as bio-pesticides such as contact powders, fumigants, repellants and antifeedants, and good warehouse management.

General Sanitation and Warehouse Management

This consists of the careful observance of all hygiene measures with which all other measures are uneconomical (Ofuya, 2001). Preventive measures with regards to storage hygiene are important in maintaining the quality of the commodity and avoiding losses without the use of chemicals. Perfect storage hygiene is the basic prerequisite for successful storage and for the effectiveness of all on-going measures such as the use of pesticides. All hygiene measures are relatively simple, effective and cheap but require knowledge, attentiveness, diligence, surveillance, responsibility and thoroughness (Odeyemi, 2003). The success of storage can be determined by the maintenance of clean surroundings, keeping the commodities cool and dry, stacking on pallets, away from building walls and keeping the store in good condition always.

Reduction in pest population can be achieved through the use of planned hygiene and stock turn-overs in commodity stores. Sanitation is particularly effective when directed at empty stores before they are refilled. Dunnage must be lifted and brushed off. Storage sites must be free of debris, old bags, unwanted machinery and unused dunnage and pallets. All sweepings, spoilages and residues should be removed. A high standard of cleanliness should be maintained by regular brushing of wall ledges, ceilings and floors. The store should be sprayed or dusted with insecticide before restocking. All commodities should be inspected before intake for excessive moisture content and infestation. Infested commodities should be rejected or fumigated before loading into storage and infested grains must not be stocked with non-infested ones. Old stocks should be disposed of off before new ones are received into storage.

Use of Cultural Measures

This includes(i) site selection/location (ii) proper timing of harvesting schedule, (iii) mixed-cropping (iv) destruction of harvest residues.

(I) *Site Selection /Location:* In the context of Integrated Pest Management (IPM), cultural or cultivation methods are understood to mean all those methods which, as well as performing their crop farming function, have a negative impact on the conditions of life of the pests. In the best case scenario, a measure will have a negative impact on the population density of a pest and a positive impact on the natural enemy population of the pest without having a negative effect on the output of the cultivated plant (Cochrane, 1994).

Through the choice of appropriate site for planting, the crop is placed in a favourable habitat which promotes its healthy growth and development and increases its resistance to pests. A crop can also be fully protected against certain pest organisms when located at sites where those pests do not occur. Therefore, as the 'active' form of cowpea beetles *(C. maculatus)* are good fliers and can fly long distances to infest crops on the field, storehouses should be located far away from cowpea fields to prevent cross-infestations.

(ii) *Proper Timing of Harvesting Schedule:* A properly timed harvesting schedule for cowpea would reduce infestation by *C. maculatus.* For example, cowpea seeds harvested very late (4 weeks after the recommended harvest time) were infested by *C. maculatus* to a significantly greater extent than cowpeas harvested early or at the end of the recommended harvest time in Kenya (Olubayo and Port, 1997).

The pods of cowpea should be picked before they start to split open because the female beetles prefer to oviposit on the exposed seeds (Singh *et al*., 1990). In Nigeria, the regular (weekly) harvest of ripe cowpea reduced bruchid attack by two-thirds compared to a single final harvest (Caswell, 1976).

(iii) *Mixed-cropping:* Olubayo and Port (1997), observed that *C. maculatus* populations were significantly reduced in a maize/cowpea intercrop compared to a monocrop.

(iv) *Destruction of Harvest Residues:* Harvest residues help pests survive unfavourable climatic conditions (Cochrane, 1994). The pests can be reduced considerably by destroying or ploughing in the harvest residues. Storage of dry cowpea and maize in granaries immediately after harvest gives physical protection and considerably reduces infestation.

Regulatory or Phyto-sanitary Measures

There is an assemblage of regulations provided by different national governments to check, restrict or exclude the entry of certain plants or their products which are likely to carry pests or diseases into a country through importation.

Mechanical Control Measures

The various mechanical measures available for adoption in cowpea storage include (i) use of natural armours (shucks /pods), (ii) threshing and sieving, and (iv) use of modernized storage *structures.*

(i) *Use of Natural Armours:* Caswell (1976) demonstrated that bruchid attack in conventional granaries was considerably reduced when cowpea was stored in the pods compared to threshed ones in jute bags. The pod walls and shucks served as physical and possibly toxic barriers to the bruchid larva, preventing it from gaining easy access and boring into the grains, thereby reducing the population build-up.

(ii) *Threshing and Sieving:* Ofuya and Ogunyemi (2003) observed that infested seeds of cowpea can be sieved during storage to reduce damage by *C. maculatus.* Sieving caused crushing of *C. maculatus* eggs on seeds and so reduced adult emergence from the affected seeds. The sieving method may be adopted by students, households and small-scale farmers that handle small quantities of cowpea seeds. Threshing also reduced the level of seed damage by *C. maculatus* in storage due to the loss of eggs on the outside of pods as well as first instar larvae that may be boring through the pod wall (Caswell, 1976).

(iv) *Using Modernized Storage Structures:*

A modernized form of the storage system is the crib which guarantees good aeration and even drying of seeds during storage. The unthreshed grains can be stored in the cribs for 3-6 months. Adaptation has been made by fitting rodent guards on the crib stands. One advantage of this system is the strong natural ventilation which ensured continued drying in storage. On the contrary, however, insects and birds may have unrestricted access to the stored grains/pods if adequate precautions are not taken (Odeyemi and Daramola, 2000).

Physical Control Measures

Physical control of stored-product pests consists basically of modifying the environment in which insects live so that it becomes deleterious for the survival of the target species. It involves such techniques as the manipulation of density-independent factors such as temperature and humidity as well as density-dependent factors such as the amount of available oxygen and amount of carbon dioxide or carbon monoxide. Insects generally have narrow environmental limits within which they survive and breed successfully. Any technique which can alter either the temperature or the humidity without any detectable adverse effect on the commodity will provide adequate protection.

The various physical measures adopted for use in grains storage include(i) solarization (ii) storage in fireplace and use of high temperature(iii) use of low temperature (iv) controlled atmosphere (hermetic) storage and (v) use of shortwave radiation

(I) *Solarization (Sun-drying)*: Drying is an important aspect in grains storage since moisture is an important factor in grain deterioration during storage. Products must be dried to sufficiently low moisture content before storage. Beetle-infested cowpeas are commonly spread out in the sun in Nigeria. The attack would reduce due to the heat of the sun which may kill or repel the beetles. Also, the high temperature due to direct solar radiation may kill the developing larvae in the grains (Zehrer, 1980).

(ii) *Storage in Fireplace and Use of High Temperature:* Insects die when exposed to high temperatures because of their limited physiological capacity to thermo-regulate. Eggs, larvae, pupae and adults of *C. maculatus* are all affected by the deleterious effect of high temperatures. When commodities are dried above the fire, care must be taken to prevent cracking of the grains and loss of viability. Over-drying or over-exposure to a heat source can cause breakage of seeds, damage to seed coat, bleaching, scorching, discolouration, loss of germinative power and nutritional changes. Heat exposure of cowpeas seeds, therefore, should not be more than 35^0C. Too rapid drying of seeds with high moisture content can cause damage such as bursting or 'case-hardening,' which causes the surface of the grain to dry out rapidly, sealing moisture within the inner layers. Under-drying or slow drying, on the other hand, results in deterioration due to fungi and bacteria. (Odeyemi and Daramola, 2000).

(iii) *The Use of Low Temperature:* Most research workers disinfect cowpea grains suspected to be laden with weevils'eggs by deep-freezing for about 2 weeks. All stages of *C. maculatus* were killed when subjected to freezing temperatures for less than 32 days; eggs being more susceptible to cold than other stages of the insects (Huis van, 1991).

(iv) *Controlled Atmosphere (Hermetic) Storage:* The hermetic technique is an air-tight technology for grain storage that functions on the principle that as the insects respire and use up oxygen that may be contained in the storage device, carbon dioxide builds up. The insects will die from reduced oxygen (hypoxia), lack of oxygen (anoxia) and eventual carbon dioxide build up and poisoning (hypercarbia). It can be practiced on

almost any scale as long as the devices to be used are provided with tight fitting lids which keep out air. Sealed polythene bags can also be used for partial hermetic storage of grains. Successful hermetic storage depends on the fulfillment of a number of requirements which include storing only dry grain, making sure that the containers or structures are really air-tight, filling the containers as completely as possible and keeping the container at uniform cool temperature.

Biological Control or Use of Natural Enemies (Parasitoids, Predators, and Antagonists)

Biological control involves the use of living organisms to reduce the population of certain pests. Organisms employed are the natural enemies of the pest species, or individuals of the pest species modified, such that they destroy members of their own species (Cochrane, 1994). Many natural enemies attack bruchids (Huis van, 1991). Caswell (1976) suggested that storage of cowpea in the pod in shucks enables the parasitoids of *C. maculatus* to overtake the fast-developing population of the bruchid at a shorter time than in shelled (threshed) cowpea. Isolation of strains of the bacterium *Bacillus thuringiensis* that are toxic to beetles (Hernstadt *et al*., 1986) accompanied by appropriate developments in biotechnology for increased toxicity of the specific strains (Evans, 1987) will facilitate its use for *C. maculatus* control.

Bio-technological Control and the Use of Resistant Varieties

Bio-technological genetic engineering may offer promise in developing cowpeas that are resistant to the more recalcitrant cowpea pod borer and the pod bugs. Cowpea varieties can be developed for tolerance or resistance to *C. maculatus* attack. The choice of resistant or tolerant varieties as a preventive measure is sufficient to keep the pest population below the control threshold (Cochrane, 1994). The resistance of cowpea to pests occurs in three different forms: chemical, morphological and nutritional. The plant can develop chemical substances which attract pests (attractants) or repel the pests (repellants). The plant can develop some morphological characteristics which favour the crop but impede the development of a pest. Such characteristics include the plant's leaf size, shape and colour; the presence or absence of secretory glands; toughness of the plant's / seed's tissue or coat, and the presence of epidermal hairs which impair the mobility of insects. The combination of nutrients within a plant genotype can make a plant appear more or less suitable to particular pest as a source of food or as a place to lay eggs.

Use of Inert Materials

Wolfson *et al* (1991) found that a minimum ratio of 3 parts of wood ash to 4 parts of cowpeas prevented population growth of *C. maculatus* and that a 3 cm layer of ash on top of stored seeds prevented infestation.

The Use of Conventional or Synthetic Insecticides

Many synthetic insecticides (either as dust or fumigants)are effective against *C. maculates* (Adedire, 2001). Insecticidal dust of Organo-phosphorus compounds (malathion, chlorpyrifos methyl, fernitrothion, methacrifos or pirimiphos-methyl); carbamate (carbaryl);or synthetic pyrethoids (permethrin and deltamethrin) can protect shelled cowpeas stored in bags or in air-tight containers from C *maculatus* damage for several months (Ofuya, 2001; Adedire, 2001). The use of synthetic insecticides in pest management is becoming less attractive due to high cost, increased incidence of pest resistance, high mammalian toxicity, high level of persistence in the environment, workers' safety, adulteration, leaving of poisonous residues in food after use and other health hazards (Ofuya, 2001).

The Use of Plant Materials as Insecticides

Current research efforts on stored-products development are being focused more on ecologically-tolerable, readily available and cheaper control measures especially the use of plant-derived insecticides such as plant powders, oils, and extracts (Adedire, 2001). There is also an increasing awareness that plants possess chemicals which naturally protect them from pests. The tropical region is well-endowed with a wide array of these floristic species with defensive chemicals and quite a number of them has been used traditionally in protecting cowpea against beetles' attack (Adedire, 2001; Longe and Ofuya, 2010).

The plant materials are sometimes mixed with the legume pods or seeds in storage for reducing bruchid attack (Golob *et al*., 1999). Many of the plants used have known medicinal and pharmacological properties (Sofowora, 1982) and some have been subjected to empirical verification for effectiveness against *C. maculatus* (Longe and Ofuya, 2010).

Plant products used as protectants for stored agricultural commodities are normally obtained from leaves, roots, flowers, fruits, seeds, barks and stems of plants (Dupriez and de Leener, 1989) which can be made into various forms such as *plant material formulations and admixtures,*

dusts, wettable powders, emulsifiable concentrate formulations, plant material fumigants, repellants and antifeedants, as well as plant oils and extracts as attractants and synergists. Examples of plant material fumigants, for instance, are Eugenia aromatica(Clove) powderand Corymbia citrodora (Eucalyptus plant) leaf oil.

The Use of Integrated Pest Management (IPM) Approach

This is a process by which farmers draw from a range of pest control methods to achieve the most effective, economical and sustainable combination for a particular situation (Thomas and Waage, 1996). In IPM, the emphasis is placed on self-renewing pest subjugation tactics such as the use of plant resistance and biological control. Insecticides are used only when absolutely necessary, albeit judiciously, through choosing selective chemicals, that are less hazardous to natural enemies of insect pests) or minimum insecticide application. Ecological backlashes or other desirable side effects are thereby preventable in properly fashioned and implemented IPM programmes.

Studies have been conducted to combine different methods for integrated control of bruchids attacking cowpeas in storage. Lale (1993) and Seek *et al*. (1996) have demonstrated effective protection of stored beans against bruchid attack by combining hermetic storage with the activity of plant-derived insecticides. Lale and Mustapha (2000) have demonstrated the possibility of combining neem seed oil with varietal resistance for the control of cowpea storage beetle.

Conclusion

It is clear that depredation of stored food commodities by *Callosobruchus maculatus* constitutes a major constraint to a successful cowpea production and utilization in the tropics and a major factor militating against the crops availability and also food security in Nigeria. It is imperative, therefore, that greater attention should be paid to the crop during storage in order to make them available for use throughout the year. Any reduction in loss between harvest and consumption would increase the availability of food grains and help to attain the sustainable development goal on food and nutrition security.

References

Adedire, C.O. (2001). Biology, ecology and control of insect pests of stored cereal grains. In: Ofuya, T.I. and Lale, N.E.S. (eds). Pests of Stored Cereals and Pulses in Nigeria: Biology, Ecology, and Control, Dave Collins Publications,Nigeria:59-94.

Caswell, G.H. (1976). The storage of grain legumes. In: A. Youdeowei (ed.), Entomologyand the Nigerian Economy. *Entomological Society of Nigeria:* 131-142.

Caswell, G.H. (1982). Damage to stored cowpea in the Northern part of Nigeria. *SamaraJournal of Agricultural Research* 1: 111-119.

Chi, Y.H., Ahn, J.E. Yun, D.J. Lee, S.Y. Liu, T.X. and Zhu-Salzman K. (2011). Changes in oxygen and carbon dioxide environment alter gene expression of cowpea bruchids. *Journal of Insect Physiology* 57: 220-230

Cochrane D. J.(1994). Integrated Pest Management Guidelines. Rossdorf: TZ-Verl. Ges: 15-33.

Credland,P.F. and Wright, A.W., (1989). Factors affecting female fecundity in the cowpea seed beetle, *Callosobruchus maculatus* (Coleoptera: Bruchidae). *Journal of Stored Products Research* 25: 125-136.

Devereau, A.D., Gudrups, I. Appleby, J.H. and Credland P.F..(2003). Automatic, rapid screening of seed resistance in cowpea, *Vigna unguiculata* (L.) Walpers, to the seed beetle *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) using acoustic monitoring. *Journal of Stored Products Research* 39:117-129.

Dobie, P., Haines C.P., Hodges, R.J. and **Prevett, P.F.** (1984). Insects and arachnids of tropical stored products In:Ofuya, T.I. and Lale, N.E.S.(Editors) Pests of Some Cereals and Pulses in Nigeria: 24-26.

Dupriez, H., Leener, P. de (1989). AficanGardens and Orchards: Growing Vegetables and Fruits. London, UK; Macmillan Publishers Ltd., 333 pp.

Evans, D.E. (1987). Stored products. In: A.J. Burn, T.H. Coaker and P.C. Jepson (eds). Integrated pest management. *Academy Press, London*: 425-461.

Fox, C. W. and Reed D. H. (2010). Inbreeding depression increases with maternal age in a seed-feeding beetle. *Evolutionary Ecology Research* 12(8): 961-72.

Fox, C. W. and Reed D. H. (2011). Inbreeding depression increases with environmental stress: an experimental study and meta-analysis. *Evolution* 65(1): 246-58.

Fox, C.W., Bush, M.L. Roff, D.A. and WallinW.G. (2004). Evolutionary genetics of lifespan and mortality rates in two populations of seed beetles, *Callosobruchus maculatus*. *Heredity* 92:170-181.

Golob, P., Moss, C., Males, M., Fidgen, A. and Evans, J. (1999). The Use of Spices and Medicinal as Bioactive Protectants for Grains. FAO, Rome. 239.

Hernstadt, C., Soares, G.G., Wilcox, E.R. and Edwards, D.L.(1986). A new strain of *Bacillus thuringiensis* with activity against Coleopteran insects. *Biotechnology* 4: 307-308.

Huis, A. van. (1991). Biological methods of bruchid control in the tropics: A review.*Insect Science and its Application* 15: 87-102.

Jackai, L. E.N. and Daoust, R.A. (1986). Insect pests of cowpeas. *Annual Review of Entomology* 31: 95-119.

Lale, N.E.S. (1992). Oviposition deterrent and repellent effects of products from drychilli pepper fruits, *Capsicum* species on *Callosobruchus maculatus*. *PostharvestBiology and Technology,* 1: 343-348.

Lale, N.E.S. (1993). A laboratory assessment of the effectiveness of four storage devicesand *Capsicum fructescens* in the abatement of infestation of stored cowpeas by*Callosobruchus maculatus* (Coleoptera: Bruchidae). *Reveue de Zoologie Africaine*107: 39-43.

Lale, N.E.S. (2001). The impact of storage insect pests on post-harvest losses and theirmanagement in Nigerian agricultural system. *Nigerian Journal of Experimental andApplied Biology.* 2: 231-239.

Lale, N.E.S. (2002). Stored-product Entomology and Acarology in Tropical Africa. *MolePublications,* Maiduguri, Nigeria. 110-113.

Lale, N.E.S. and Mustapha, A. (2000). Potential for combining neem *(Azadirachtaindica* A. Juss) seed oil with varietal resistance for the management of the cowpeabruchid. *Callosobruchus maculatus* (F.). *Journal of Stored Products Research* 36:215-222.

Lale, N.E.S. and Okunade, S.O. (2000). Effect of weevil infestation on the caffeinecontent of stored kola nuts *(Cola nitida* Scott Vent et Endl.) in Maiduguri, Nigeria.*Journal of Plant Diseases and Protection* 107: 88-92.

Longe O. O., (2012). Investigations into fumigant effect of Eucalyptus oil against Callosobruchus maculatus (Fabricius). International Journal of Science and Technology Research, 4: 22-27.

Longe O. O. and Ofuya T. I., (2010). Investigations into fumigant effect of Eugenia aromatica dust against Sitophilus zeamais (Motschulsky). Journal of Agricultural Research and Policies, 5: 87-92.

Miller, J.C. and Fernadez, G.C.J., (1986). Plant factors affecting biological nitrogen fixation in cowpea. *Tropical Grain Legume Bulletin,* 32:25-30.

Messina, F.J. (1989). Genetic basis of variable oviposition behaviour in *Callosobruchusmaculatus* (Coleoptera: Bruchidae). *Annals of Entomological Society of America*82: 792-796.

Messina, F.J. and Renwick. J.A.A. (1985). Dispersal polymorphism *of Callosobruchusmaculatus* (Coleoptera: Bruchidae):variation among populations in response tocrowding. *Annals of Entomological Society of America* 78: 201-206.

Nnanyelugo, D.O., Ngoddy, P.O., Okeke, E.G**.** and Ngwu, E.K. (1997). Impact of a cowpea research project in Nigeria, using the rapid appraisal technique. Pages 333-340. In: Advances in cowpea research, edited by Singh, B.B., Ohan D,R., Dashiell K.E. and Jackai L.E.N.IITA, Ibadan, Nigeria and JIRCAS, Tsukuba, Ibaraki, Japan. 375p.

Odeyemi, O. (1993). Insecticidal properties of certain indigenous plant oils against *Sitophilus zeamais* Mots. *Appl. Ent, Phytopathology.* 60: 19-27.

Odeyemi, O. (2003). Evaluating the efficiency of different *Agrobacterium tumefaciens* strains for cowpea *(Vigna unguiculata* L. Walp). transformation. Postgraduate Diploma Thesis. The Federal University of Technology Akure. 67-71.

Odeyemi O.O. and Daramola A.M. (2000). Pests of stored food. In:*Food Storage and Pest Problems.* Akure. 1: 64-69.

Ofuya, T.I. (2001). Biology, ecology and control of insect pests of stored legumes in Nigeria. In: Ofuya and N.E.S. Lale Pests of Stored Cereals and Pulse in Nigeria: Biology, Ecology and Control. *Dave Collins Publication,* Nigeria. 24-58.

Ofuya, T.I. (2003). Beans, Insects and Man. Inaugural Lecture Series 35. *The Federal University of Technology, Akur*e, Nigeria. 45pp.

Ofuya, T.I. and Agele, S.O., (1990). Ability of ovipositing *Callosobruchus maculatus*(Fabricius) (Coleoptera: Bruchidae) female to discriminate between seeds with different number of emergence holes. *Journal of stored products Research* 26: 117-120.

Ofuya,T.I. and Ogunyemi, O.O. (2003). Evaluation of seed sieving for the reduction of *Callosobruchus maculatus* (F.) damage to infested cowpea in storage. *Applied Tropical Agriculture*81: 1-4.

Ofuya, T.I. and Longe O.O. (2009). Fumigant toxicity of some botanical powders to *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). *Proceedings of the 2nd Annual Conference of the Federal University of Technology, Akure*. 43-48 pp.

Okigbo, B.N., (1986). Welcome Address.*Tropical Grain Legume Bulletin 32: 5-9.*

Olubayo, F.M. and Port, G.R., (1997). The efficacy of harvest time modification and inter-cropping as methods of reducing field infestation of cowpeas by storage bruchids in Kenya. *Journal of Stored Products Research* 33: 271-276.

Olotuah, O.F. (2006). Efficacy of Insecticidal Formulations of *Eugenia aromatica* and*Piper guineense* in the control of *Callosobruchus maculatus* (Fabricius) and *Sitophilus zeamais* (Motschulsky). PhD Thesis, Department of Crop, Soil and Pest Management, Federal University of Technology, Akure.68-73.

Padulosi, S. and Ng, N.Q. (1997). Origin, taxonomy and morphology of *Vignaunguiculata* (L.) Walp. In:Singh, B.B. Mohan D.R., Dashiell K.E., and L.E.N. Jackai. IITA, Ibadan, Nigeria and JIRCAS, Tsukuba, Ibaraki, Japan.: 1-12.

Qi, Y.T. and Burkholder, W.E. (1992). Sex pheromone, biology and behaviour of theweevil, *Callosobruchus maculatus* (Fabricius) (Coleoptera: Bruchidae). *Journal of Chemical Ecology* 8: 527-534.

Quin, F.M. (1997). Introduction Pages. In: Singh, B.B. Mohan D.R., Dashiell K.E., and L.E.N.. Jackai. Advances in Cowpea Research, IITA, Ibadan, Nigeria and JIRCAS, Tsukuba, Ibaraki, Japan. ix-xv.

Raina, A. K. (1990). *Callosobruchus* spp. infesting stored pulses (grain legumes) in India and comparative study of their biology. *Indian Journal of Entomology* 32(4), 303-10.

Seek, D., Lognay, G., Haubruge, E., Marlier, M. and Caspar, C. (1996). Alternative protection of cowpea seeds against *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) using hermetic storage alone or in combination with *Boscia senegalensis* (Pers.) Lam. ex Poir. *Journal of Stored Products Research* 32: 39-44.

Singh, S.R. and Van Emden H.F. (1979). Insect pests of grain legumes. *Annual Review of Entomology* 24. 255-278.

Singh, S.R. and Jackal, L.E.N., Dos Santo, J.H.R. and Adalia, C.B. (1990). Insectpests of cowpea. In: Singh (ed). S.R. *Insect Pests of Tropical Food Legumes,* JohnWiley and Sons, Chichester. 43-89.

Singh, B.B., Chambliss, O.S. and Sharma, B. (1997). Recent advances in cowpeabreeding.*Advances in Cowpea Research,* edited by B.B. Singh, D.R.Mohan Raj, K.E. Dashiell, and L.E.N. Jackai, IITA, Ibadan, Nigeria and JIRCAS, Tsukuba, Ibaraki, Japan. 375.

Singh, S.R., Luse, R.A., Leuschner, K. and Nangju, D. (1998). Groundnut oil treatments for the control of *Callosobruchus maculatus* (F.) during cowpea storage.*Journal of Stored Products Research* 14: 77-80.

Sofowora, A. (1982). *Medicinal plants and traditional medicine in Africa.* John Wiley and Sons, Chichester. 101-112.

Southgate, B.J. (1978). The importance of the Bruchidae as pests of grain legumes, their distribution and control. In: Singh, S.R., van Emden and Taylor T.A. (eds). *Pests of Grain Legumes: Ecology and Control.* Academic Press, London. 219-229.

Tarawali, S.A., Singh, B.B., Peters, M. and Blade, S.F. (1997). Cowpea haulms as fodder. *In:* Advances in Cowpea Research, edited by B.B. Singh, D.R. Mohan Raj, K.E. Dashiell, and L.E.N. Jackai, IITA, Ibadan, Nigeria and JIRCAS, Tsukuba, Ibaraki, Japan.313-325.

Taylor, T.A. and Agbaje, L.A., (1974). A further note on the incidence of 'active females' of *Callosobruchus maculatus* (F.) on mature cowpea in the field in Nigeria. *Journal of Stored Products Research* 10, 123-125.

Thomas, M and Waage, J. (1996). Integration of Biological Control and Host Plant Resistance Breeding. CTA, Wageningen, The Netherlands. 99 pp.

Tran, B. M. D. and Credland P. F. (1995). Consequences of inbreeding for the cowpea seed beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). *Biological Journal of the Linnean Society* 56 483-503.

Verdcourt, B. (1990). Studies in the *Leguminosae-papilionoidae* for the Flora of TropicalEast Africa IV. Kew Bulletin. 24: 507-569.

Wolfson, J.L., Shade, R.E., Mentzer, P.E. and Murdock, L.L. (1991). Efficacy of ash for controlling infestations of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in stored cowpea. *Journal of Stored Products Research* 27: 239-243.

Zehrer, W. (1980). Traditional methods of insect pest control in stored grains. In *Post-Harvest Problems. Documentation of an OAU/GTZ feminr, Schriftenreihe* No. 115,GTZ Eschborn, 121-135.

Community Parenting: A Community Approach to Protecting the Child from Abuses

W. G. Ojebiyi, O. R. Ashimolowo and P.B. Abdulsalam-Saghir,
Department of Agricultural Extension and Rural Development,
Federal University of Agriculture,
Abeokuta, Nigeria

All correspondence to oluwagbemiga2013@gmail.com;

Abstract: Nigeria has an agrarian economy and her desire to meet the needs of the citizens must recognize the important roles of children as only the well-developed children can grow into productive adulthood. Incidences of abuses and maltreatment of children including neglect are becoming increasingly noticed in both rural and urban areas of Nigeria despite the importance attached to children as sources of joy to the family. Poverty associated with single parenthood caused by the death of either parent or divorce is on the increase and this has become prominent in promoting the child neglect. The effects of poverty on these families can be reduced through conomanalty family parenting. This paper considered community parenting as a strategy to curbing child abuse and did this by providing an operational definition of terms; presenting the situational analysis of children in Nigeria; explaining community parenting as a concept; relating the traditional child-rearing practices to community parenting, and discussing community parenting in the light of the ecological systems theory. Diversity, volunteering, and professionalism are the identified key factors in the formation of community-based child protection groups. The paper concluded that the older children and all adults in the communities have the responsibility of ensuring child protection from violence, deprivation of rights, neglect, and exploitation. It is recommended that communities should form community-based child protection groups to fill the vacuum created by governments' and parents' lack of readiness to protect children.

Keywords:Community parenting, child abuse, child development, child protection, poverty

Introduction

Children are an important element in any society that wishes to develop. A child is a precious gift from God for the continued existence of mankind. The importance of children is much more displayed in African societies, especially in Nigeria. Children are considered as a sign of the blessings to marriages (Ajayi and Owumi, 2013) and the absence has often led to extra-marital affairs, separation, and divorces. Despite this desire for and significance attached to children, there are daily gory reports of several forms of abuses on children all over the country.

Nigeria has an agrarian economy and her future well-being and desire to meet the food and fibre needs of the citizens must recognize the critical roles of children as only the well-developed children can grow into productive adulthood. The role played by parents in ensuring productive and effective child development cannot be overemphasized. This is because the children are born weak, unable to defend themselves and hence are vulnerable to intended and unintended abuses which include child neglect, child labour, early/forced child marriage, child prostitution, child trafficking, street hawking, street begging, etc (Law, 2009; Owolabi, 2012). These abuses are usually perpetrated by parents, teachers, older adults, other children through bullying and other persons in charge of providing care for the child at home, in school, on the farm and other places of work either intentionally or unintentionally (Chukwu, 2008). This is because although some parents intentionally abuse children, most others have no choice but to use what they have (a child) to get what they want (money and other means of survival in the households) through hawking for sustenance.

The child remains the hope of any nation's social, political and economic development only if proper care is accorded to its development. This is because only well-developed childhood can transform into the productive adulthood necessary for the growth and development desired for any country. Thus, the requirement for the sustainable development of a country is paying attention to the best interests of the child (Owolabi, 2012). This was at the heart of world leaders when they adopted the United Nation's Convention on the Rights of Child (CRC) in 1989. The African leaders also developed the African Charter on the Rights and Welfare of the Child in 1990 which led to the promulgation of the Child's Rights Act (CRA) in Nigeria in 2003. Due to Nigeria's federal constitution which puts issues on children in the purview of state governments, the Act would be

domesticated at state levels for the child's rights to be fully provided for and protected (UNICEF, 2007; Akinwumi, 2009). At least two-thirds of the states' assemblies have passed the Child Right's Law which domesticated the CRA (UNICEF, 2007). The CRA also provided for community involvement in child protection by stipulating that there should be Child's Rights Implementation Committee at the local government level.

Although, significant efforts have been made at the federal level and in the states that had domesticated the CRA in public sensitization and awareness, similar efforts have not been intensified at community levels. The efforts are still directed at sensitizing the parents and other care-givers while leaving out the complementary roles of other persons within the society in ensuring that child's rights are protected. Therefore, the objective of this paper is to discuss the need for parenting at the community level and how this can curb all the forms of child abuse now prevalent in Nigeria.

Definition of key terms

Child: A child is any person (male or female) that is not an adult or is still a minor. In this context, a child refers to persons younger than 18 years old and includes adolescents and younger children.
Parent: This refers to a mother or a father who gave birth to a child or children and has the responsibility of caring and providing guidance to the child/children in order to ensure that such child/children would lead a good life. In this presentation, parents would not only refer to those of biological origins but also those that discharge parental roles of care and support on children and include foster parents, adoptive parents, older brothers, sisters, grandparents and step-parents with whom a child lives (FSPC, 2007).

Parenting: This is a functional term for the processes involved in promoting and supporting the development and socialization of the child (Richter and Naicker, 2013). According to FSPC (2007), parenting refers to the experiences, skills, qualities and responsibilities involved in being a parent and in teaching and caring for a child. Based on this, parenting refers to all the processes involved in the provision of care and guidance used in raising children in such a manner that the child is well-prepared to realize his/her full potentials as a human being.

Child abuse: This refers to any act that endangers the physical, psychological/emotional, health and educational welfare and development of a child. This can be categorized as physical abuse, emotional abuse, sexual abuse, neglects and child exploitation (Ojebiyi, 2014).

Child abuse: Situation of Nigerian children

In line with the provisions of the United Nations' Convention on the Rights of Children (CRC) and the African Union's Charter on the Rights and Welfare of Children (CRWC), the Nigeria's Child's Rights Act (CRA) made certain provisions on the rights and welfare of Nigerian children (CRA, 2003). These include fundamental right to survival and development, right to name (registration of birth), freedom of association and peaceful assembly, freedom of thought, conscience and religion, right to privacy and family life, right to freedom of movement, right to freedom from discrimination, right to dignity of the child, right to leisure, recreation and cultural activities, right to health and health service, right to parental care, protection and maintenance, right to free, compulsory and universal basic education (Sections 4-15) (CRA, 2003).

There are also contractual rights of the child: the right of the child in need of special protection measure as well as the right of the unborn child to protection against harms (Sections16-18). The protection rights include the prohibition of child marriage; child betrothal, tattoo and skin marks; exposure to use, production and trafficking of narcotic drugs; exploitative labour; abduction, removal and transfer from lawful custody; use of children in criminal activities; buying, selling, hiring or otherwise dealing in children for the purpose of hawking or begging for alms or prostitution; and unlawful sexual intercourse with a child (Sections 21-31).

The situation of the Nigerian child is better understood with the violation and breach of most of the rights than in compliance. With respect to education, most communities, especially in rural areas, lack the presence of schools and where present, they are characterized by poor or dilapidated buildings, inadequate educational facilities to aid both learning and teaching. Teachers in some schools are unqualified. Although most states claim to run a tuition-free education, schooling is still characterized by different costs such as Development fee, PTA fee, computer fee, lesson/extra class fees, sports fees, etc. These extra costs have the potentials of denying access to quality education as parents unable to pay would prevent their children from attending school and put them to work or hawk goods. The report of UNICEF Nigeria (2006) that

approximately 15 million children under 14 were working to support their family and pay their school fees provides a good explanation for the low school attendance among children of school age. This also affects the net enrolment ratio as well as literacy and numeracy rates in Nigeria but which vary among the regions. NPC (2010) reported that at least 7 million Nigerian children of school age were out of primary school and buttressed an earlier report of NPC and ICF Macro (2009) that the net attendance at primary school was only 62.1% during the 2008 Demographic Health Survey. This situation would have worsened in the north-east zone where the Boko Haram insurgency led to the closure of schools especially following the abduction of more than 200 *Chibok* girls.

Health services in Nigeria have been both ineffective and inefficient especially in rural areas. The World Health Organization (WHO) (2009) attributed this to inadequate qualified and experienced medical practitioners, inadequate health facilities, lack of medical equipment and medicines. The cost of accessing health services prevents poor households from getting quality medical services (Sharma*et al.*, 2005) such that traditional medical assistance is still largely patronized for the provision of health services (Antai, 2010). Lack of awareness about certain diseases and their treatments is the cause of poor health conditions in most children such that child mortality and maternal death rates are high (Holmes *et al.*, 2012). Nigeria's under-five mortality rate was above the average of 150 per 1000 live births in West and Central Africa regions despite the fact that it is the wealthiest country in those regions (UNICEF, 2011). This may be connected to most children being born with the help of unskilled traditional birth attendants. UNDP (2009) added socio-cultural norms and gender inequality to the list of factors affecting the demand for modern health care services in Nigeria.

With respect to the child's rights to name (registration of birth), most mothers in the rural areas give birth at traditional birth attendants' places and such births are not registered. Thus, the World Health Organization (WHO) observed that only 38.9% of births in 2008 were attended to by skilled personnel and probably registered. Global One 2015 (2012) also reported that 59.4% and 24.7% of mothers in rural and urban areas respectively delivered their babies in modern health facilities. This implies a variation in the provision of health facilities to the disadvantage of the rural areas and so makes the proper planning on effective child protection measures difficult.

Most children's rights to survival and development could not be realized due to poverty. The children go hungry without eating due to the households' inability to secure food which makes malnutrition prevalent in Nigeria. Thus, most of the children are stunted and wasted. NPC and ICF Macro (2009) reported that 41% of children under five are stunted while 23% are severely stunted.

Nigeria has been noted for her significant role in child trafficking being the source, transit and destination country for trafficked children (United States Embassy, 2010; 2014; United Nations Office on Drugs and Crime, 2012). This means that as Nigerian children are being trafficked to other countries like Saudi Arabia, Niger, Equatorial Guinea, some children from other countries were also trafficked to Nigeria to work as labourers and domestic servants. At other times, Nigeria's porous borders serve as easy routes for the trafficking of children from one country to another. Trafficked children either in or out of Nigeria are found working in agriculture, begging for alms, domestic service, mining, street peddling, market labourers and for commercial sexual exploitation (Isioma, 2010; IRIN, 2010; USDS, 2013a,b, c).

Corporal punishment and other disciplinary measures (flogging, slapping and even hitting with objects) meted out by parents, teachers, and other caregivers inflict marks on the skins of children. Ojebiyi (2014) reported the prevalence of scarring of children in Ogun State in violation of the provision that prohibits tattoos and skin marks.

Inadequate feeding of children and abortion were also among the prevalent forms of child's rights abuses in rural and urban areas of Ogun State. This situation is similar in all the southwestern states and is expected to be worse in the northern part of the country where food production has been seriously affected due to insecurity associated with farmer-cattle rearers' violent crises and the insurgency. The ensuing malnutrition would result in stunting and wasting of children. These together with low access to quality education and health service delivery have consequential negative impacts on the survival and development of the child as reflected in the high rates of child and infant mortality and prevalence of malnutrition (Holmes *et al.*, 2012).

Community parenting as a concept

The discussion so far has shown that the child's rights are far from been realized in Nigeria, despite the ratification of numerous international and regional legislations and protocols as well as the promulgation of the Child's Rights Act (CRA) and the subsequent domestication in two-thirds of the states. This then calls for all persons concerned to act as parents not only to their biological or adoptive children but also to all children within their reach in an approach referred to as community parenting.

Community parenting refers to any situation in which a child has caregivers in addition to his or her biological or adoptive parents (WiseGEEK, 2015). These caregivers may be family members (grandparents, aunts, uncles, or older brothers and sisters, close family friends) or other parents in the community who help each other with their children (Kessler, 2007). This situation is becoming popular due to the increasing emergence of many single parents, blended families, adopted children and other non-traditional family situations. A single parent, for instance, in a bid to provide basic needs of the children may take up paid jobs that prevent him/her from giving attention to the children. Parenting is a full-time responsibility, and not everyone can do it alone. Community parenting, in which more than two care givers take responsibility for a child, can help provide the child with additional support in growing up, and can create strong bonds between adults. In one form of community parenting, parents and children may spend time together as a group, while each parent takes his or her turn watching the children as they play (WiseGEEK, 2015). Community parenting of this sort requires great trust between the parents but it helps to form strong community bonds between both the parents and the children. Parents benefit from such situations because the community offers extra safety and support for their child.

It can be deduced from the foregoing that community parenting focuses on older adults seeing every child as their own and providing for their basic needs, care, nurture, and even guidance so as to serve the best interest of all children. This will enhance a healthy family and community life through adequate empowerment because children who otherwise would become miscreants, if neglected, would have been taken care of, thereby reducing crime rates and other vices in the society.

Traditional childrearing practices in Nigeria: A form of community parenting

The extended family system is being practiced by the majority of people in Nigeria either with or in close proximity to relatives (Orubuloye, 1995). Thus, the traditional childrearing practices in Nigeria are communal within the extended family system or lineage such that the cost of raising a child (in terms of time, finance, emotion and another material support) is not solely borne by the biological parents but shared by all extended family members (maternal/paternal grandparents, uncles, aunts, cousins and siblings) (Ajayi and Owumi, 2013). The extended family members willingly participate in childrearing because they see that all children make up the strength of the family lineage. Thus, Nukunya (1992) conceived the extended family system as a social arrangement in which an individual has extensive reciprocal duties, obligations, and responsibilities to his relations outside his nuclear family.

Under this family system, it is a common to see surrogate mothers (mother-in-laws or sister-in-laws) from the wife's or husband's family volunteering to take care of the newborn child and the nursing mother (Fapohunda and Todaro, 1988). Ajayi and Owumi (2013) noted that this practice would lessen the emotional burden of the nursing mother particularly at first births and during the early periods of childrearing. Children are often transferred from their biological homes to the homes of relatives (uncles, aunts, cousins, grandparents, etc) where they are raised.

Childrearing in Nigeria is not limited to biological parents or close relatives but it most often than not extends to other members of the society. This is in line with general notions of some of the ethnic groups in Nigeria, especially the Yorubas who generally say *"Oju merinlo n bimo, igbaojuni n to", "Oyun ni a okibaeyangbe, a maa n ba eyan to omo"*. All these simply mean is that raising and rearing a child is a communal responsibility of all adults. In the process, it may be difficult to distinguish the child of a mother from those of others since there is no discrimination in the provision of the children's basic needs. Thus, in the traditional society, the death of one or both parents of a child do not automatically turn the child into a homeless, street child because the family and societal system have provisions for their care through sharing of responsibilities among uncles, aunts, grandparents, siblings and friends of the child's parents. One can confidently say that some of the successful adults today are products of this childrearing system.

Despite the success stories and the enormous benefits that the children and parents can derive from community parenting, the situation has changed. Nowadays, the parents are usually left alone to take care of their children under the practice of “me and my family” despite the little or complete lack of parenting skills and experiences. The new and inexperienced families tend to suffer from shocks relating to family maintenance. This has been exacerbated by the vast socio-economic changes taking place in Nigeria whereby many women have to join the workforce in order to assist with the financial situation of the family (Akinlabi and Olatunji, 2013). Thus, children from three months of age are enrolled in crèche/day care centersto allow mothers concentrate at work thereby shifting the parental responsibilities to the crèche (Bassey, 2014).

Ecological systems theory

Bronfenbrenner (1990) who believed that a person's development was affected by the surrounding environment developed the ecological systems theory. He categorized the environment that affects a person's development into five (5) different levels: the microsystem, the mesosystem, the ecosystem, the macro system and the chronosystem.

Microsystem: This is the closest system to the child and which it has direct contact with. This includes the home (parents, older siblings), school (teacher, peers), and daycare (nanny) and it involves bidirectional relationships. This means that the reactions in the environment will affect how the environment treats the individual in return. According to Bronfenbrenner (1990), it is the most influential level of the ecological system theory and implies that whatever is done at this level to the child can have long-lasting effects on the child's development.

Mesosystem: This represents the interactions between the different components of a person's microsystem and relates to the interdependency of the different microsystems and the influence of their interactions on the child's development. The interdependency and interactions, as noted by Bronfenbrenner (1990), have indirect influences on the child's development. The interactions between the person's microsystems can be expressed by considering the interactions between a child's parents and the teacher in a school. A situation whereby the child's parents visit the school and take an active role in his school activities like attending Parent-Teachers' Association (PTA) meetings to get feedbacks on the child's behavior and academic performance in school is expected to produce a child with better educational performance and better behavior than a child whose parents were unaware of how their child does in school.

Exosystem: At this level, the children are not active participants but are affected by whatever decisions were made by the different microsystems and the interactions that exist between them. For instance, the transfer of working parents may affect the child's education due to the need to change school and teachers. This change whether once or frequently has been shown to have a negative impact on the child's educational development. Emotional distress may set in for children whose either parent was transferred and just come home at infrequent times. This is because such children are not likely to be happy due to anxiety when the parent is out of the home. Losing a job, stress at work leading to the transfer of aggression on the children, separation, divorce, re-marriage, death of either parent are examples of situations at this level where children's active participation in the decision-making is not required but they are affected by decisions made.

Macrosystem: This refers to the cultural environment in which the child lives and all other systems that affect it. These include the economy, cultural values, and political systems. The impact of these systems on child development can be positive or negative depending on the situation. For instance, the *Boko Haram* insurgency has had negative impacts on the child's education in the north-eastern zone of the country as schools remained closed for several months.

Chronosystem: This refers to the environmental events and transitions that occur throughout a child's life including any socio-historical events (https://abridental.com/chronosystem/).

The implication of this theory is that a child's development is not only affected by the inputs of care, nurture and other roles from the parents but also in the guidance and counseling roles of other internal and external persons, communities and institutions (formal and informal). These external roles may be in the form of giving advice to parents on how to care for their children, reporting child abuse incidences to appropriate authorities or taking collective actions toward the betterment of the children in one's communities.

Influence of parenting on child development

At least 60% of Nigeria's population is below 18 years (Holmes *et al.*, 2012) such that the significance of children to national development in Nigeria cannot be overlooked. Thus, for the attainment of sustainable development, the majority of these children should transform into productive adulthood. The achievement lies in effective parenting. Empirical evidence reported by developmental psychologists and child and youth advocates exist on the significant influence of parenting on child's overall development. Bronfenbrenner (1990) had established that a strong mutual attachment with at least one caring adult is essential to the social, emotional, physical and mental development of children. Parents and other caring adults have also been seen as foremost developmental assets to ensuring productive child development (Pittman, 2006;Klem and Connell, 2002). Shonkoff and Phillips (2000) further reiterated that children grow and thrive in the context of close and dependable relationships that provide love and nurture, security, responsive interaction, and encouragement for exploration.

The absence of effective parenting has a life-long negative effect on child development. Karr-Morse and Wiley (1997) noted that child abuses during the first two years of life are associated with violent behavior in older children and adults. Proficiency in parental roles can assure the survival and development of children and youth (Kali and De Leire, 2004; Bradley and Caldwell, 1995).

Why community parenting?

The responsibility of providing children with the basic resources of life such as food, clothing and shelter lies on the parents. According to Alvy (2007), the parents are in charge of taking care of these resources such that they ensure that the home environment is safe and clean. They are further responsible for protecting the children from all forms of harms. According to Daly *et al*. (2015) opined that parents offer identity, love, care, provision and protection to children as well as economic security and safety. Parents are also in charge of upholding and respecting the needs and rights of children within the extended families and communities at large even as they are their children's first and foremost teachers, guidance counselors and nurturers (Alvy, 2007).

By giving consideration to the numerous roles associated with parenting and the fact that most parents (especially those in rural areas) have little or no formal training, Sanders *et al*., (2003), observed that the need to involve other older adults aside from the biological parents in the provision of parental care has become inevitable. The need for community members to be actively engaged in parenting is also attributed to the increasing growth of divorce rates, death of either parent leading to rising number of single parents and the emergence of child-headed households that result from the loss of parents during the war.

The grinding poverty that has made many parents neglect their children is also a reason for community parenting in which community members can play a complimentary role providing basic needs and offering advice and counseling to the children. The growth of working parents especially as career women that prevents most mothers from paying attention to their children also warrants the need for community parenting. Despite these situations, communities have overlooked the challenges facing modern parents/caregivers, many of whom according to FSPC (2007) are struggling to raise children while earning a living.

The importance of community parenting has been emphasized by the world leaders and development psychologists. Daly *et al*. (2015) noted the central role played by families, parents and caregivers in a child's wellbeing and development. Although, it was explicitly stated in the United Nation's Convention on Child's Rights that parents, legal or customary guardians have the primary responsibility for the upbringing and development of the child, non-governmental organizations, and community organizations are also not left out in protecting the children.

The essence of involving all in child protection services was also reiterated by Save the Children, a non-governmental organization. Save the Children (2008) attributed the responsibility of protecting children from violence, abuse, neglect and exploitation to everybody. The organization stressed that families, communities, governments, non-governmental organizations and even children themselves together play a crucial role in realizing children's rights to protection. Hence, community parenting can be strengthened through the establishment of community-based child protection groups.

What is a community-based child protection group?

According to Save the Children (2008), community-based child protection groups

(CBCPGs)are a group of people, often volunteers, who aim to improve the protection and well-being of children in a village, urban neighbourhood or other communities such as a camp for Internally displaced Persons (IDPs), a temporary settlement or migrant communities. Due to the category of children they protect and the roles played, CBCPGs are also known as Orphan and Vulnerable Children Committees, Child Protection Committees, Child Welfare Committees, and Anti-Trafficking Committees.
In CBCPGs, children and adults are made to identify local protection issues as well as develop the most appropriate solutions for service providers after collaborative deliberation among all concerned stakeholders. In order to realize children's rights to protection, an effective child protection system must engage and transform community perspectives. This is because community involvement plays a vital role in child protection (Save the Children, 2008).

Nigeria has ratified several international and continental legislations on the rights and welfare of children. These legislations and protocols include the United Nations' Convention on the Rights of the Child, African Union's Charter on the Rights and Welfare of Children, ILO C.138 on Minimum Age, ILO C. 182 on Worst Forms of Child Labour, UNCRC on Option Protocol on Armed Conflicts, UNCRC Optional Protocol on the Sale of Children, Child Prostitution and Child Pornography and the Palermo Protocol on Trafficking in Persons (United States Department of Labour, 2014). The response was the Child's Rights Act enacted with a view to incorporating the multifaceted aspects of the country with respect to ethnicity, culture, religion, etc. and which has been domesticated in at least two-thirds of the states as Child Rights Laws. Despite this, there is little or no local or national government capacity and commitment to protecting the children such that children's rights are violated on a daily basis. This is indicated by the poor commitment of adequate resources to child protection issues, lack of facilities and structures needed to protect the children's rights, poorly qualified workforce and limited local services to meet children's needs (Save the Children, 2008).

In cases where the government is unable to protect the children, the responsibility of ensuring children's protection falls almost wholly on the children themselves and community in which children live. Therefore, CBCPGs are at the forefront of efforts in addressing child protection in many countries where they are increasingly being recognized by governments and non-governmental organizations as vital to the establishment of an effective and comprehensive national child protection system.

Formation of community-based child protection groups (CBCPGs)

In order that the crucial roles of protection groups would be appreciated in the establishment of effective national child protection system, they must engage and work with community members. Every group has to be formed after a thorough analysis of the child protection needs of the community. This will facilitate the identification of the parenting needs of the children in the community, the local resources that could be used in protecting the children as well as planning interventions that could assist the community in ensuring that the children are well protected. This means that membership of CBCPGs would vary from one community to another. A general rule of thumb in the formation of CBCPGs is to take care of the following factors:

- Diversity: the different categories of people within the community such as men, women, girls, boys, the poorest families, people affected by HIV and AIDS, people with disabilities, people from minority groups should be included in the membership of the groups.
- Volunteering: child protection issues are time-consuming and hence require the commitment of people who are willing and ready to work in this area. Therefore, although people may be invited, their membership should be made voluntarily by them. The volunteers could be community or religious leaders, representatives from an employer's association, members of a school management committee.
- Professionalism: the membership of the CBCPGs should involve individuals that are professionals in social services such as local government representatives, teachers, police, health workers, lawyers, social workers, school/daycare proprietors and other professionals.

Conclusion

The supportive role of family members and the community at large in childrearing cannot be overlooked. Ensuring children's protection from violence, deprivation of rights, neglect and exploitation is a responsibility of all adults and even older children in the communities. Community parenting has the potential to fill in the vacuum created by governments' lack of readiness and biological parents' incapability to protect children. Therefore, each community is encouraged to form CBCPGs on different areas and ensure a high level of diversity in its membership. In places with no CBCPGs, individuals should do their best formally and informally to serve the best interest of children by providing care and nurture to all children within their vicinities. Efforts should also be made at organizing orientation programmes aiming at training parents, especially younger ones (teenage parents) on the basic requirements in childbearing and rearing practices.

References

Ajayi, J. O.,and Owumi, B. (2014). Socialization and child rearing practices among Nigerian ethnic groups. *Academic Journal of Interdisciplinary Studies*, *2*(2): 249-256

Akinlabi, F. B.,and Olatunji, B. F. (2013). Social economic and educational implications of parental separation on theupbringing of school children in Ekiti State. *Global of Advanced Res. J. Peace, Gender and Dev. Studies, 2* (2): 021-025

Akinwumi, O. S. (2009). Legal impediments to the practical implementation of the Child Rights Act 2003. *International Journal of Legal Information, 37*(3): 10-21.

Alvy, K. T. (2007). What is Effective Parenting? *The National Effective Parenting Initiative.* Retrieved from www.EffectiveParentingUSA.org

Antai, D. (2010). Social context, social position and child survival: Social determinants of child health inequalities in Nigeria. Stockholm: Department of Epidemology, University of Stokholm.

Bassey, A. O. (2014). Domestic stress management by parents and children upbringing in Calabar South Local Government Area, Cross River State, Nigeria. *Educational Research*, *5*(5): 179-182

Bradley, R. H., and Caldwell, B. M. (1995). Caregiving and the regulation of child growth and development: Describing proximal aspects of care giving systems. *Developmental Review*, 15: 38-85.

Bronfenbrenner, U. (1990). Discovering what families do. In: Blankenhorn, D., Bayme, S. and Elshtain, J. B. (eds). Rebuilding the Nest: A New Commitment to the American Family. Milwaukee, WI: Family Service America. *http://www.montana.edu/www4h/process.html, accessed6/7/07.*

Child's Rights Act (2003). The Child's Rights Act of the Federal Republic of Nigeria. 221 pp.

Chukwu, T. (2008). Implementing the Child's Rights Act 2003 with the children in mind

Save the Children (2008). A Common Responsibility: The Role of Community-based Child Protection Groups in Protecting Children from Sexual Abuse and Exploitation. Discussion paper published by International Save the Children Alliance, Cambridge House, UK. 25pp.

Sharma, S., Smith, S., Sonneveldt, E., Pine, M., Dayaratna, V. and Sanders, R. (2005). Formal and Informal Fees for Maternal Health Care Services in Five Countries: Policy, Practice and Perspectives. Policy Working Paper 16. Washington, DC: USAID.

Shonkoff, J. P. and Phillips, D. A. (eds). (2000). From Neurons to Neighborhoods: The Science of Early Childhood Development. Washington, D.C.: National Academy Press.

UNDP. (2009). *Human Development Report Nigeria 2008–2009*: *Achieving Growth with Equity*. United Nations Development Programme,Abuja.

UNICEF, (2007). Progress for Children: A World Fit for Children. Statistical Review, Number 6. United Nations Children's Emergency Fund, New York.

UNICEF,(2011). Programme Guidance on Social Protection for Children. Final Draft for Consultation. Division of Policy and Planning, Global Policy Section, United Nations Children Fund, New York..

UNICEF, Nigeria. (2006). Information Sheet: Child Labour. United Nations Children Fund Nigeria, Abuja.

UNODC, 2012. Global Report on Trafficking in Persons 2012. United Nations Office on Drugs and Crime, United Nations: Vienna. Available on http://www.unodc.org/unodc/data-and-analysis/glotip.html

United States Department of Labour (2014). 2013 Findings on the Worst Forms of Child Labour

USDS. (2013a). Equatorial Guinea. In: Trafficking in Persons Report. United States Department of States, Washington, DC. June 19, 2013. Available on http://www.state.gov/j/tip/rls/tiprpt/countries/2013/215457.htm

USDS. (2013b). Niger. In: Trafficking in Persons Report. United States Department of States, Washington, DC. June 19, 2013. Available on http://www.state.gov/j/tip/rls/tiprpt/countries/2013/21553.htm

USDS. (2013c). Saudi Arabia. In: Trafficking in Persons Report. United States Department of States, Washington, DC. June 19, 2013.Availableon http://www.state.gov/j/tip/rls/tiprpt/countries/2013/215608.htm

United States Embassy (2010). Abuja Reporting. February 19, 2010.

United States Embassy (2014). Abuja Reporting. February 25, 2014.

WiseGEEK (2015). What is Community Parenting? http://WiseGeek/What_is_community_parenting?/htm.l

WHO (UD).2000. Global Health Observatory Data Repository. World Health Organization http://apps.who.int/ghodata/

Dietary Forage Supplementations and their Effects on Broiler Performance

O. O. K. Oko and **L. F. Mboto,**
Department of Animal Science,
Faculty of Agriculture,
University of Calabar, Nigeria

Corresponding author's email address: oluwatosin.kennedyoko@gmail.com

Abstract: This study evaluated the effects of forage supplementation of diets on the growth and carcass characteristics of broilers. Fresh samples of *Costus afer, Eleusine indica*, and *Tridax* procumbens plants were collected and analyzed for their chemical compositions. Commercial starter and finisher diets served as control while 600g of sole forage *(Costus afer*, *Eleusine indica*, and *Tridax procumbens)*, 1:1 mixture of *Costus afer-Eleusine indica*, *Costus afer-Tridax procumbens*, *Eleusine indica-Tridax procumbens* and 1:1:1 mixture of *Costus afer-Eleusine indica-Tridax procumbens* were supplemented into the basal diet. 168 day-old Hybro chicks were equally allotted to the eight diet groups; the 21 birds in each group were divided into seven (7) birds per replicate and fed for 56 days. Data were collected on growth performance and carcass characteristics. The chemical composition of the three forages differed significantly (P<0.05); *Costus afer* contained the highest crude protein (16.69%) and moisture (9.86%), *Tridax procumbens* had the highest crude fat (3.92%) and ash/minerals (16.90%) contents. Forage supplementation of the diet depressed final body weight, weight gains, and feed conversion ratio but enhanced feed intake. Sole *Costus afer and Costus afer-Eleusine indica-Tridax procumbens* mixture slightly improved the carcass yield (73.00-78.08%). The effect on drumstick and wing weights were significant (P<0.05)whereas other prime cuts and organ weights showed no differences (P>0.05). Forage supplementation, especially with sole *Costus afer*, *Eleusine indica-Tridax procumbens* and *Costus afer-Eleusine indica-Tridax procumbens mixtures* improved the carcass yields and should be a management practice in broiler production.

Keywords: Alternative poultry system, green feeding, performance, poultry

Introduction Livestock production is an important component of the farming systems in Nigeria but there has been a shift from ruminants to the production of monogastric animals in order to meet the increased demand for animal protein in the last two decades. The broiler industry is considered the ideal livestock enterprise that will meet the need for a rapid supply of cheap and high-quality animal protein. However, the increased grain use, high cost of feeds and disease incidences have limited the growth of the sector (Oko *et al*., 2011).

Therefore, current research is geared towards the incorporation of forages into poultry nutrition in order to meet the goal of intensified-sustainable production through proper management of forage grasses, legumes, shrubs, and trees (Mansour *et al*., 2014).A forage-focused sustainable intensified poultry system explores the utilization of plant materials (forage supplements) either as fed basis, dried or extract form and incorporated into poultry diets to improve production efficiency. The principal goal of this system is in the production of healthy animals using cheap, nutritious and available feed resources with minimal medications in an environment-friendly manner (Spencer, 2013). Pasture intake by poultry enhanced immune function, improved performance and better meat sensory quality (Ponte *et al*., 2008; Adedeji, 2013). The forages incorporated into poultry diets include *Aspilia africana* (Agiang *et al.,* 2011), moringa (Melesse *et al*., 2011), duckweed (Saroeun, 2010), alfalfa (Bloxham and Lilburn, 2013) and Siam weed (Fasuyi *et al*., 2005).

The bush cane (*Costus afer*- family, Costaceae), is an herbaceous weed found throughout the world. It contains high amounts of nutrients and is listed by the World Health Organization as one of the most used medicinal plants and thus referred to as "global alfalfa" (Idrus *et al*., 2014). Coat button or daisy (*Tridax procumbens*)is native to tropical America, contains about 34.57% crude proteinand is widely-distributed throughout Africa where itis used in the treatment of various ailments (Wiehoff, 2013).Goose grass (*Eleusine indica*) is an adventitious forage species, native to tropical and sub-tropical regions with crude protein content of 11.00% (Sun *et al*., 2012a).

The pharmaceutical potentials of these forages are being harnessed (Sun *et al*., 2012b) however no published work is available on their use as supplemental feeds despite the fact that birds relish and search for them under the free-range system. Therefore, this study attempts to evaluate

the impacts of dietary supplementation with *Costus afer, Tridax procumbens and Eleusine indica* (sole or mixtures) on the growth and carcass characteristics of broilers.

Materials and Methods

Fresh samples of *Costus afer, Eleusine indica* and *Tridax procumbens* plants were collected from the Teaching and Research Farm, University of Calabar, Calabar. Sub-samples were oven-dried and analyzed for the chemical composition using standard methods described in AOAC (2005). Commercial starter and finisher diets (Table 1) purchased from reputable marketers served as the basal diets (Control- Treatment 1); 600g of sole forage (*Costus afer, Eleusine indica* and *Tridax procumbens*), 1:1 mixture of *Costus afer-Eleusine indica, Costus afer-Tridax procumbens, Eleusine indica-Tridax procumben*s and 1:1:1 mixture of *Costus afer-Eleusine indica-Tridax procumbens* were supplemented into the basal diet to constitute Treatments 2, 3, 4, 5, 6, 7 and 8, respectively as follows:

Treatment 1 - Control- Basal diet
Treatment 2- Basal diet + 600g of *Costus afer*(Ca)
Treatment 3- Basal diet + 600g of *Eleusine indica* (Ei)
Treatment 4- Basal diet + 600g of *Tridax procumbens*(Tp)
Treatment 5- Basal diet + 300g Ca + 300g Ei
Treatment 6- Basal diet + 300g Ca + 300g Tp
Treatment 7- Basal diet + 300g Ei + 300g Tp
Treatment 8- Basal diet + 200g Ca + 200g Ei + 200g Tp

A total of one hundred and sixty-eight (168) day-old Hybro strain chicks was used for the 56-day experiment in deep litter system. Each treatment had 21 birds divided into seven (7) birds in three replicates. The standard management practices were adhered to except vaccination or medication so as to assess the effects of the treatments on the health status of the birds. Data were collected on the behaviour of the birds (forage preference) and weekly growth performance (mortality, body weight, weight gain, feed intake and feed conversion ratio). On day 56, three birds were picked per treatment for the measurement of carcass characteristics (carcass yield, organ weights and gastro-intestinal morphometry). Data were analysed in a one-way analysis of variance in a completely randomized design and treatment means separated using Duncan's Multiple Range Test of GenStat Release 8.1 (GENSTAT, 2011) software package.

Table 1: Gross composition of basal diets*

Composition (%)	Broiler starter	Broiler finisher
Crude protein	21.00	18.00
Fat and oil	6.00	6.00
Crude fibre	5.00	5.00
Calcium	1.00	1.00
Available phosphorus	0.45	0.40
Lysine	1.00	0.85
Methionine	0.50	0.34
Salt	0.30	0.30
Metabolisable energy (Kcal/kg)	2800	2900
Net weight /kg bag	25.00	25.00

*Composition from bag labels, Top feed PLC

Results and Discussion

Table 2 shows the chemical composition of the forages. The chemical composition differed significantly (P<0.05) among the forages. *Costus afer* had the highest crude protein (16.69%) and moisture (9.86%) with moderate amounts of crude fat (2.52%), anti-nutrients, minerals and vitamins and the least crude fibre (19.88%), fibre fractions and ash (7.88%). *Eleusine indica* had the least crude protein (8.33%), crude fat (2.29%) and vitamins, moderate ash (9.94%), moisture (8.70%) and minerals but the highest crude fibre (28.57%) and anti-nutrients. *Tridax procumbens* was the richestin crude fat (3.92%), ash/minerals (16.90%) and vitamins;moderate in crude protein (16.12%) and crude fibre (24.77%) but least in moisture (6.74%) and anti-nutrients. These forages are good sources of nutrientsand low in anti-nutrients indicating that they have low toxicity.The nutrient contents are within the ranges previously described for tropical forages (Igboh, 2009; Sun *et al*., 2012a; Idrus *et al*., 2014)

while the phytochemical constituents are lower than the toxic range (Iji *et al*., 2004) and so would be safe as feed for poultry.

The phytochemical screening for active components of the forages is shown in Table 3. Cardenolides and chalcones were absent in all three forages. *Costus afer* contained appreciable amounts of alkaloids, saponins and phenols, moderate amounts of tannins, glycoside and trace amounts of phlobatannin while flavonoid, anthraquinone, steroids were not detected. *Eleusine indica* contained appreciable alkaloids, tannins, phenols and phlobatannins, moderate saponins, flavonoids, glycosides and steroids and trace amounts of anthraquinones and terpenes. *Tridax procumbens* contained appreciable alkaloids and phenols, moderate saponins, tannins, flavonoids and phlobatannins while anthraquinones, steroids and terpenes were completely absent. The presence of these phytochemicals could also explain some of the medicinal activities ascribed to these forages (Anyasor *et al*., 2010; Sun *et al*., 2012b).

Table 2: Proximate compositions of selected forages

Composition (%)	Ca	Ei	Tp	SEM
Crude protein	16.69^{a}	8.33^{b}	16.12^{a}	0.09
Crude fat	2.52^{bc}	2.29^{c}	3.92^{a}	0.03
Crude fibre	19.88^{c}	28.57^{a}	24.77^{b}	0.02
Ash	7.88^{c}	9.94^{b}	16.90^{a}	0.02
Moisture	9.86^{a}	8.70^{b}	6.74^{c}	0.02
Nitrogen free extract	43.17^{a}	42.17^{b}	31.55^{c}	0.05
Neutral detergent fibre	42.81^{c}	61.38^{a}	45.64^{b}	0.02
Acid detergent fibre	29.86^{c}	43.84^{a}	31.78^{b}	0.01
Acid detergent lignin	10.99^{c}	19.64^{a}	12.29^{b}	0.02
Anti-nutrients				
Phytate	0.16^{b}	0.17^{a}	0.14^{c}	0.02
Oxalate	0.12^{a}	0.13^{a}	0.11^{b}	0.01
Tannin	0.03	0.03	0.02	0.00
Saponin	0.35^{b}	0.39^{a}	0.25^{c}	0.02
Minerals				
Sodium	0.22^{c}	0.24^{b}	0.36^{a}	0.02
Potassium	0.66^{c}	0.70^{b}	1.27^{a}	0.03
Calcium	0.41^{b}	0.22^{c}	0.50^{a}	0.02
Phosphorus	0.32^{c}	0.32^{b}	0.37^{a}	0.02
Magnesium	0.25^{c}	0.27^{b}	0.29^{a}	0.02
Iron (mg/kg)	172.5^{b}	178.45^{b}	234.70^{a}	0.12
Copper (mg/kg)	3.75^{b}	4.35^{b}	6.65^{a}	0.15
Zinc (mg/kg)	23.60^{c}	26.50^{b}	52.45^{b}	0.22
Vitamins				
Vitamin A(mg/kg)	2658.35^{a}	262.5^{b}	2865.50^{a}	0.89
Vitamin B_1 (mg/kg)	0.92^{a}	0.47^{c}	2.41^{a}	0.02
Vitamin B_2 (mg/100g)	0.12^{b}	0.08^{b}	0.17^{a}	0.01
Vitamin C (mg/kg)	5.31^{c}	3.74^{c}	12.63^{a}	0.02

% NFE = 100 – (%M +% CP + % CFA + % CFI + % Ash)
Ca-*Costus afer,* Ei- *Eleusine indica* Tp - *Tridax procumbens*

Table 3:Phytochemical screening of the three forages

Constituent	Ca Observation	Ei Observation	Tp Observation
Alkaloids	+++	+++	+++
Saponins	+++	++	++
Tannins	++	+++	++
Phenols	+++	+++	+++
Flavonoids	_	++	++
Philobatanins	+	+++	++
Glycosides	++	++	+++
Anthraquinines	_	+	_
Steroids	_	++	_
Terpenes	_	+	_
Cardenoloides	_	_	_
Chalcones	_	_	_

+++ - AA - Appreciable Amount ++ - MA - Moderate Amount
\+ - TA - Trace Amount __ - CA - Completely Absent

Table 4 shows the scale of preference of selected forages by broiler birds as determined by their respective intake. Total forage consumed ranged from 414.00-2036.00g and was significantly (P<0.05) different among the treatments. Broilers fed the diet supplemented with the mixture of three forages had the highest intake followed by mixtures of two forages- *Costus afer* and *Tridax procumbens*, *Eleusine indica* and *Tridax procumbens* and *Costus afer* and *Eleusine indica* in that order and sole *Tridax procumbens* and *Costus afer* while the least intake was in birds fed *Eleusine indica*. This observation supports the practice of serving a variety of forages to poultry so that the bird can choose the forage that would provide adequate nutrients needed for its physiological activities (Spencer, 2013). The preference for *Tridax procumben* sand *Costus afer* could be due to their higher nutritive contents, especially protein, such that birds fed *Tridax procumbens* and *Costus afer* and their mixtures will be expected to perform better than those on *Eleusine indica* which was least consumed.

Table 4: Forage intake by birds on different dietary treatments

Parameter	C	*Ca*	*Ei*	*Tp*	CE	C T	E T	CET	SEM
Total forage intake (g)	-	949.00^{e}	414.00^{f}	1013.00^{d}	1617.00^{c}	1715.00^{b}	1670.00^{bc}	2036.00^{a}	39.70
Weekly forage intake (g/wk)	-	118.50^{d}	51.70^{e}	126.60^{d}	202.10^{c}	214.30^{b}	208.80^{bc}	254.50^{a}	4.97
Daily forage intake (g/day)	-	16.94^{d}	7.39^{e}	18.09^{d}	28.86^{c}	30.62^{b}	29.83^{bc}	36.36^{a}	0.71

Means followed by different superscript across rows are significantly (P< 0.05) different
C- Control Ca– *Costus afer,* Ei – *Eleusine* indica, Tp – *Tridax procumbens*
CE –1:1 mixture of *Costus afer* and *Eleusine indica*, CT – 1:1 mixture of *Costus afer* and *Tridax procumbens*, ET – 1:1 mixture of *Eleusine indica* and *Tridax procumbens*
CET – 1:1:1 mixture of *Costus afer*, *Eleusine indica* and *Tridax procumbens*

There were significant (P<0.05) differences in all growth parameters (except for weekly feed intake and daily feed intake) between dietary treatments (Table 5). Final body weight was highest in the control treatment but did not differ from birds on diets supplemented with CET, ET, *Ca*, CE and CT forages. The weight gain (2827.00-3272.78g), weekly weight gain (353.40-409.10g/week) and daily weight gain (50.48-58.44g/day) followed the same trend observed in body weight. This suggests that forage supplementations depressed the body weight of birds probably due to the presence of the anti-nutrients.Forage supplementation enhanced feed intake but slightly reduced feed conversion ratio especially in the treatments involving sole *Eleusine indica* or *Tridax procumbens* forages. Birds on mixed forages and sole *Costus afer* had feed conversion ratio (2.36-2.45) which did not differ from the control (2.20). Birds on sole *Costus afer* consumed more feed probably due to its more succulent nature and high crude protein content thus enhancing the digestion of the concentrate. Birds on sole *Tridax procumbens* had the least feed intake implying that the appreciable amount of tannins and saponins in the plant could exert some negative impact on its palatability.

Percentage mortality was significantly (P<0.05) highest in the control group (9.52%);the birds on sole *Tridax procumbens*,*Costus afer-Tridax procumbens* and *Eleusine indica-Tridax procumbens* mixtures had zero mortality while 4.76% mortality was recorded in other treatments. This result is comparable to the findings of Fasuyi *et al*. (2005) and confirms that forage supplementations could improve the health and immune status of broilers since no vaccination was given throughout the experiment. Three treatments: *Eleusine indica-Tridax procumbens*, *Costus afer-Eleusine indica-Tridax procumbens* and *Costus afer* slightly improved the carcass yield of broilers compared to the control (Table 6). The slight improvement in the carcass yield of broilers fed these forages agrees with previous reports (Silverman, 2001, Saroeun, 2010). The drum stick and wing weight as % of live weights were significantly (P<0.05) affected by dietary treatments whereas the other prime cuts showed no differences. Out of the organs, only the relative weights of the lungs, oesophagus, and pancreas were significantly (P>0.05) affected by the dietary treatments.

The relative weights of intestinal segments were (P<0.05) influenced by dietary treatments. Forage supplementation tended to increase the relative weights of the duodenum, ileum and caecum but led to significant reduction in the weight of the jejunum. Total intestinal, duodenal and jejunal

lengths were not (P>0.05) affected by forage supplementation. The values obtained for intestinal segment lengths, in this study, are higher than those reported by Mabelebele *et al.* (2014).

Conclusion and Recommendations

The three forages studied *Costus afer, Eleusine indica* and *Tridax procumbens* are rich sources of nutrients and can play significant roles in sustainable poultry production.

- Forage supplementation had positive impacts on the immune and growth status of broilers.
- Forage mixtures improved the carcass yield compared to the control or where only one of the forages was used in feed supplementation.
- *Costusafer* produced a better overall performance compared to the *Tridax procumbens* while the least performance was recorded in *Eleusine indica*.
- For the forage mixtures, *Eleusine indica-Tridax procumbens* and *Costus afer-Eleusine indica -Tridax procumbens*gave a better performance than other combinations.

It is, therefore, recommended that forage supplements should be given to broilers under intensified management to boost their immune status, enhance growth, behaviour and carcass yield. For sole forage feeding, *Costus afer* should be the choice while the *Eleusine indica-Tridax procumbens* and *Costus afer-Eleusine indica-Tridax procumbens* mixtures should be given to broilers for improved performance.

Table 5: Growth performance of broilers as influenced by dietary forage supplementations

Parameter	C	*Ca*	*Ei*	*Tp*	CE	C T	E T	CET	SEM
Initial weight, g	38.33	38.33	38.33	39.67	39.67	39.33	38.67	39.33	1.65
Final weight, g	3311.11^{a}	3133.33^{ab}	2877.76^{b}	2866.67^{b}	3100.00^{ab}	3077.78^{ab}	3211.11^{ab}	3155.56^{ab}	172.00
Total weight gain, g	3272.78^{a}	3095.00^{ab}	2839.44^{b}	2827.00^{b}	3060.33^{ab}	3038.44^{ab}	3172.45^{ab}	3116.23^{ab}	172.30
Weekly weight gain, g/week	409.10^{a}	386.90^{ab}	354.90^{b}	353.40^{b}	382.50^{ab}	379.80^{ab}	379.80ab	389.50^{ab}	21.54
Daily weight gain, g/day	58.44^{a}	55.27^{ab}	50.71^{b}	50.48^{b}	54.65^{ab}	54.26^{ab}	56.65^{ab}	55.65^{ab}	3.08
Total feed intake, g	6911.29^{b}	7455.05^{a}	7343.87^{ab}	7256.81^{ab}	7494.38^{a}	7445.95^{ab}	7417.14^{ab}	7506.52^{a}	237.90
Weekly feed intake, g/week	876.41	931.88	918.00	907.10	936.80	930.75	927.14	938.31	32.33
Daily feed intake, g/day	125.20	133.13	131.14	129.58	133.83	132.96	132.45	134.05	4.62
Feed conversion ratio	2.20^{a}	2.41^{ab}	2.58^{b}	2.57^{b}	2.45^{ab}	2.45^{ab}	2.36^{ab}	2.44^{ab}	0.14
Mortality, %	9.52^{a}	4.76^{b}	4.76^{b}	0.00^{c}	4.78^{b}	0.00^{c}	0.00^{c}	4.76^{b}	6.30

Means with different superscript across rows indicate significant (P< 0.05) differences

C- Control,

Ca – Costus afer,Ei – Eleusine indica, Tp – Tridax procumbens,

CE – mixture of *Costus afer-Eleusine indica,* CT - mixture of *Costus afer-Tridax procumbens,* ET - mixture of *Eleusine indica-Tridax procumbens,*

CET - mixture of *Costus afer-Eleusine indica-Tridax procumbens*

Table 6. Carcass characteristics of broiler chicken fed Dietary forage supplements

Parameter	C	*Ca*	*Ei*	*Tp*	CE	C T	E T	CET	SEM
Live weight	3311.11[a]	3133.33[ab]	2877.76[b]	2866.67[b]	3100.00[ab]	3077.78[ab]	3211.11[ab]	3155.56[ab]	172.00
Dressed weight	2558.83	2443.99	2016.67	2121.77	2263.00	2346.50	2512.69	2463.86	209.30
Dressing %	77.28	78.00	77.10	73.73	73.00	76.24	78.25	78.08	2.64
	Prime cuts, % Live weight								
Back weight	15.72	15.43	15.97	15.26	14.40	16.02	15.74	16.45	1.09
Breast weight	24.58	26.34	25.39	23.87	23.13	24.31	25.19	23.26	1.69
Drum stick weight	9.55[c]	11.36[ab]	11.30[ab]	9.96[b]	10.32[ab]	11.19ab	11.26[ab]	12.34[a]	0.98
Head weight	1.99	1.77	1.92	2.32	1.87	1.66	1.72	2.06	0.30
Neck weight	4.66	4.44	5.63	4.76	4.36	4.15	4.49	4.11	0.69
Shank weight	3.43	3.25	3.34	3.56	3.17	4.14	3.44	4.11	0.82
Thigh weight	12.70	14.14	12.77	11.72	11.28	12.83	13.07	13.71	1.28
Wing weight	8.76[ab]	8.16[ab]	8.16[ab]	7.63[b]	8.06[b]	8.25[ab]	8.40[ab]	8.89[a]	0.49
	Organ weight, % Live weight								
Crop weight	0.29	0.32	0.27	0.28	0.24	0.22	0.31	0.31	0.05
Empty Gizzard	1.51	1.27	1.51	1.53	1.27	1.46	1.44	1.48	0.18
Full gizzard	2.05	1.69	1.92	1.93	1.75	1.88	1.73	1.88	0.22
Gall bladder	0.11	0.12	0.12	0.15	0.14	0.12	0.11	0.12	0.03
Heart	0.41	0.41	0.38	0.37	0.41	0.36	0.35	0.41	0.05
Liver	1.71	1.55	1.66	1.62	1.55	1.55	1.55	1.66	0.15
Lungs	0.32[b]	0.39[ab]	0.40[ab]	0.37[ab]	0.31[b]	0.37[ab]	0.33[b]	0.48[a]	0.06
Oesophagus	0.15[a]	0.12[bc]	0.11c	0.10c	0.09[c]	0.12[abc]	0.11c	0.15[ab]	0.02
Pancreas	0.21	0.18[ab]	0.08[b]	0.14[ab]	0.13[ab]	0.13[ab]	0.14[ab]	0.24[a]	0.06
Proventriculus	0.41	0.36	0.33	0.46	0.36	0.36	0.38	0.36	0.07
Spleen	0.21[a]	0.16	0.13	0.17	0.20	0.20	0.16	0.15	0.05

References

Adedeji, O. S. (2013). Effect of different organic feed ingredients on growth performance, haematological characteristics and serum parameters of broiler chickens. *World Journal of Agricultural Sciences* 9 (2): 137-142.

Agiang,E. A., Oko, O. O. K. and Essien, G. E. (2011). Quails response to aqueous extract of bush marigold (*Aspilia africana*) leaf. *American Journal of Animal and Veterinary Sciences* 6(3): 130-134.

Anyasor, G. N., Ogunwenmo, K. O., Olatunji, A.O. and Blessing, E. A. (2010). Phytochemical constituents antioxidant activities of aqueous and methanol stem extracts of *Costus afer.* Ker Gawl. (Costaceae). *African Journal of Biotechnology* 9(31): 4880-4882.

Bloxham, D. and Lilburn, M. (2013). The effect of source of forage and level on feed intake and diet digestibility in redbros. Undergraduate Research Thesis, Department of Animal Sciences, the Ohio State University. http://hdl.handle.net/1811/54565 Accessed January 15, 2016, 15.30hr Nigerian time.

Fasuyi, A. O., Fajemilehin, K. S. O. and Aro, S. O. (2005). Nutritional potentials of Siam weed (*Chromolaena odorata*) leaf meal (SWLM) on laying hens: biochemical and haematological implications. *Pakistan Journal of Nutrition* 4(5): 336-341.

GenStat (2011). GenStat Release 8.1 software package. Lawes Agricultural Trust.

Idrus, Z., Mohammad, R. G., Mohammad, B., Mansour, M., Jamal, F., Reza, F. and Saleh, T. (2014). Effects of purslane extract on performance, immunity responses and cecal microbial population of broiler chickens. *Spanish Journal of Agricultural Research* 12 (14): 1094-1095.

Igboh, M. N., Ikequchi C. C. and Ikewuchi J. C. (2009). Chemical profile of *Tridax procumbens. Pakistan Journal of Nutrition* 8 (5): 548-550.

Iji, P. A., Khonalok, S. S. and Govs, R. M. (2004). Intestinal function and body growth of broiler chicken on major based diets supplemented with *Mimosa tannus*and microbial enzyme. *Journal Science of Food and Agriculture* 84(12): 1451-1458.

Mabelebele, M., Alabi. O. J., Ngambi, J. W., Norris, D and Ginindza, M. M. (2014). Comparison of gastro intestinal tracts and pH values of digestive organs of Ross 308 broiler and indigenous venda chickens fed the same diet. *Asian Journal of Animal and Veterinary Advances* 9: 71-76.

Mansour, M., Jamal, F., Reza, F., Mohammad, B., Idrus, Z., Mohammad, R. and Selah, T. (2014). Effects of purslane extract on performance, immunity responses and caecal Microbial population of broiler chickens. *Spanish Journal Agricultural Research* 12(4): 1094-1098.

Melesse, A., Tiruneh, W. and Negesse, T. (2011). Effects of feeding *Moringa stenopetala* leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. *Tropical and Subtropical Agroecosystems* 14(2): 485-492.

Oko, O. O. K. and Agiang, E. A. (2011). *Aspilia africana* leaf meal as an egg booster and yolk colourant in quails. *International Journal of Agriculture3(1): 103-108.*

Ponte, P. I. P., Rosado, C. M. C., Crespo, J. P., Crespo, D. G., Mourao, J. L. and Chaveiro-Soares, M. A. (2008). Pasture intake improves the performance and meat sensory attributes of free-range broilers. *Poultry Science* 87: 71-79.

Wiehoff, D. (2013). How the Chicken of Tomorrow becomes the Chicken of the World Institute for Agriculture and Trade policy, Retrieved 31 December, 2015, 12. 50 pm, Nigerian time.

Saroeun, K. (2010). Feed selection and growth performance of local chickens offered different carbohydrate sources in fresh and dried form supplemented with protein-rich forages. M. Sc. Thesis, Department of Animal Nutrition and Management, Swedish University of Agricultural Sciences. ISBN 978-91-86197-96-4.

Silverman, A. (2001). The 'Pasture' in Pasture Poultry, Continued. APPPA GRIT! *American Pastured Poultry Producers Association* 18: 14-15.

Spencer, T. (2013). Pastured Poultry Nutrition and Forages. A project of the National Center for Appropriate Technology. NCAT Agricultural specialist. www.attra.ncat.org. retrieved December 12, 2015, 17.00hr Nigerian time.

Sun, T., Liu, Z., Qin, L. and Long, R. (2012a). Aspects of lipid oxidation of meat from free-range broilers consuming a diet containing grasshoppers on alpine steppe of the Tibetan Plateau. *Poultry Science* 91: 224-231.

Sun, T., Liu, Z., Qin, L. & Long, R. (2012b). Meat fatty acid and cholesterol level of free-range broilers fed on grasshoppers on alpine rangeland in the Tibetan Plateau. *Journal of the Science of Food and Agriculture* 92: 2239-2243.

Phosphorus Fertilizer Effects on Maize Dry Matter Yield and Nutrient Uptake and Properties of Ultisols Developed on Coastal Plain Sands in Southern Nigeria

O.J. Ayodele and **O.S. Shittu**,
Department of Crop, Soil and Environmental Sciences
Ekiti State University, Ado-Ekiti, Nigeria
E-mail: , olubunmi.shittu@eksu.edu.ng

Abstract: One feature of acid soil infertility is poor crop growth caused by phosphorus (P) deficiency resulting from fixation of native and applied P by Al, Fe, and Mn that can attain high levels. Application of P to satisfy the fixation capacity is a management option to improve crop yields in acid soils. Maize grown in pots was used to assess the potentials of P fertilizer in improving the productivity of four Ultisols developed on Coastal Plain Sands in Southern Nigeria. Direct P application increased maize dry matter and P uptake during the first cropping of three P-deficient soils while the soil with moderate available P had a low response. Soil available P, exchangeable Ca and Mg, and plant tissue P and Ca increased whereas soil and plant Fe and Mn decreased. Residual effects of applied P were low on maize dry matter yield and P uptake but showed in increased available P, exchangeable Ca and Mg. Successive cropping decreased available P, exchangeable Ca and Mg in the soils thereby causing low performance of plants high in Mn and Fe contents.

Keywords: **Ultisols, acid soils, phosphorus, response, nutrient content**

Introduction

Ultisols account for 46.5% of the soil resources in Nigeria and belong to the low and very low productivity classes (Agboola *et al*., 1997). The Ultisols formed on acid sands or Coastal Plain Sands occupy a substantial portion of the agricultural lands in Southern Nigeria. The soils are highly-weathered and intensively-leached with the constraints to productivity being chemical rather than physical and so give low yields of arable crops. The main features are poor nutrient reserves, low basic cation content and extreme to high soil acidity such that crop performance is affected by aluminum (Al) and manganese (Mn) toxicity, deficiencies or imbalances among the basic cations (Abruna *et al*., 1975).

Two approaches used in the management of acid soils are to plant acid-tolerant crops and apply appropriate liming materials to neutralize soil acidity. Crops would grow well in acid soils if tolerant of high soil solution concentrations of Al and Mn, and efficient at absorbing native soil nutrients. Fruit trees, root and tuber crops and some food grain legumes used by farmers for subsistence and commercial production for centuries are adapted, even as no tropical plant of agricultural significance is immune to acid soil infertility. This offers no viable alternative to liming given the low yield potentials of such crops that are adapted to the poor native soil fertility levels. The presumed tolerance can be due to the shifting cultivation (or bush fallow) and slash-and-burn practices which provide adequate nutrients for the predominant low-input and low-output traditional cropping systems (Araki, 1993). Thus, application of lime, even at modest rates, is the first requirement for effective utilization of acid soils because of the ability to decrease the detrimental effects of soil acidity. It eases the effort to build up nutrient fertility status especially that of phosphorus (P) whose widespread deficiency is due to conversion of native and applied P to insoluble forms through fixation processes by clay, Fe and Al ions and oxides.

Plays vital roles in physiological functions and forms an integral component of several biochemical compounds in the plant such that reduction in its availability and uptake reflects in low crop productivity. The use of fertilizer to increase the supply of available P in soils is the conventional recommendation to enhance uptake by crops, especially during the early stage of growth, and increase yields. Crop responses to applied P are attributed to enhanced P supply by the soil and an improvement in the ability of the

plant to absorb the nutrient after the elimination of Al toxicity (Pandey *et al*., 1994). The main P fertilizer sources are superphosphates (calcium phosphate compounds derived from the primary mineral apatite) usually added in large amounts. The beneficial action relates to the effects of soluble Ca on soil acidity and P in reducing the toxicity of Al and Fe through their precipitation as phosphates in the soil solution (Brady and Weil, 2002).

The little research attention on the management of acid soil infertility in Nigeria relates to the use of lime and manures but which farmers have not been advised to apply before the application of fertilizers. The ensuing poor growth and yields of arable crops, especially maize, are some of the reasons for the poor adoption of fertilizers by smallholder farmers. Furthermore, the influence of applied P fertilizer on soil factors responsible for the problem of widespread P deficiency is not fully understood. Therefore, this study aims to assess the effects of P application on the growth of maize in acid soils and evaluate the residual effects on the crop and some soil chemical properties.

Materials and Methods

Surface (0-15 cm) samples were randomly collected from farms in four locations (Oko and Ugbogiobo in Edo State; Oleh and Agbarho in Delta State of Nigeria) to represent the upland and lowland areas of soils developed on unconsolidated sands and sandstones (acid sands or Coastal Plain Sands) respectively (Ojanuga *et al*., 1981). The features of the farms and general physiographic characteristics of the locations are shown in Table 1.

Table 1: Physiographic features of the locations where soil samples were collected

	Agbarho	*Oleh*	*Oko*	*Ugbogiobo*
Location	5°30'N, 5°52'E	5°32'N, 5°42'E	6°25'N, 5°30'E	6°33'N, 5°37'E
Land Use	ADP Farm used for cultivation of arable crops with regular fertilizer use; water table within 1 m of the soil surface.	Citrus farm mixed with pineapples. No fertilizer use history and water table was about 1 m to soil surface	ADP On-Station Research Farm for the cultivation of arable crops; the previous crop was maize with regular use of fertilizer.	Oil palm nursery site cleared from >7-year fallow; no fertilizers used on the site before.
Vegetation	Seasonal swamp forest	Seasonal swamp forest	Moist lowland forest	Moist lowland forest
Rainfall	2384 mm	2866 mm	2257 mm	2242 mm
Landform	Sombreiro-Warri deltaic plains	Sombreiro-Warri deltaic plains	Undulating coastal plain terraces dissected by deep gullies and long slopes	Undulating coastal plain terraces dissected by deep gullies and long slopes
Soil group	Yellowish brown soils of Calabar fasc	Yellowish brown soils of Calabar fasc	Reddish brown soils of Benin fasc	Reddish brown soils of Benin fasc
Soil unit	Freshwater and mangrove swamp	Freshwater and mangrove swamp	Nearly level plains on Coastal Plain Sands	Nearly level plains on Coastal Plain Sands
Soil type	Typic Tropaquent/ Aquic Kandiudult	Typic Tropaquent/ Aquic Kandiudult	Arenic Kandiudult	Oxic Kandiudult

Sources : Vine (1970), Ojanuga *et al*. (1981), FDALR (1990)

Pot Studies

Three (3) kilograms (kg) of air-dried and sieved (<2 mm) soil samples were measured into 5-litre plastic perforated buckets. The treatments were 0, 20 and 40 kg P.ha^{-1} supplied with single super phosphate (18% P_2O_5) and each received basal N, K, and Mg at 90, 60 and 25 kg.ha^{-1} from urea (46% N), muriate of potash (MOP, 60% K_2O) and magnesium sulphate (20% MgO) respectively. The treatments were replicated four times and arranged as a 4×3 factorial in a split-plot design with locations as the main plots and P levels used as sub-plots. The fertilizers were thoroughly mixed with the soils and water added to near field capacity. Four seeds of maize (*Zea mays*, SUWAN 1-SR-Y variety) were sowed in each bucket and seedlings thinned to two after emergence. The maize plants were watered daily and grown for six weeks. Maize top-growth was harvested by cutting the plants at the soil surface, put in paper bags, oven-dried at 60°C for 48 hours and weighed. The soils were left to dry for about two weeks, sampled and grown to maize for the second cycle of six weeks, to assess the residual effects of the P fertilizer added.

Analysis of Soil and Plant Samples

The initial soil samples were analyzed for particle size distribution, pH in distilled water at 1: 2 soil-solution ratio, organic carbon, total N, exchangeable cations (Ca, Mg, K and Na), total exchangeable acidity, cation exchange capacity (CEC), available P, Mn, Al and Fe using the procedures described in IITA (1979) Laboratory Manual. The soil samples taken after the first and second cropping were analyzed for pH, exchangeable cations, available P, Fe and Mn.

Dried plant samples were ground finely in a Wiley mill and digested with a ternary mixture of concentrated nitric, perchloric and sulphuric acids (25-5-5 v/v). Total P in the digests was determined using the vanado-molybdate yellow method, total K by flame photometry and total Mn and Fe with atomic absorption spectrophotometer. Total N was determined with the micro-Kjeldahl method. Dry matter yield data from direct and residual effects of applied P were subjected to analysis of variance (ANOVA) and treatment means separated using the Duncan Multiple Range Test (DMRT) as described in Steel *et al*. (1997). The changes in soil properties caused by the addition of P after the first and second cropping were determined by subtraction of the pre-cropping values.

Results

Table 2 shows that the soils were extremely acidic (pH 4.0-4.6) loamy sands with low exchangeable cation content and organic matter that varied between 1.2 and 1.8%. Available P was less than 5.0 mg.kg^{-1} in three locations and 17.5 mg.kg^{-1} in Ugbogiobo soil while total N varied between 0.07 and 0.12%.

Table 3 shows the dry weight of maize top-growth as influenced by direct P application in the first cropping and the residual effects during the second cropping. Yield increased in all soils and was highest at 40 kg P.ha^{-1} but which did not differ significantly from the 20 kg P.ha^{-1} rate.

The responses, expressed as % yield increase and relative yield, show that Ugbogiobo which produced the highest dry matter yield had the least responses to P while the response was medium at Agbarho and Oleh but greatest at Oko (Table 4). Agbarho had the highest dry matter yield in the second cropping but yield responses to residual applied P were either negative as in the soils from Oko and Ugbogiobo or slight at Agbarho (2.4%) and Oleh (17%).

Table 2: Properties of soils developed on Coastal Plain Sands used for the study

Properties	Agbarho	Oleh	Oko	Ugbogiobo
Sand, %	90.4	90.0	83.4	85.4
Silt, %	6.0	4.0	2.0	3.0
Clay, %	3.6	6.0	14.6	11.6
Textural class	S	LS	SL	SL
pH (water)	4.3	4.1	4.0	4.6
Organic matter, %	1.61	1.80	1.20	1.86
Total N, %	0.09	0.10	0.07	0.12
Available P, mg.kg^{-1}	5.3	2.1	3.6	17.5
Exchangeable cations, cmol.kg^{-1}				
K	0.10	0.08	0.06	0.29
Ca	0.60	0.15	0.20	0.90
Mg	0.30	0.35	0.20	0.80
Na	0.02	1.31	0.34	0.53
Acidity	3.98	3.41	3.88	2.70
CEC	5.00	5.32	4.68	5.42
Base saturation, %	20.40	35.53	17.10	46.50
Al, mg.kg^{-1}	12.2	24.3	23.0	7.3
Fe, mg.kg^{-1}	1.4	1.7	1.1	2.5
Mn, mg.kg^{-1}	22.0	14.0	21.9	28.0

S = Sand; SL = Sandy loam; LS = Loamy sand
CEC = Cation exchange capacity

Table 3: Direct and residual effects of applied P on dry matter yield of maize

Soils	0	20	40	Mean
		Direct		
Agbarho	6.13e	8.10d	9.15cd	7.79y
Oleh	1.38g	2.10g	3.28f	2.25z
Oko	0.90g	3.28f	3.30f	2.49z
Ugbogiobo	10.53bc	11.98a	10.68ab	11.06x
Mean	4.73k	6.36j	6.60j	-
Soils	0	20	40	Mean
		Residual		
Agbarho	4.01a	2.97b	4.13a	3.70w
Oleh	1.15ef	1.37e	0.87f	1.13z
Oko	1.17ef	1.69de	1.21ef	1.36y
Ugbogiobo	2.59c	2.35c	1.83d	2.26x
Mean	2.23j	2.09jk	2.01k	-

SE= 0.48
SE= 0.13
Mean values for direct and residual cropping and values across soils and P rates followed by same alphabets do not differ significantly (P= 0.05).

Table 4: Yield responses of maize to direct phosphorus application in acid soils

% Yield Increase	Relative Yield, %				
	P rate, kg.ha^{-1}		P rate, kg.ha^{-1}		
Soils	20	40	20	40	Rating
Agbarho	32.8	50.8	75.3	66.3	Medium
Oleh	50.0	135.7	66.7	42.4	Medium
Ugbogiobo	13.3	-2.9	88.2	100.0	Low
Oko	255.6	266.7	28.1	27.3	High

Table 5: Direct and residual effects of P application on %P and P uptake of pot -grown maize in Ultisols

Direct Effect

	%P				P Uptake			
Sites	0	20	40	Mean	0	20	40	*Mean*
Agbarho	0.021	0.023	0.032	0.025^{c}	0.128	0.186	0.294	*0.203^{b}*
Oleh	0.023	0.028	0.035	0.029^{b}	0.032	0.059	0.116	*0.069^{d}*
Ugbogiobo	0.028	0.021	0.024	0.024^{c}	0.294	0.250	0.245	*0.263^{a}*
Oko	0.040	0.044	0.048	0.044^{a}	0.036	0.141	0.158	*0.112^{c}*
Mean	*0.028^{b}*	*0.029^{b}*	*0.035^{a}*	-	*0.123^{c}*	*0.159^{b}*	*0.203^{a}*	-
	SE= 0.0011				SE= 0.0049			
	Residual Effect							
Agbarho	0.028	0.035	0.025	0.027^{a}	0.112	0.104	0.103	*0.106^{a}*
Oleh	0.025	0.019	0.021	0.022^{b}	0.028	0.026	0.018	*0.024^{d}*
Ugbogiobo	0.025	0.010	0.029	0.021^{b}	0.065	0.024	0.053	*0.047^{b}*
Oko	0.010	0.025	0.027	0.021^{b}	0.012	0.042	0.033	*0.029^{c}*
	0.022^{b}	*0.022^{b}*	*0.026^{a}*	-	*0.054^{a}*	*0.049^{b}*	*0.052^{ab}*	-
	SE= 0.0010				SE= 0.0023			

Means for sites and P rates for direct and residual cropping followed by same alphabets do not differ significant (P=0.05)

The direct and residual effects of P application on %P and P uptake are shown in Table 5. P content of maize was 0.021-0.048 and 0.010-0.035% for the first and second cropping, respectively. The P content increased with P application except in Ugbogiobo soil. P uptake followed the same trend as dry matter yield, being highest at Ugbogiobo which did not show response whereas there were marked increases from applied P in the other soils. P uptake was highest in Agbarho soil during the second cropping but only Oko soil showed increased uptake at higher P rates. The effects of P application and cropping on some soil chemical properties are shown in Table 6. The change in soil pH with applied P after the first cropping consisted of slight increase which was highest in Agbarho soil and a decrease in Ugbogiobo soil. The soils remained in the extremely acid range and the effect of applied P was not consistent in all the soils after the second cropping. Available P increased with cropping in the three soils that contained low amounts compared to the initial values. P application increased available P in all soils and the values were slightly lower after the second cropping. Cropping decreased exchangeable Ca slightly in Ugbogiobo soil and caused >100% increase in the other soils but the values increased with P application. Exchangeable Mg was increased by cropping in all soils and the values were not affected by P application. Exchangeable Al content was least affected by cropping and P application in Ugbogiobo soil but decreased in Oleh and Oko soils, and increased in Agbarho. Cropping decreased exchangeable Mn in Oleh and Oko soils but P application reduced the content in all soils. Cropping reduced exchangeable Fe and P application caused progressive decline after the first cropping while only Ugbogiobo had a slight increase after the second cropping.

Table 6: Effects of P application and successive cropping on changes in some chemical properties of acid soils

Property	P rate, kg.ha^{-1}	Agbarho		Oleh		Ugbogiobo		Oko	
		I	II	I	II	I	II	I	II
pH (H_2O)	0	0.6	0.3	0.1	-0.1	-0.3	-0.4	0.1	0.2
	20	0.7	0.5	0.2	0.1	-0.2	-0.1	0.2	-0.1
	40	0.9	0.4	0.3	0.4	-0.3	-0.2	0.3	0.1
Available P, mg.kg^{-1}	0	3.2	2.2	5.4	5.1	-1.0	-3.0	2.7	1.2
	20	4.7	5.7	11.5	10.4	3.0	3.5	5.9	4.9
	40	7.2	6.2	15.7	11.7	13.0	3.0	9.9	9.4
Ca, cmol.kg^{-1}	0	0.91	0.60	0.20	0.15	-0.04	-0.04	0.25	0.25
	20	1.23	0.80	0.23	0.17	0.29	0.10	0.25	0.23
	40	1.41	1.40	0.34	0.33	0.34	0.34	0.26	0.24
Mg, cmol.kg^{-1}	0	1.88	1.79	0.23	0.14	0.80	0.62	0.40	0.29
	20	1.82	1.71	0.14	0.15	0.82	0.60	0.39	0.30
Al, mg.kg^{-1}	40	1.84	1.72	0.25	0.15	0.82	0.70	0.42	0.31
	0	8.1	-2.7	-15.0	-15.0	0.1	-0.2	-4.1	-1.4
	20	5.4	10.8	-15.0	-13.5	-0.1	-0.1	-6.8	-2.7
Mn, mg.kg^{-1}	40	0.0	8.1	-16.2	-16.2	0.0	0.0	-6.1	-2.7
	0	11.0	0.3	-2.8	-5.5	24.8	16.5	-8.3	-13.8
	20	10.9	0.0	-2.8	-5.5	22.0	11.0	-10.8	-13.8
Fe, mg.kg^{-1}	40	2.8	-5.5	-7.7	-7.7	20.5	11.0	-11.0	-16.5
	0	-0.44	-0.11	-0.36	-0.31	-0.31	0.05	-0.39	-0.09
	20	-0.44	-0.14	-0.36	-0.28	-0.42	0.08	-0.45	-0.09
	40	-0.53	-0.11	-0.45	-0.33	-0.47	0.05	-0.48	-0.11

I = After first cropping II = After second cropping

Discussion

The upland and lowland portions of Edo and Delta States present contrasting features in vegetation, landforms, and soil types. The two soil groups (Benin fasc and Calabar fasc), represented by the samples in this study, make up more than 60% of the agricultural lands in the states and which Vine (1970) described as 'soils with loose brownish topsoil over a great depth of featureless, unmottled, non-gravelly, porous soil in which coarse sand is the predominant fraction and clay content is up to 35%'. The extreme acidity and coarse texture of the topsoils are typical characteristics of soils derived from Coastal Plain Sands parent materials and located in the humid agro-ecological zone where high annual rainfall (>1500 mm) promotes excessive leaching of bases (Ojanuga *et al.*, 1981; FDALR, 1990). The soil organic matter content is considered moderate and total N low while available P was very low in the three locations and moderate at Ugbogiobo based on criteria for soil test interpretation and topsoil fertility classes established for soils in Nigeria (Anon, 2006). These soil fertility indices reflected the land use history such that Agbarho and Oko under continuous cultivation to arable crops contained the least values but were highest in the Ugbogiobo soil sample taken from a site cleared from a >5 year-fallow. As a result, Ugbogiobo had the least responses to P in relation to the medium available P content.

Maize P content was very low in the first and second cropping, respectively compared to normal expected range of 0.4-0.8% for whole plants at 3-4 leaf stage (Jones and Eck, 1973). The roots of the maize plants were not removed after each cropping and included in the analysis of P content but the low values would be attributed to fixation of soluble P in the soils which is possible

given the high levels of exchangeable Al, Mn, and Fe. The soils were sands and loamy sands such that P fixation could not have been due mainly to the clay content but to the other factors responsible which are the high Al, Fe and Mn contents. Ugbogiobo did not show an increase in % P with P application probably because of the high pre-cropping available P level. Simpson (1960) had observed that each increment of 44-330 kg P.ha^{-1} depressed P uptake in soils with high available P. The increased P content with P application in the other soils agrees with the findings of Adediran and Sobulo (1995).

The residual effect on dry matter yield was not consistent probably because the applied P was used up mainly for the first cropping or soluble P was fixed by Al, Fe, and Mn during the cropping period characterized by drying and wetting cycles. It is also possible that the rates were too low to elicit residual effects which will influence crop growth under the acidic soil conditions. At Ugbogiobo, the yield performance of the first crop, attributed to the site peculiarity and land use history, was not repeated in the second cropping. The implication is that continuous cropping will gradually reduce the site productivity to the level observed at Oko and Oleh.

The slight increases in soil pH caused by cropping could be as a result of the higher exchangeable basic cations (K, Ca and Mg) content and the short duration of the experiment. The expectation is that the rate of decomposition and depletion of organic matter would increase especially as the soil had undergone moist and dry cycles during the cropping period. Although organic matter content after each cropping was not determined, its reduction has been linked with increased acidification of continuously cropped soils (Juo *et al*., 1996; Lal, 1999) and would not explain the increase in soil pH except for Ugbogiobo. The little effect of applied P on soil pH is an indication that the Ca supplied in the fertilizer did not completely neutralize soil acidity even as the SSP tends to leave an acidic residue in soils (Brady and Weil, 2002). Besides, the Ca values at 0.30-2.01 cmol.kg^{-1}, which are substantial increases compared to the initial levels in the soils, are still too low to effect significant changes in soil pH. The higher available P with cropping, except in Ugbogiobo sample, agrees with the observation in slightly acid to neutral soils whose available P increased in relation to increasing Al-P and Fe-P fraction from the corresponding reduction in organic matter content and greater microbial activities on fine roots and exudates (Ayodele, 1986).

The reduction in soil Al levels as P applied increased was more in Agbarho and Oko soils whose previous land use ensured high initial values. A similar reduction in Fe and Mn concentrations could be due to reaction with phosphate ions in solution to form insoluble phosphates causing lower uptake of the micronutrient cations. Thus, soluble P should be added in quantities that provide the phosphate to be fixed and inactivate ions and sesquioxides of Al, Mn, and Fe (Tisdale *et al*., 1993). The excess would be diverted for plant uptake and for this; initial heavy doses are needed in other to produce substantial residual effects. Ultimately, the path to tread is integrated nutrient management involving the application of lime and manure to depress the levels of Al, Mn, and Fe in the soils, raise pH, supply Ca and increase the availability of P for plant uptake such that responses to fertilizer P are higher. The direct application of indigenous phosphate rock sources, which have been found suitable for acid soils and whose efficiency can be increased by the addition of animal manure, is advocated for improved P nutrition in the soils.

References

Abruna, F.R., Pearson, W. and Perez-Escolar, R. 1975. Lime responses of corn and beans are grown on typical Ultisols and Oxisols of Puerto Rico. In: Bornemisza, E., and Alvarado, A. (eds). Soil Management in Tropical America. Soil Science Dept, North Carolina State University, Raleigh: 261-282.

Adediran, J.A. and Sobulo, R.A. 1995. The potentials and use of rock phosphate in the Sub-Saharan Africa- Nigeria a case study. In: Agboola, A.A. (Ed) Rehabilitation and Management of African Soils for Sustainable Productivity and Environmental Protection. Proceedings of Third African Soil Science Society Conference, Ibadan, August 21st 26th 1995. *African Soils Special Edition* XXVIII: 295-305

Agboola, A.A., Eneji, A.E., Aiyelari, E.A. and Tijani-Eniola, H. 1997. Marginal lands, water quality and agricultural land pollutants in Nigeria. In: Singh, B.R. (ed). Management of Marginal Lands in Nigeria. Proceedings of 23rd Annual Conference of Soil Science Society of Nigeria held at Usmanu Danfodiyo University, Sokoto; 2nd-5th March 1997: 303-315

Anon, 2006. Nigeria Fertilizer Strategy Report. Presented at Africa fertilizer Summit held at International Conference Centre, Abuja, 9-13th June 2006. 47pp

Araki, S. 1993. Effect of organic matter and soil fertility of the Chitemene slash and burn practice used in northern Zambia. In: Mulongoy, K., and Merckx, R. (eds). Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture. Wiley Science, U.K.: 367-375

Ayodele, O.J. 1986. Effect of continuous maize cropping on yield, organic carbon mineralization and phosphorus supply of savannah soils in western Nigeria. *Biology and Fertility of Soils* 2: 151-155

Brady, N.C. and Weil, R.R. 2002. The Nature and Properties of Soils. 13th Edition, Pearson Educ. Pub. New Delhi, India. 881pp

FDALR, 1990. The Reconnaissance Soil Survey of Nigeria (1:650,000). Soils Report Volume Three (Bendel, Lagos, Ogun, Ondo and Oyo States). Federal Department of Agricultural Land Resources, Lagos. 149pp

IITA, 1979. Selected methods of Soil and Plant Analysis. Manual Series No 1. International Institute of Tropical Agriculture, Ibadan, Nigeria. 70pp

Jones, J.B., Jr., and Eck, H.V. 1973. Plant analysis as an aid in fertilizing corn and grain sorghum. In: Walsh, L.M., and Beaton, J.D. (Eds). Soil Testing and Plant Analysis. Revised Edition. Soil Science Society of America Inc. Madison, USA: 349-364

Juo, A.S.R., Franzluebbers, K., Dabiri, A. and Ikhile, B. 1996. Soil properties and crop performance on a kaolinitic Alfisol after 15 years of fallow and continuous cultivation. *Plant and Soil* 180: 290-217

Lal, R. 1999. Land use and cropping system effects on restoring soil carbon pool of degraded Alfisols in Western Nigeria. In: Lal, R. *et al*. (eds) Global Climate Change and Tropical Ecosystems. Advances in Soil Science. CRC Press, Boca Raton: 157-165

Ojanuga, A.G., Lekwa, G. and Akamigbo, F.R.O. 1981. Survey, classification and genesis of acid soil. In: Udo, E.J., and Sobulo, R.A. (eds). Acid Soils of Southern Nigeria. Soil Science Society of Nigeria Special Publication Monograph No 1: 1-8

Pandey, S.H., Ceballos, R., Magnavaca, A.F.C., Bahia, F., Du Que Vargas, J., and Vinasco, L.E. 1994. Genetics of tolerance to soil acidity in tropical maize. *Crop Science* 34: 1511-1514

Simpson, K. 1960. Effects of soil temperature and moisture on the uptake of phosphorus by oats. *J. Sc. Food Agric*. 11: 449-456

Steel, R.D.G., Torrie, J.H. and Dickey, D.A. 1997. Principles and Procedures of Statistics: A Biometrical Approach. 3rd Edition. McGraw-Hill, New York. 665pp

Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Haylan, J.L. 1993. Soil Fertility and Fertilizers. 5th Edition. Macmillan, New York.

Vine, H. 1970. Review of Work on Nigerian Soils. Report of the National Research Council Committee on Tropical Soils. London, England

Heavy Metal Concentrations and Uptake by Leaf Amaranth in Irrigated Soils along Asa River, Ilorin, Nigeria

J. O. Olaniyan,* O. N Ajala, H. E Ahamefule and **K. Affinnih**,
Department of Agronomy,
University of Ilorin, Ilorin, Nigeria
*Corresponding Author:segnathorg@gmail.com

Abstract: Soil reclamation strategies may be necessary to maintain crop production in the face of deteriorating soil conditions associated with long-term irrigation using water that has high concentrations of heavy metals. A study was carried out to assess the contents of heavy metals (Cd, Cu, Pb and Zn) in soils along the course of Asa River in Ilorin, Kwara State, Nigeria and the uptake by leaf amaranth. The study was a two-way factorial consisting of four locations selected along the river (0, 200, 400 and 600 m) as factor A and four farmers' plots selected based on the number of years of irrigation (0, 10, 20 and 30 years) as factor B while three (3) farmers' plots with similar irrigation history were used as replicates. This arrangement gave 12 plots in each farming location and a total of 48 plots from which soil and plant samples were collected. The samples were digested with nitric-perchloric acid mixture and the total heavy metals determined with atomic absorption spectrophotometer. The ranges of the mean concentrations were: Cu (1.68-6.65), Pb (1.77-7.89), Zn (3.91-8.34), Cd (3.41-6.39) mg/kg in the soils and Cu (2.81-5.84), Pb (4.13-8.63), Zn (2.21-5.15), Cd (1.51-6.27) mg/kg in the plant samples. Cd was higher than the WHO permissible levels in the soils while leaf amaranth was a potential accumulator of Cd.

Keywords: **Heavy metals, concentration, irrigated soil, leaf amaranth, Ilorin, Nigeria**

Introduction

Water is the most important input required for plant growth in agricultural production. The bulk weight of all living organisms consists of 80-90% water. Water need for plant growth is met with soil water storage in the plant root zone. Under rainfed conditions, soil water is continuously replenished with rainfall while irrigation is essential in arid and semi-arid climates to maintain soil water storage at an optimum level to get a higher yield, as well as a supplement for dry season crop production.

Reliable supply of suitable and good quality irrigation water vastly improve agricultural production and assure the economic vitality of a region. Many countries depend on good quality surface irrigation water to grow crops for food and fiber without which their agricultural production would be drastically lowered and problems of unreliable food supply may arise. Maliwal (2004) observed that good quality water is becoming increasingly scarce on a global basis due to urbanization and industrialization. Consequently, the disposal of pollutant-contaminated waste waters from industries and other sources on land, water bodies and crops have brought about soil and water pollution and deterioration in the quality of the crop produce as a result of heavy metal contamination.

Vegetables constitute an important part of the human diet since they contain carbohydrates, proteins, vitamins, minerals and fibre required for human health. They also act as neutralizing agents for acidic substances formed during the digestion of meat (Thompson and Kelly, 1990). As human activities increase, especially with the application of modern technologies, pollution and contamination of the human food chain have become inevitable (Sukreeyapongse *et al*., 2002; Yusuf *et al*., 2003). Heavy metal contamination in vegetables cannot be underestimated because they are important components of the human diet. Heavy metal contamination of the food items has become one of the most important aspects of food quality assurance such that international and national regulations on food quality have lowered the maximum permissible levels of toxic metals in food items due to an increased awareness of the risks these metals pose to food chain contamination (Radwan and Salama, 2006).

Rapid and unorganized industrialization and urbanization have contributed to the elevated levels of heavy metals in the urban environment of the developing countries. Heavy metals are non-biodegradable and persistent environmental contaminants which may be deposited on the surfaces and then adsorbed into the tissues of the vegetables. Plants take up heavy metals by

absorbing them from deposits on the parts of the plants exposed to the air from the polluted environment as well as from contaminated soils or direct contact from irrigated water (peradventure the water is polluted) (Kachenko and Singh, 2006; Singh and Kumar, 2006).

Water contamination by heavy metals in some areas is practically inevitable due to natural processes of rock weathering and anthropogenic activities which produce industrial, agricultural and domestic effluents. Waste water from the mining industries, electroplating, paint or chemical laboratories often contains high concentrations of heavy metals, especially cadmium (Cd), copper (Cu) and lead (Pb). These elements, at concentrations exceeding the physiological demand of the plants, could manifest toxic effects in them and also would enter the food chains, get biomagnified and pose a potential threat to human health. A study carried out in Ghana using water rich in Cd and Pb to irrigate cabbage, carrots and lettuce revealed that Cd and Pb concentrations increased significantly with the amount of irrigation water (Mensah *et al*., 2008).

In many developing countries, it is a common practice to grow vegetables along the banks of rivers passing through urban centres. The water of such rivers has often been polluted by heavy metals as a result of industrial effluents being discharged into them (Kashem and Singh, 1999; Othman, 2001). The extent of absorption of the elements depends on the nature of the plant, chemical constitution of the pollutant, concentration of the element in the soil and the interaction with other metals (Zurera-Cosano*et al*., 1989).

The uptake and bioaccumulation of heavy metals in vegetables is influenced by many factors such as climate, atmospheric depositions, nature of the soils and concentrations of the heavy metals in the soils (Scott *et al*., 1996; Voutsa *et al*., 1996). Elevated levels of heavy metals invegetables have been reported from long-term uses of treated and untreated waste water (Adeniyi, 1996; Sinha *et al*., 2005; Sharma *et al*., 2006). The other anthropogenic sources of heavy metals include the addition of manures, **sewage sludge**, fertilizers and pesticides which modify the physico-chemical properties of the soil such as pH, organic matter and bioavailability of heavy metals in the soil (Yusuf and Osibanjo, 2006). Whatmuff (2002) and McBride (2003) found that increasing concentrations of heavy metals in soil increased the uptake by crops. The cultivated areas near highways are also exposed to atmospheric pollution in the form of metal-containing aerosols deposited on the soil and absorbed by the vegetables or deposited on the leaves and fruits and then absorbed. Prolonged consumption of unsafe concentrations of heavy metals through foodstuffs may lead to the chronic accumulation of the heavy metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases (Jarup, 2003). Heavy metals have been reported to produce mutagenic, teratogenic, neurotoxic and carcinogenic effects even at very low concentrations (Al-Saleh *et al*., 1996; Waalkes *et al*., 1999). Leaf amaranth (*Amaranthus cruentus*) was chosen for this study because it is one of the commonest species cultivated and most regularly consumed vegetable in Ilorin. Thus, the aim of this study was to determine the concentration and assess the level of heavy metals in the soils and leaf amaranth (*Amaranthus cruentus*) grown with irrigation water from Asa river.

Materials and Methods

Study Site

The study area covered selected portions of Asa River in Ilorin West Local Government Area, Kwara State, Nigeria. Asa River is a major river of economic, agricultural and environmental significance in Ilorin. The river flows in the south-north direction and divides Ilorin into two parts: a western part representing the core or indigenous area and the eastern part where the Government Reservation Area (GRA) is located (Oyebanji, 1993). The tributaries of Asa River in are Agba, Aluko, Atikeke, Mitile, Odota, Okun and Osere. The river receives effluents from industries located along its course apart from domestic wastes and other activities carried out but that the major identified source of pollution of Asa River was direct runoff of effluents from the industries (Adekunle and Eniola, 2008; Adekola and Eletta, 2007).

The project was carried out at four (4) locations selected at 200 m interval (0, 200, 400 and 600 m) along Asa River bank used by farmers for dry season irrigated farming. The distances chosen correspond to the intervals of the river which serve as the farmers' sources of irrigation water. A hand-held Global Positioning System (GPS) receiver was used to determine the actual location of the selected farms: control (0 m 08°27'05.5" N and 004°35'33.6''E) before the industrial area (upstream); second location (200 m 08°28'03.1" N, 004°33'29.7"E) behind a steel industry; third

location (400m 08°28'41.8" N and 004°33'34.4" E) at the rear of Seven Up (7-Up) and Coca Cola Bottling Companies (Osere River which receives effluents from soap and pharmaceutical industries discharges into Asa River at this point);and fourth location (600 m 08°29'56.6"N and 004°34'08.5" E) further downstream and receives effluents from the previous sources and sewage discharge by human beings. At each farming location, three (3) farmers' plots with different irrigation histories (0, 10, 20 and 30 years of irrigation duration) were selected while three (3) farmer's plots with similar irrigation history were used as replicates.

Land preparation

The farm work was managed entirely by the farmers while the researcher provided technical advice and collected the necessary data. The gross plot measured 20×20 m with 40 rows of plants in each plot. The spacing of 0.45 m between rows and 0.45 m within rows was adopted for the vegetable.

Data Collection

Soil sampling, preparation, and analysis

Soil composite samples of 4-5 kg were collected from each plot with the aid of stainless steel soil auger from the top (0-20 cm) soil. The soil samples were air-dried and sieved with 2 mm mesh. 2 g of the samples were weighed into a digestion flask and treated with 10 ml of an acid mixture made up of concentrated nitric acid (HNO_3), hydrochloric acid (HCl) and sulphuric acid (H_2SO_4). The samples were mixed and heated for 30 minutes on a hot plate at 80-90°C at which they were brought to boil and a clean solution was obtained. The digests were cooled, filtered and diluted with 50 ml of de-ionized water. Cu, Pb, Zn and Cd in the samples were determined with Atomic Absorption Spectrophotometer (210/211 VAP Buck Scientific).

Plant sampling, preparation and analysis

Plant samples were randomly taken from the inner 18×18 m of each of the 48 plots. Mature leaves just below the growing tips of the main branches and stem were collected. The samples were washed in a solution containing 0.3% detergent and rinsed with ionized water, packaged in paper bags and oven-dried for 48 h at 65°C. The samples were ground in a mortar with pestle. 2 g of ground samples were weighed into digestion flasks and treated with 10 ml of an acid mixture made up of concentrated nitric acid (HNO_3), hydrochloric acid (HCl) and sulphuric acid (H_2SO_4) and digested for 30 minutes on electric hot plate at 90°C. The digests were allowed to cool and were filtered. The filtrate was diluted to 50 ml with de-ionized water; Cu, Pb, Zn and Cd were determined with Atomic Absorption Spectrophotometer (210/211 VAP Buck Scientific).

Statistical analysis

Data collected for soil and plant samples were subjected to Analysis of Variance (ANOVA) using Genstat Discovery (Edition 4) statistical package and the means were separated using the least significant difference (LSD) at 5% probability level.

Results and Discussion

Effect of water source and irrigation duration on heavy metals (Cu, Pband Zn) concentration in the soils

Tables 1-3 show that the distance between the points from which irrigation water was sourced and the irrigation duration had significant ($p<0.05$) effects on the mean concentrations of heavy metals (Cu, Pb and Zn) in the soils. The mean concentrations of these metals increased significantly ($p<0.05$) for every 200 m increase in distance between irrigation water sources up to 400 m downstream with the lowest value (1.68 mg/kg Cu, 1.77 mg/kg Pb and 3.91mg/kg Zn) in the control location whereas the highest value (6.65 mg/kg for Cu, 7.89 mg/kg for Pb and 8.34 mg/kg for Zn) was at 400 m. The mean soil heavy metal concentrations decreased at 600 m downstream. The significant increase observed at 200 and 400 m could be as a result of higher heavy metals (Cu, Pb and Zn) content of Asa River at these locations which increased the soil heavy metal concentrations following prolonged irrigation. Eletta (2004) reported that various companies soap and detergent, beverages, bottling hospitals and pharmaceutical industries have contaminated Asa River with their effluents and the application of the water to soil would contaminate the soils while the contamination in the control site (0 m) could be attributed to natural and/or anthropogenic inputs. The decrease in these metals concentration observed at 600 m could be as a result of mobility and/or mineral precipitation of the metals in the soil. Levy (1992) reported that the distribution is believed to be controlled by mineral precipitation, dissolution and mobilization reactions of heavy metals in soils.

The mean effect of irrigation duration showed that soil Cu, Pb and Zn concentrations increased significantly over intervals of 10 years. The highest concentration of 4.57 mg/kg for Cu, 6.33 mg/kg for Pb and 6.58mg/kg for Zn in the soil were observed following 30 years of the use of

Asa River water for irrigation while the lowest values (2.80 mg/kg for Cu, 3.76 mg/kg and 4.19 mg/kg for Zn) were obtained on the newly-established farms without history of prior use of Asa River water for irrigation. The results showed that these metals accumulated in the soil as the farmers kept using Asa River water for irrigation. Gupta *et al*. (2008) reported that irrigation water is the cause of heavy metals accumulation in the soil, especially when the water is contaminated. Comparing the levels of Cu, Pb and Zn in soils with permissible limits recommended by WHO (2005) at 100, 2-200 and 300 mg/kg for Cu, Pb and Zn respectively, the concentrations of these heavy metals were below the permissible limits. The implication of this is that there is no threat of soil contamination by Cu, Pb and Zn when this river was used for irrigation of soil by the farmers. The same observation was reported by Chiroma *et al*. (2012) who investigated the heavy metals in soil irrigated with waste water/contaminated water.

The use of Asa River water at 400 m downstream for 30 years gave the highest concentration of 8.72, 9.99 and 10.02 mg/kg for Cu, Pb and Zn respectively. This could be as a result of heavy metal-laden Osere River received by Asa River at this location and following the continuous use for irrigation got accumulated in the soil over time. However, the values are below the WHO (2005) permissible level which implies that the soil is not hazardous because there is no treat of the contaminants in the soil.

Table 1: Effects of Source of water and irrigation duration on the concentration of copper (mg/kg) in treated soil

Source of Water (m) Factor A	Irrigation Duration (years)Factor B				Mean
	0	10	20	30	
0	1.03	1.13	2.30	2.27	1.68
200	2.11	2.71	2.18	2.23	2.27
400	5.03	6.33	6.50	8.72	6.65
600	3.05	4.07	4.84	5.07	4.26
Mean	2.80	3.56	3.96	4.57	—

$LSD_{0.05}$
Factor A = 0.020
Factor B = 0.022
A×B = 0.339

Table 2: Effects of source of water and irrigation duration on the concentration of Lead (mg/kg) in treated soil

Source of Water (m)Factor A	Irrigation Duration (years)Factor B				Mean
	0	10	20	30	
0	1.10	1.47	2.02	2.48	1.77
200	5.56	7.56	8.35	9.18	7.66
400	5.99	7.99	7.60	9.99	7.89
600	2.40	2.49	2.95	3.66	2.88
Mean	3.76	4.87	5.23	6.33	—

$LSD_{0.05}$
Factor A =0.403
Factor B= 0.332
A×B= 0.510

Table 3: Effects of source of water and irrigation duration on the concentration of Zinc (mg/kg) in treated soil

Source of Water (m)Factor A	Irrigation Duration (years)Factor B				Mean
	0	10	20	30	
0	3.00	3.80	4.20	4.66	3.91
200	3.45	4.85	5.52	6.30	5.03
400	6.25	8.15	8.95	10.02	8.34
600	4.05	5.83	6.00	5.32	5.30
Mean	4.19	5.66	6.17	6.58	—

$LSD_{0.05}$
Factor A= 0.304
Factor B= 0.210
A×B=0.421

Effect of source of water and irrigation duration on cadmium (Cd) concentration in treated soil Table 4 shows the mean concentrations of Cd in the soils. The distance between points from which irrigation water was sourced and irrigation duration had significant ($p<0.05$) effects on the mean concentration of Cd. The mean concentrations of Cd in soil increased significantly ($p<0.05$) for every 200 m increase in distance between irrigation water sources up to 400 m downstream. The lowest value (3.41 mg/kg) was obtained in the control (0 m) whereas the highest value (6.39 mg/kg) was observed at 400 m. The mean soil Cd content was lowest at 600 m downstream. The significant increase observed at 200 and 400 m could be traced to effluents discharged by the steel processing industry along Asa River which was sited before these locations and other man-made inputs such as burning of fossil fuels, sewage sludge or fertilizer application by the farmers. Oliver, / 1997) had observed that large concentrations of Cd in the soil are mostly from man-made sources such as steel processing, burning of fossil fuels, application of fertilizers, and sewage sludge. The low value at 600 m could be as a result of dissolution or ion exchange in the soil (Levy, 1992).

Table 4: Effects of source of water and irrigation duration on the concentration of cadmium (mg/kg) in irrigated soil

Source of Water	Irrigation Duration (years)Factor B				
(m)Factor A	0	10	20	30	Mean
0	2.50	3.71	3.20	4.23	3.41
200	3.55	5.58	7.04	7.40	5.88
400	4.25	6.25	7.21	7.83	6.39
600	3.10	4.13	5.22	5.89	4.84
Mean	3.35	5.16	5.67	6.33	—

$LSD_{0.05}$
Factor A = 0.404
Factor B = 0.402
A×B = 0.552

The mean effects of source of water and irrigation duration showed that soil Cd concentration increased significantly over intervals of 200 m and over 10 year-periods. The highest soil Cd concentration (6.33 mg/kg) was observed following 30 years of using Asa River water for irrigation while the lowest (3.35 mg/kg) was obtained on the newly established farms. This implies that there was Cd accumulation in the soil as the farmers kept using Asa River water for irrigation. Comparing the levels of total Cd observed in the soils with permissible limits recommended by WHO (2005) at 0.01-0.7 mg/kg, the total Cd values were in excess. This high concentration would have implications on the microbial processes in the soil and so pose a threat to the whole soil ecosystem. It would reduce the population of soil microorganisms which would affect soil nutrient transformations (Lenntech, 2014).

The use of Asa River water at 400 m to irrigate the land for 30 years produced the highest soil Cd concentration (7.83 mg/kg). This could be as a result of heavy metal-laden Osere River received by Asa River at this location (400 m) and following continuous use for irrigation got accumulated in the soil over time.

Effect of source of water and irrigation duration on heavy metals (Cu, Pb, Zn) concentration in the irrigated leaf amaranth

Tables 5-7 indicate that distance along the course of the river and the irrigation duration had significant ($p<0.05$) effects on the mean concentration of heavy metals (Cu, Pb and Zn) in leaf amaranth. The metals increased significantly in the plant tissue ($p<0.05$) for every 200 m change in distance between irrigation water sources up to 400 m. The lowest values (2.81 mg/kg for Cu, 4.13 mg/kg for Pb and 2.21 mg/kg for Zn) were observed in the control location whereas the highest values (5.84 mg/kg for Cu, 8.63mg/kg for Pb and 5.15 mg/kg for Zn) were obtained at 400 m.

The mean plant concentration of the heavy metals decreased at 600m downstream. The high values observed at 200 and 400 m could be attributed to effluents discharged by industries into the river whose use for irrigation got into the soil and was consequently absorbed by the plants. Adeniyi (1996) reported that the higher the accumulation of metals in the soil, the more the plant uptake into their tissue. The decrease observed at 600 m location could be as a result of dilution.

Table 5: Effects of source of water and irrigation duration on the concentration of copper (mg/kg) in treated vegetable plants

Source of Water	Irrigation Duration (years)Factor B				
(m)Factor A	0	10	20	30	Mean
0	2.01	3.07	3.05	3.09	2.81
200	3.02	5.22	5.62	5.80	4.92
400	4.25	6.28	6.40	6.41	5.84
600	3.07	5.30	5.54	5.56	4.87
Mean	3.09	4.97	5.15	5.22	

$LSD_{0.05}$
Factor A= 0.015
Factor B= 0.012
A×B= 0.023

Table 6: Effects of source of water and irrigation duration on the concentration of lead (mg/kg) in treated vegetable plants

Source of Water	Irrigation Duration (years)Factor B				
(m)Factor A	0	10	20	30	Mean
0	2.70	4.79	4.60	4.44	4.13
200	3.40	10.46	10.41	10.25	8.63
400	5.11	9.21	9.44	9.54	8.33
600	4.04	8.07	8.17	8.20	7.12
Mean	3.81	8.13	8.14	8.11	

$LSD_{0.05}$
Factor A= 0.029
Factor B= 0.018
A×B= 0.036

Table 7: Effects of source of water and irrigation duration on the concentration of zinc (mg/kg) in treated vegetable plants

Source of Water	Irrigation Duration (years)Factor B				
(m)Factor A	0	10	20	30	Mean
0	1.01	2.41	2.61	2.82	2.21
200	2.40	4.20	4.31	4.40	3.82
400	3.20	5.21	5.82	6.38	5.15
600	3.40	5.52	5.71	5.90	5.13
Mean	2.50	4.34	4.61	4.88	

$LSD_{0.05}$
Factor A= 0.027
Factor B= 0.020
A×B= 0.039

The effect of irrigation duration on Cu, Pb and Zn concentration in plant tissue was significant. The concentration soil heavy metals increased over the intervals of 10 years with the highest (5.22 mg/kg for Cu, 8.14 mg/kg for Pb and 4.88 mg/kg for Zn) observed following 30 years of using Asa River water for irrigation while the lowest values (3.09 mg/kg Cu, 3.81 mg/kg Pb and 2.50 mg/kg Zn) were observed on newly established farm plots. The significant increase observed over intervals of 10 years of irrigation could be an indication of bio-accumulation of these heavy metals in the plant tissue. Comparing the heavy metal concentrations in plant tissues with permissible limits recommended by WHO (2005) at 10 mg/kg for Cu and Pb and 50 mg/kg for Zn, these heavy metals were below permissible limits. The implication is that the use of the river water by farmers for irrigation does not pose threats of contamination by Cu, Pb and Zn such that the plant is safe for consumption.

Effect of water source and irrigation duration on cadmium (Cd) concentration in leaf amaranth.

Table 8 shows the mean concentrations of Cd in leaf amaranth at various points along the river from which irrigation water was sourced and irrigation duration. The two factors had significant ($p<0.05$) effects on the mean concentration of Cd.

The mean Cd concentration increased significantly ($p<0.05$) for every 200 m distance between irrigation water sources up to 600 m. The lowest value (1.51 mg/kg) was observed in the control location (0 m) whereas the highest value (6.27 mg/kg) was observed at 600 m. The significant increase observed over the 200-600 m range could be adue to contaminated soil or exposure of plant surface to air pollution (Miller and McFree, 1983).

The mean effect of irrigation duration showed that plant Cd concentration increased significantly over the intervals of 10 years. The highest concentration of Cd in the plant (4.43 mg/kg) was observed in leaf amaranth grown in soils that have been irrigated with water from Asa River for 30years while the lowest (2.37 mg/kg) was obtained in farms without history of Asa River water for irrigation. The permissible critical limits in plants recommended by WHO (2005) at 0.3 mg/kg is below the total Cd concentrations in the leaf amaranth. This high concentration can have severe effects on seedling length and dry weight, reduce photosynthesis activity, and cause structural changes in chloroplasts, which would lead to reduction in plant growth and yield. The consumers of such plants are prone to diseases like cancer (Oliver, 1997 and Raza *et al*., 2013).

Generally, the use of Asa River water at 600m downstream for 30years increased plant Cd concentration to the highest level (7.15mg/kg). This could be traced to the sources of contaminant at 200-400m which were received by at 600m. The continuous use of the water for irrigation caused the metal to accumulate in the soil over time and which was then taken up by plant.

Table 8: Effects of source of water and irrigation duration on the concentration of cadmium (mg/kg) in treated vegetable plants

Source of Water	Irrigation Duration (years) Factor B				
(m)Factor A	0	10	20	30	Mean
0	0.95	1.63	1.71	1.74	1.51
200	1.50	3.51	3.55	3.60	3.05
400	2.42	4.81	4.90	5.23	4.34
600	4.62	6.28	7.03	7.15	6.27
Mean	2.37	4.06	4.29	4.43	

$LSD_{0.05}$
Factor A = 0.025
Factor B= 0.011
A×B= 0.022

Conclusion The use of Asa River water for irrigation has significantly increased the heavy metals (Cu, Pb, Zn and Cd) contents of the soils depending on the source of water and the duration of use. Only the concentration of Cd was found to exceed the WHO (2005) permissible limits in soils. The heavy metals concentrations in leaf amaranth also increased in relation to the source of water and the duration of use. Cd content of leaf amaranth exceeded the WHO (2005) permissible levels in plants. Comparing the four locations, pyrite was prominent at 400 m distance where the river receives effluents discharged from detergent and pharmaceutical industries through Osere River. It is, therefore, recommended that effluent discharge and dumping of refuse along the river channel should be forcefully discouraged and that government should help in providing household disposal sites for the inhabitants of the town. The significant increase in the level of human and industrial activities along the course of the river would necessitate regular monitoring of the water in Asa River. Finally, there is the need for coordinated efforts at the level of the community dwellers, non-governmental organizations(environmental rights groups) and the government to rescue the downstream of Asa River from the current hazard-posing environmental problems if the land across the river is to be used for dry season irrigation and farming activities.

References

Adekola, F.A. and Eletta, O.A.A. (2007). A study of heavy metal pollution of Asa River, Ilorin, Nigeria: Trace metal monitoring and geochemistry. *Environmental Monitoring and Assessment* 125: 157-163.

Adekunle, A.S. and Eniola, I.T.K. (2008). Industrial effluents on quality of segment of Asa River within an Industrial Estate in Ilorin, Nigeria. *New York Journal of Science* 1:17-21

Adeniyi, A.A. (1996). Determination of cadmium, copper, iron, lead, manganese and zinc in waterleaf (*Talinumtriangulare*) in dumpsites. *Environ. Int*. 22: 259-262.

Al-Saleh, I., Mustafa, A.,Dufour, I., Taylor, A. and Hiton, R. (1996). Lead exposure in the city of Arar, Saudi Arabia. *Arch. Environ. Health*, 51: 73-82.

Chiroma, T.M., Ebewele R.O. and Hymore, F.K. (2012) Levels of heavy metals (Cu, Zn, Pb, Fe and Cr in bush green and roselle irrigated with treated and untreated urban sewage water. *International Research Journal of Environment Sciences*1(4): 50-55

Das, A.K. (1990). Metal ion induced toxicity and detoxification by chelation therapy. In: Das, A.K. (Ed.) A Textbook on Medical Aspects of Bio-Inorganic Chemistry, 1st Edn. CBS, New Delhi: 17-58.

Eletta, O.A.A. (2004) Physico-chemical Characterization, Speciation and Interaction Studies of Some Pollutants in the Water and Sediment of Asa River Ilorin Nigeria. PhD Thesis, University of Ilorin, Ilorin Nigeria.238pp

Eriksson, A. A. and Anderson, R. (1997) The State of Swedish Farm Land. Tech. Rep.4778, Swedish Environment Protection Agency, Stockholm, Sweden.

Gupta, K., Singh, P. and Rahman, N. (2008) Adsorption behaviour of Hg(II), Pb(II), and Cd(II)from aqueous solution on Duolite C-433: A synthetic resin. *Journal of Colloid and Interface Science* 275 (2): 398-402.

Jurrien S.J. Kabata A-Pendias and H. Pendias, (2001). Trace Metals in Soils and Plants, CRC Press, Boca Raton, Fla,USA, 2nd edition.

Jarup, L. (2003). Hazards of heavy metal contamination. *Br. Med. Bull*. 68: 167-182

Kachenko, A.G. and Singh, B. (2006). Heavy metals contamination in vegetables grown in urban and metal smelter contaminated sites in Australia. *Water Air Soil Pollut*. 169: 101-123.

Kashem, M.A. and Singh, B.R. (1999). Heavy metal contamination of soil and vegetation in the vicinity of industries in Bangladesh. *Water Air Soil Pollu*. 115:347-361.

Khairiah, J., Zalifah, M.K. Yin, Y.H. and Aminah, A. (2004). The uptake of heavy metals by fruit type vegetables grown in selected agricultural areas.*Pak. J. Biol. Sci*. 7:1438-1442.

Khan, S., Cao, Q., Zheng, Y.M., Huang, Y.Z. and Zhu, Y.G. (2008). Health risk of heavy metals in contaminated soils and food crops irrigated with waste water in Beijing, China. *Environ. Pollut*, 152:686-692.

Levy D.B, Barbarick K.A. Siemer E.G. and Summers L.E (1992). Distribution and partitioning of trace metals in contaminated soils near Leadville, Colorado. *Journal of Environmental Quality* 21 (2): 185-195.

Lenntech, A. (2014) Heavy metal pollutants in wastewater effluents: Sources, effects and remediation. *Advances in Bioscience and Bioengineering* 2 (4): 37-43.

Maliwal, G.L., Mapanda, F., Mangwayana, E. N., Nyamangara, J. and Giller, K. E. (2004). The effects of long-term irrigation using water on heavy metal contents of soils under vegetables. *Agriculture, Ecosystem and Environment* 107: 151-156.

Mashauri, D.A. and Mayo, A. (1990). The environmental impact of industrial and domestic wastewater in Dar Es Salaam. In: Khan, M.R. and H.J. Gijzen, (Eds.) Environmental Pollution and its Management in East Africa. University of Dar Es Salaam, Tanzania: 23-32.

McBride, M.B. (2003). Toxic metals in sewage sludge-amended soils: Has proportion of beneficial use discounted the risks?*Adv. Environ. Res*. 8: 5-19.

Mensah, E., Allen, H.E., Shoji, R., Odai, S.N.,Kyei-Baffour, N.,Ofori, E. and Mezler, D. (2008). Cadmium (Cd) and lead (Pb) concentrations effects on yields of some vegetables due to uptake from irrigation water in Ghana. *Int. J. Agric. Res*. 3: 243-251.

Miller, W. P. and McFree, W. W. (1983). Analysis of leaching behaviour of sludge-applied metals in two field soil *J. Environ. Qual*.**12:** 579.

Oliver, M.A. (1997). Soil and human health: a review. *European Journal of Soil Science* 48:573-592

Oyebanji, J.O. (1993). A spatio-temporal analysis of activity linkages in Ilorin, Kwara State. *Savannah* 21: 24-26

OnwaluO.A. andAhaneku, A.H. (2001) Impact of waste water on irrigation water quality in Ilorin, Nigeria.*Journal of Technology Development* 7: 31-37

Othman, O.C. (2001). Heavy metals in green vegetables and soils from vegetable gardens in Dares Salaam, Tanzania. *TanzaniaJ. Sci. Assoc. Crop Sci*. 27: 37-48.

Radwan, M.A. and Salama, A.K. (2006). Market basket survey for some heavy metals in Egyptian fruits and vegetables. *Food Chem. Toxicol*. 44: 1273-1278.

Raza, A.E. (2013) Heavy metals levels of some fruits and leafy vegetable from selected markets in Lagos, Nigeria. *Afri.Food Sci* 4(2): 389-393.

Scott, D., Keoghan, J.M. and Allan, B.E. (1996). Native and low-input grasses: a New Zealand high country perspective. *N. Z. J. Agric. Res*. 39: 499-512.

Sharma, R.K., Agrawal, M. and Marshall, F.M. (2006). Heavy metal contamination in vegetables grown in wastewater irrigated areas of Varanasi, India. *Bull. Environ. Contaminat.Toxicol.* 77: 312-318.

Singh, S. and Kumar, M. (2006). Heavy metal load of soil, water and vegetables in peri-urbanDelhi.*Environ. Monitor. Assess*. 120: 79-91.

Sinha, S., Pandey, K. Grupta, A.K. and Bhatt, K. (2005). Accumulation of metals in vegetables and crops grown in the area irrigated with river water.*Bull. Environ. Contaminat.Toxicol*. 74: 210-218.

Sugiyama, M., 1994. Role of cellular antioxidants in metal-induced damage. *Cell Biol. Toxicol*., 10: 1-22.

Sukreeyapongse, O., Panichsakpatana, S. and Hansen, H. (2002). Transfer of heavy metals from sludge amended soil to vegetables and leachates. Paper presented at the 17th World Congress of Soil Science (WCSS), 14th - 21st August 2002, Thailand. Symposium No 29, Paper No. 1969.

Tyler. T, Lowrence (1967) Assessment of the fertility and pollution status of irrigated vegetable farms around Addis Ababa city.Final Report.Addis Ababa Agricultural Office, AddisAbaba, Ethiopia.and environmental quality in the wastewater disposal area Chemosphere, 55, 227–25.

Thompson, H.C. and Kelly, W.C. (1990). Vegetable Crops. 5th Edn, Mcgraw Hill Publishing Company Ltd., New Delhi.

Voutsa, D. A.Grimanis and C. Samara, (1996). Trace elements in vegetables grown in an industrial area in relation to soil and air particulate matter. *Environ. Pollut*., 94: 325-335.

WHO (1992). Cadmium environmental health criteria. World Health Organization: 134.

WHO (2005) Guidelines for soil and plant quality: Health criteria and compounds. Information 2nd edition.World Health Organization, ISBN:92-4-154638-7, 516pp.

Waalkes, M.P., Anver, M.R. and Diwan, B.A. (1999). Chronic toxic and carcinogenic effects of oral cadmium in the nobel (NBI/Cr) rat: Induction of neoplastic and proliferative lesions of theadrenal, kidney, prostrate and testis. *J. Toxicol. Environ. Health*, 29: 199-214.

Wang, X., Sato, T., Xing, B. and Tao, S. (2005). Health risks of heavy metals to the general public in Tianjin, China via consumption of vegetables and fish. *Sci. Total Environ.*, 350: 28-37.

Whatmuff, M.S., (2002). Applying bio-solids to acid soil in New South Wales: Are guideline soil metal limits from other countries appropriate?*Aust. J. Soil Res*., 40: 1041-1056.

Wong, J.W., Li, G.X. and Wong, M.H. (1996). The growth of *Brassica chinensis* in heavy-metal-contaminated sewage sludge compost from Hong Kong. *Bioresour. Technol*., 58: 309-313.

Yusuf, A.A., Arowolo, T.A. and Bamgbose, O. (2003). Cadmium, copper and nickel levels in vegetables from industrial and residential areas of Lagos City, Nigeria. *Food ChemToxicol.*41: 375-378.

Yusuf, K.A. and Osibanjo, O. (2006). Trace metals in water and sediments from OlogeLagoon, Southwestern Nigeria *Pak. J. Sci. Ind. Res*., 49: 88-96

Zurera-Cosano, G., Moreno-Rojas, R. Salmeron-Egea, J. and Lora, R.P. (1989). Heavy metal uptake from greenhouse border soils for edible vegetables. *J. Sci. Food Agric*., 49: 307-312

Performance of Low-N Maize Hybrids (*Zea mays* L.) and Relationship among Traits under varied Soil Nitrogen Conditions

G.O. Agbowuro and A.E. Salami
Department of Crop, Soil and Environmental Sciences, Ekiti State University, Ado-Ekiti, Nigeria
E-mail: ayodeji.salami@eksu.edu.ng

Abstract: Experiments were conducted at the Teaching and Research Teaching Farm, Ekiti State University, Ado-Ekiti in the late seasons of 2014 and 2015 to evaluate the performance of nine maize hybrids under two soil nitrogen (N) levels (30 kg $N.ha^{-1}$and 90 kg $N.ha^{-1}$). The experiments were conducted using a randomized complete block design with three replicates. Data were obtained on ear height, plant height, days to 50% anthesis, days to 50% silking, anthesis-silking interval, ear aspect, plant aspect, ear rot, leaf blight, leaf spot, stay green and grain yield. Results showed that the coefficient of variation (CV) was relatively low for all the studied traits except anthesis-silking interval under both fertility conditions. Considering the performance of the hybrid maize, there were no significant differences in grain yield in the two modified N environments (low and high). Under low-N conditions, grain yield had a positive and significant correlation with stay green ($p<0.05$) but not under high-N condition. Ear height and plant height showed positive and significant correlations with grain yield under low and high-N environments indicating a possible effect of pleiotropism. Thus, selecting for high ear height, plant height and stay green traits can influence the improvement in grain yield in a breeding programme.

Keywords: grain yield, fertility, hybrid maize, environments, traits.

Introduction

Maize (*Zea mays* L.) is one of the most widely distributed crops in the world and it contributes to food supply in most of the developing nations. Nigeria is a leading producer of maize in the continent, after South Africa, with 2.5% contribution to global production (FAOSTAT, 2016). Maize accounts for about 40% of the total cereal production in Nigeria (Ogunniyan and Olakojo, 2014). It is cultivated mostly by resource-poor farmers in the rainforest and the savannah zones of Nigeria (Iken and Amusa, 2004). Wide variation in yield occurs mainly due to the genetic variability of the seeds used and diverse agronomic practices, variable climatic conditions and biotic stresses. The introduction of hybrids is one of the most important advances made in accelerated maize production. Hybrids do not transmit increased vigour to the offsprings so that the parent stocks must be crossed each year to produce a new crop of hybrid seeds. This is done by seed companies and by farmers who specialize in the production of hybrid seeds. Yield increases of 25 to 50% have been attributed to the use of maize hybrids (Taimur *et al*., 2011).

N is the major limiting essential nutrient to maize production (Badu-Apraku *et al*., 2010; Ismaila *et al*., 2010). Its deficiency negatively affects leaf expansion, emergence rate, radiation interception, radiation use efficiency and distribution of assimilates among the vegetative and reproductive organs (Uhart and Andrade, 1995). Also, low soil N and uptake by the crop have caused reduction in kernel number and number of ears (Lemcoff and Loomis, 1986; Pearson and Jacobs, 1987 and Monneveux *et al.*, 2006), prolonged anthesis-silking interval (Jacobs and Pearson, 1991) and accelerated senescence (Moll *et al.*, 1994). Low N affects maize growth throughout the life cycle of the crop compared to drought which occurs at any time during the period of growth (Banziger and Araus, 2007).

Most soils in Nigeria are inherently low in N and its deficiency is due to the rapid loss through plant uptake or losses through erosion, volatilization or leaching (Halajnia *et al.*, 2015). The use of N fertilizer to supplement N level in the soil has been recognized as a factor in accelerated maize production. However, the continuous use of N fertilizers at high rates not only increases crop production costs but can negatively impacts soil, water, and air quality within a given ecosystem (Tilman *et al*., 2002). The manufacture of N fertilizer is an energy-intensive process that is becoming increasingly costly due to the use of natural gas as both reactant and heat source for the conversion of atmospheric N_2 to anhydrous

ammonia (NH_3). For these reasons, research has been focussed on the strategies which will reduce the amounts of supplemental N fertilizer used in maize production so as to produce positive economic and environmental benefits. A possible approach to reduce N deficiency in soil is to lower crop N demand through selection for low-N tolerance (Smith *et al*., 1995). The use of maize varieties capable of utilizing low soil nitrogen (N) for optimum yield referred to as low-N maize, is a pragmatic strategy to address the problem of low yield per unit area. This study examined the performance of low-N hybrid maize and the relationships between their traits under low-and high-soil N regimes.

Materials and Methods

The experimental site was the Teaching and Research Farm of Ekiti State University, Ado-Ekiti, Nigeria located on 7°37'N, 5°13'E. The site experiences a tropical humid climate with distint wet and dry seasons. The site has been previously cultivated to arable crops like maize, cassava, and vegetables. A composite soil sample was taken randomly from the experimental site to the depth of 15 cm. The soil sample was air-dried, crushed passed through 2 mm sieve and used for the determination of physical and chemical properties. The hybrids were developed from parents of the low-N genetic materials obtained from International Institute of Tropical Agriculture, Ibadan. The parents are (i) LNTP-YG (ii) $TZPBProlC_4$ (iii) $TZLComp1C_6LNC_1$ (iv) $BR99TZLComp_4$ DMSRSR (v) DMR-ESR-W-LN (vi) $TZPBProlC_3LNSYN$. The experiment was laid out in a Randomized Complete Block Design with three replicates. Each plot consisted of two rows of 5 m length. The experiment was carried out under two soil N conditions. The low- and high-N soil conditions were induced by spot application of urea fertilizer to supply 30 and 90 kg $N.ha^{-1}$. The spacing adopted was 75cm inter-row and 50 cm intra-row. Three seeds were sown per hill and later thinned to two seedlings per hill at 3 weeks after planting (WAP) to give a planting density of 53,333 plants ha^{-1}. Weeds were controlled manually throughout the experiment. Data were recorded on ear height, plant height, days to 50% anthesis, days to 50% silking, anthesis-silking interval, ear aspect, plant aspect, ear rot, leaf blight, leaf spot, stay green and grain yield.

Data were subjected to analysis of variance by Statistical Analytical System (SAS, 1995).

Results and Discussion

The top 15 cm soil in the experimental site contained 0.09% total N, 8.80 mg kg^{-1} available phosphorus (P) and 0.10 $Cmol.kg^{-1}$ exchangeable potassium (K). These major nutrients are low when compared with critical values of 0.15% total N, 10 $mg.kg^{-1}$ available P and 0.20 $cmol.kg^{-1}$ exchangeable K established for soils in Nigeria (Adepetu *et al.*, 2014). The low test value of total N will guarantee the noticeable response of maize to the application of fertilizer.

The traits measured in maize hybrids are shown in Table 1. The ranges of the traits were quite large under both low- and high-N conditions. Similar values were obtained for plant height, days to 50% anthesis and 50% silking while the other traits were different. The mean values for plant height, ear aspect, ear rot, leaf blight and leaf spot were higher under low-N conditions. The coefficient of variation (CV) was low for all the traits except anthesis-silking interval under both fertility conditions. These results agree with the earlier reports by Mehdi *et al*. (2001); Taimur *et al*.(2011) indicating lower CV for various traits in maize hybrids under low-N and high-N environments. Singh and Chaudhary (1997) had suggested that a low CV is desirable for the selection of traits in breeding populations. The mean performance of the traits in the two environments (high- and low-N) is presented in Table 2.

The mean value for grain yield, the primary trait, is higher under high-N environment but this did not differ significantly from the low-N environment. The days to 50% anthesis, days to 50% silking were significant ($P<0.01$) indicating that low-N soil condition delayed flowering as earlier observed by Abe *et al*. (2013). Stay green was significantly ($P>0.01$) affected by the soil N conditions with high-N environment having an enhanced stay green value than low-N environment. A higher stay green value promotes longer photosynthetic duration and would ensure higher grain yield. Leaf disease (blight and spot), as well as plant and ear aspect ratings, were lower under high-N compared to low-N condition.

Plant health conditions were better with improved soil fertility condition. There were no significant differences observed between ear height, plant height, anthesis-silking interval, leaf spot, plant aspect and stay green under the two soil N conditions. This shows that low-N maize hybrid can perform reasonably well under low soil N condition. Correlation coefficients between the plant traits under low- and high-N conditions are shown in Table 3.

Table 1: Maize traits and performance of low maize hybrids under low- and high-N environments

Traits	Range	Mean	C. V %
	High-N Environment		
Ear height (cm)	67.70-87.20	76.84±6.31	8.22
Plant height(cm)	117.40-180.50	157.97±18.43	11.67
Days to 50% Anthesis	62.00-66.00	64.11±0.95	1.48
Days to 50% Silking	64.00-68.00	66.16±1.05	1.59
*ASI	0.30-3.70	1.79±0.79	41.92
Ear aspect	2.00-3.50	2.69±0.41	15.29
Ear rot	2.00-3.50	2.50±0.42	16.87
Leaf blight	2.00-3.50	2.30±0.34	14.83
Leaf spot	1.50-3.00	2.11±0.32	15.52
Plant aspect	1.50-4.00	2.94±0.65	22.38
Stay green	2.50-4.00	3.11±0.42	13.79
Grain yield	2.11-5.12	3.69±0.85	23.19
	Low-N Environment		
Ear height (cm)	62.9-88.20	75.63±7.12	9.41
Plant height(cm)	117.3-182.60	158.56±18.35	11.57
Days to 50% Anthesis	64.00-67.00	65.50±1.00	1.54
Days to 50% Silking	66.00-69.00	67.77±0.96	1.42
ASI	0.10-4.20	1.71±1.04	60.79
Ear aspect	2.50-4.00	3.41±0.41	12.17
Ear rot	2.00-4.00	2.75±0.48	17.64
Leaf blight	2.00-3.00	2.47±0.28	11.67
Leaf spot	2.00-2.25	2.25±0.22	10.22
Plant aspect	2.50-4.50	3.22±0.58	18.04
Stay green	2.00-3.50	2.77±0.44	15.85
Grain yield	1.73-5.53	3.66±0.86	23.52

*ASI= Anthesis-silking interval

Table 2: Mean performance of low-N maize hybrid in low- and high-N environments.

Traits	High	Low	t-test	Pr > t
Ear height (cm)	76.84	75.63	0.65	0.52
Plant height (cm)	157.97	158.56	-0.12	0.90
Days to 50% anthesis	64.11	65.50	-5.20	0.0001**
Days to 50% silking	66.16	67.77	-5.85	0.0001**
ASI	1.79	1.71	0.34	0.73
Ear aspect (1-5)	2.69	3.41	-6.41	0.0001
Ear rot (1-5)	2.50	2.75	-2.02	0.04*
Leaf blight (1-5)	2.30	2.47	-1.93	0.05*
Leaf spot (1-5)	2.11	2.55	-1.80	0.07*
Plant aspect (1-5)	2.94	3.20	-1.64	0.10
Stay green (1-5)	3.11	2.77	2.82	0.006**
Grain yield	3.69	3.66	0.14	0.88

*, ** Significant at < 0.05 and < 0.01 levels of probability respectively.

Table 3: Correlation coefficient among agronomic traits of low N maize hybrid grown under Low N (upper diagonal) and High N (Lower diagonal)

Traits	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ear height (cm)	(1) -	0.43*	0.12	-0.23*	0.20	0.07	0.05	0.26*	0.17	-0.01	-0.03	0.39*
Plant height(cm)	(2) 0.22*	-	-0.25*	-0.27*	0.21*	0.42*	0.14	0.13	-0.11	0.04	0.17	0.50*
Days to 50% anthesis	(3) 0.19	-0.23*	-	0.40*	-0.38*	-0.48*	-0.48*	-0.46*	-0.10	-0.67*	0.07	0.18
Days to 50% silking	(4) -0.05	-0.23*	0.65*	-	0.36*	-0.45*	-0.43*	-0.26*	-0.02	-0.26*	0.14	-0.31*
ASI	(5) -0.40*	-0.05	-0.49*	-0.08	-	0.09	0.18	0.45*	-0.06	0.44*	-0.05	-0.15
Ear aspect (1-5)	(6) -0.02	0.005	-0.24*	0.05	-0.04	-	0.11	0.40*	0.05	0.38*	0.69*	0.10
Ear rot (1-5)	(7) -0.24*	-0.03	-0.29*	0.20	-0.07	0.44*	-	0.24*	0.23*	0.63*	-0.53*	-0.09
Leaf blight (1-5)	(8) 0.04	-0.04	-0.43*	-0.49*	0.05	0.36*	0.13	-	-0.07	0.28*	-0.12	-0.18
Leaf spot (1-5)	(9) 0.16	0.03	-0.11	-0.12	-0.16	0.20	0.20	0.05	-	-0.03	0.11	0.04
Plant aspect (1-5)	(10) -0.37*	-0.21*	-0.18	0.23*	-0.11	0.27*	0.79*	0.07	0.23*	-	-0.46*	0.33*
Stay green (1-5)	(11) -0.27*	0.22*	-0.35*	-0.36*	0.50*	-0.05	-0.25*	0.12	0.28*	-0.23*	-	0.16*
Grain yield (t ha^{-1})	(12) 0.32*	0.31*	0.07	-0.12	0.11	-0.38*	-0.61*	-0.53*	-0.19	-0.61*	-0.01	-

The correlation coefficient values between grain yield and other agronomic traits were generally higher under high N environment compared to low-N environment. Under low-N, grain yield showed positive and significant correlations with stay green, ear height, plant height and days to 50% anthesis. An increase in the value of stay green would ensure more absorption of photo-assimilates and a larger portion of assimilates would be remobilized to grains, leading to increased grain yield. Grain yield and disease ratings and plant aspect had negative and significant correlations in both environments which are similar to the findings of Monneveux *et al. (*2006). The diseased state of crops generally impairs normal growth and physiological activities to the detriment of a good yield. This, however, was less expressed under the low N environment.

Conclusion

Maize hybrids developed from parents of the low-N genetic materials evaluated under varied soil N conditions performed better, in terms of agronomic traits under the high-N soil environment. The lack of significant difference in the grain yield between the two soil N environments showed that the hybrids are less sensitive to the low-N condition. This unique trait is desirable in maize, particularly, in Nigeria where N deficiency is widespread in the soils and cost of N fertilizer is on the increase.

References

Abe A., Adetimirin V.O., Menkir A., Moose S.P. and Olaniyan A.B. (2013). Performance of tropical maize hybrids under conditions of low and optimum levels of nitrogen fertilizer application – grain yield, biomass production and nitrogen accumulation. *Maydica Electronic Publication.* 58: 141-150

Adepetu, J. A; Adetunji, M. T. and Ige V. I. (2014) Soil Fertility and Crop Nutrition. Jumak Publishers, Ibadan: 430pp

Badu-Apraku, B., Menkir, A., Ajala, S., Akinwale, R., Oyekunle, M. and Obeng-Antwi, K. (2010). Performance of tropical early-maturing maize cultivars in multiple stress environments. *Canadian Journal of Plant Science* 90: 831-852.

Banziger, M. and Araus, J. L. (2007). Near-comprehensive coverage of new advances in crop breeding for drought and salinity stress tolerance In: Jenks, M.A. (ed) Advances in Molecular Breeding: Toward Drought and Salt Tolerant Crops. Springer: 587-601.

FAOSTAT (2016) FAOSTAT, Food and Agricultural Organization of the United Nations, Statistics Division, 2016. Available at http://faostat3fao.org

Halajnia, A., Oustan,S., Najafi, N., Khataee A. R., and Lakzian, A. (2015). Effects of Mg-Al layered double Hydroxide on nitrate leaching and nitrogen uptake by maize in a calcareous soil. Journal 47 (9): 1162-1175

Ismaila, U., Gana, A.S., Tswanya, N.M. and Dogara, D. (2010). Cereals production in Nigeria: problems, constraints and opportunities for betterment. *African Journal of Agricultural Research* 5(12): 1341-1350

Jacobs, B. C. and Pearson, C. J. (1991). Potential yield of maize determined by rate of growth and development of ears. Field Crops Research. Ansterdan 27 (2) 281-298

Lemcoff, J.H. and Loomis, R. S. (1986). Nitrogen influences on yield determination in maize. *Crop Science* 26: 1017-1022.

Moll, R.H., W.A. Jackson and Mikkelsen, R. L. (1994). Recurrent selection for maize grain yield: dry matter and nitrogen accumulation and partitioning changes. *Crop Science* 34: 874-881.

Monneveux, P., Sanchez, C., Beck, D. and Edmeades, G. O. (2006). Drought tolerance improvement in tropical maize source populations: Evidence of progress. *Crop Science* 46(1): 180-191.

Pearson, C.J. and Jacobs B. C. (1987). Yield components and nitrogen partitioning of maize in response to nitrogen before and after anthesis. *Australian Journal of Agricultural Research* 38: 1001-1009.

S.A.S. Institute, 1995. SAS/STAT User's Guide. Version 6, 4th ed. Vol. I and II. SAS Inst. Inc. Cary N.C., U.S.A.

Singh R.K. and Chaudhary B. D. (1985) Biometrical Methods in Quantitative Genetics Analysis. 2nd ed. Kalyani Publishers, New Delhi, India. 304pp.

Smith, M.E., Miles, C.A. and Van Beem, J. (1995). Genetic improvement of maize for nitrogen use efficiency. In: Jewell, D.C.,Waddington, S.R., Ransom, J.K. and Pixley, K.V. (eds). Maize Research for Stress Environments. Proceedings of the 4th Eastern and Southern Africa Regional Maize Conference, Harare, Zimbabwe, 28 March-1April 1994. Mexico D.F. CIMMYT. 306 pp.

Taimur M., Malak, A. K., Sayed, J. A., Zaheer, A., Mehran, M. and Kamil, M. (2011): Genotypic and phenotypic relationship among maturity and yield traits in maize hybrids (*Zea mays* L.) *International Research Journal of Agricultural Science and Soil Science* 1(8): 339-343

Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R.L. and Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature* 418: 671–677

Uhart, S.A. and F.H. Andrade. (1995). Nitrogen deficiency in maize: I. Effects on crop growth, development, dry matter partitioning and kernel set. *Crop Science* 35: 1367-1383.

Physiological Responses of Broilers to Dietary Bitter Leaf, Ginger Rhizome, and their Mixture

[1]F. U. Igene, [2]O. O. K. Oko, [3]C. A.Eneji[3]and[2]M. A. Isika

[1]*Department. of Aminal Science, Ambrose Alli University, Ekpoma, Nigeria.*
[2]*Department. of Animal Science, University of Calabar, Calabar, Nigeria.*
[3]*Department. of Food Science and Technology, University of Calabar, Calabar, Nigeria*
Corresponding Author's Email: oluwatosin.kennedyoko@gmail.com

Abstract: The effects of dietary supplementation of bitter leaf (BLM), ginger rhizome (GRM) and their mixture were assessed on the growth performance, carcass, hematological and serum biochemistry of 360 day-old Hybro-broiler chicks in a 42-day experiment. The experimental treatments were the basal diet (with no additive) serving as control, 0.25% BLM (treatment 2), 0.25% GRM (treatment 3) and 0.125% BLM + 0.125% GRM (treatment 4). Each diet was fed to 90 chicks at 15 birds in six replicates. Feed and water were given ad libitum. Weekly weight gain, feed intake, feed conversion ratio and survivability were measured. At day 42, two birds were picked per replicate for carcass, haematological and serum biochemical analyses. GRM improved the immune response of broiler and ensured feed efficiency. Spice supplementation significantly ($P<0.05$) reduced dressed weight, abdominal fat, dressing percentage and eviscerated weight. Hb, PCV, RBC and WBC counts increased following spice supplementations. Total protein increased by 9.06% in GRM but reduced by 28.13% in BLM. This study concluded that 0.25% BLM, 0.25%GRM or their mixture at 0.125% each could enhance the immune status and health of broiler chickens.

Keywords: Feed additives, Chickens, Blood chemistry, Performance

Introduction

The increasing commercialization and intensification of the poultry industry, in order to meet the growing animal protein demand, have led to an upsurge in stress and disease outbreaks in the flock with negative economic implications (Castanon, 2007). Therefore, research focus is now on the utilization of suitable feed additives, including prebiotics, probiotics, organic acids and herbal products in the poultry feed for improved and sustained poultry growth and health (Oko *et al*., 2012; Seifi, 2013; Oko *et al*., 2014). In recent times, there has been increased application of herb and spice products as alternatives to antibiotics in poultry feeds with significant improvement observed in their production performance and health (Hashemi and Davoodi, 2011; Oko *et al*., 2011a and b; Mohammed and Zakariyàul, 2012; Ghasemi and Taherpour, 2015). Several reports have shown the beneficial antimicrobial effects of spices and herbs in poultry (Dorman and Deans, 2000; Oko *et al*., 2011, 2012).

Some herbs and spices used incorporated into poultry diets include: *Aspilia africana* (Oko *et al*., 2011), ginger (Eltazi, 2014), bitter leaf (Owen and Amakiri, 2011), *Piper nigrum* (Valiollahi *et al*.,2013) and garlic (Dieumou *et al*., 2009). Ginger (*Zingiber officinale*) is a perennial plant belonging to the family Zingiberaceae. Its leaves, rhizome, and roots are used in many countries as a spice with several medicinal properties even as it is a rich source of nutrients with an appreciable amount of protein (10.1%), fibre (18.3%) and ash (4.9%) (Eltazi, 2014). It also contains active chemical constituents; volatile oils (x-terpeneol, borneol, citronyl acetate, curcumene, geranial, geraniol, linalool, neral and zingiberone) and pungent compounds like gingerol and shogaols (Ravindran and Babu, 2005). Gingerol, gingerdiol and gingerdione possess antioxidative, antimicrobial and digestive enzyme-stimulating activities (Dieumou *et al*., 2009). Ginger has also been reported to possess some pharmacological potent substances implicated for anti-inflammatory, anti-parasitic, antiseptic, anti-oxidant and immune-modulatory effects (Great, 2003). Bitter leaf (*Vernonia amygdalina*) is one of the leafy vegetables commonly consumed in Nigeria in the preparation of soup, prevention of malaria, treatment of stomach upset, as a de-wormer and in the treatment of diabetics (Kafaru, 1994). These activities have been attributed to the presence of some physiologically-active compounds such as sequiterpene lactones, vernodaline, vernomyelin, and saponins (Igbakin, 2009). Owen *et al*. (2009) reported that bitter leaf contains about 21.50% crude protein, 13.10% crude fibre and 11.05% ash indicating that it is a rich source of nutrients.

The use of bitter leaf and ginger rhizome in poultry diets is well documented (Owen *et al*., 2011; Mohammed and Zakariyàul, 2012; Ghasemi and Taherpour, 2015). However, there is limited information on their mixture as feed additives. This study, thus, attempts to evaluate the effects of single or mixture of bitter leaf and ginger rhizome as natural feed additives on performance, carcass and blood profile of broiler chickens.

Materials and Methods

Fresh leaves of bitter leaf and ginger rhizomes were sliced, air-dried for 72 hours and milled using a laboratory hammer mill (DIETZ, 7311 Dettingen-Teck, West Germany) with 0.33 mm sieve to form Bitter leaf meal (BLM) and ginger rhizome meal (GRM). Three hundred and sixty (360) unsexed Hybro broiler chicks were randomly divided into four groups with six replicates of 15 chicks each/treatment. The experimental treatments were the basal diet (with no additive) serving as control, 0.25% BLM (treatment 2), 0.25% GRM (treatment 3) and 0.125% BLM + 0.125% GRM (treatment 4). All the birds were maintained under the same management conditions, fed on theregular starter (day 0-21) and finisher (day 22-42) diets (Table 1). In order to assess the efficacy of the treatments on the immune status of the birds, no medication was administered throughout the experimental period.

A controlled lighting regime at uniform temperature was maintained at the ambient temperature gradually lowered from 33°C to 22°C on day 28 and was then left constant. The floor pens measured 1.2×1.5 m. Each pen consisted of one hanging tube feeder, one bell type drinker and a litter top dressing with about 5 cm of wood shaving.

Measurement of growth performance and carcass characteristics

Body weight gain and feed intake were measured at 7, 14, 21, 28, 35 and 42 days of age. Feed conversion ratio was calculated as feed intake divided by the body weight gain. Mortality was monitored daily throughout the experiment. At day 42, two birds were randomly selected per replicate (48 birds), starved for 12 hours and weighed prior to slaughtering. The dressed weight, weight of prime cuts (drumstick, thigh, breast and back) and abdominal fat were measured. Dressing percentage was calculated while the weights of the prime cuts and abdominal fat were expressed as relative weight of the live weight

Tables 1: Composition of basal diets

Ingredient	Starter (day 0 -21)	Finisher (day 22 – 42)
Maize	50.29	54.00
Soybean meal	33.31	34.70
Fish meal	5.00	1.00
Wheat offal	3.00	5.00
Crayfish waste	4.00	1.00
Calcium phosphate	3.10	3.00
Salt	0.30	0.30
Lysine	0.30	0.30
Methionine	0.20	0.20
*Vitamin premix	0.50	0.50
Total	**100**	**100**
Crude protein (%)	21.00	18.00
ME(kcal/kg)	2879.16	2,900.00

Blood chemistry parameters

Six birds were selected from each treatment for thecollection of blood samples. Four (4) ml of blood samples were collected from the brachial vein and divided into two groups for haematological and serum biochemical analyses. Blood samples for haematological analysis were collected into Ethylene diamine tetraacetic (EDTA) anticoagulant-treated bottles. The red blood cells (RBC), white blood cells (WBC) counts were determined by the hemocytometer method using the Natt-Herrick solution; hematocrit and haemoglobin values were measured by microhematocrit and cyanmethemoglobin methods, respectively (Kececi *et al*., 1998). To determine blood

heterophils and lymphocytes counts, 100 leukocytes/samples were counted by optical microscope for heterophils to lymphocyte separation according to theprotocol described by Lucas and Jamroz (1961) and heterophil and lymphocytes ratio was calculated.

Statistical analysis

Data obtained were analyzed in a completely randomized design by analysis of variance using the general linear model (GLM) procedure of SAS (2001). The contrast between were separated using the LS MEANS option of SAS was used to separate treatment means (SAS Institute, 2001).

Results and Discussion

The growth performance of broiler due to supplementation of feed with BLM, GRM, and their mixture is presented in Table 2. The final weight (2,660-2,770 g) and daily feed intake (145.60-155.33 g/day) were not significantly (P> 0.05) different among the dietary treatments. The birds fed the control diet were heavier at the end of the experiment but had the lowest feed intake. Mohammed and Zakariya (2012) had earlier reported that bitter leaf did not affect the final weight and feed intake of broilers while El-Deek *et al.* (2002) also noted that ginger meal had no significant effect on the growth performance of broiler. The slight increase in feed intake with spice supplementation agrees with the observation made by Valiollahi *et al*. (2013) following ginger and black pepper supplementation.

Ginger and bitter leaf had been shown to act as stimulants to improved feed digestion. The daily weight gain (62.33-65.00g/day), feed conversion ratio (2.24-2.53) and mortality (0.48-1.68%) were significantly (P< 0.05) affected by the dietary treatments. Diet supplementation depressed weight gain (4.03%), feed conversion ratio (12.95%) and decreased mortality (250%). GRM appeared to improve the immune response of broiler and gave a feed efficiency that was similar to the control groups. The high mortality in the control group could be due to the fact that the birds were susceptible to pathogens. These findings agree with the report of Gbolade (2009) who obtained reduced mortality in birds fed bitter leaf diets. The BLM and GRM mixture produced a better performance in broilers compared to BLM alone. The values obtained for growth performance were within the ranges previously reported for birds fed bitter leaf (Oleforuh-Okoleh *et al*., 2015) and ginger rhizome (Kehinde *et al*., 2011; Eltazi, 2014).

Table 2: Effect of bitter leaf and ginger supplemented diets on growth performance of broiler chickens

Parameter	Control	BLM	GRM	BL+GR	SEM
Av. Initial live weight (g/chick)	40.00	40.00	40.00	40.00	0.00
Av. final live weight (g/chick)	2,770	2,660	2,700	2,680	0.08
Av. Daily weight gain (g/day/bird)	65.00^{a}	62.38^{b}	63.33^{b}	62.89^{b}	0.06
Av. Daily feed intake (g/day/bird)	145.60	155.33	148.83	152.74	2.05
Feed conversion ratio	2.24^{c}	2.53^{a}	2.35^{bc}	2.43^{b}	0.05
Mortality (%)	1.68^{a}	1.20^{b}	0.48^{c}	0.48^{c}	0.12

$^{a, b \text{ and } c}$ Means with different superscripts across row indicate significant (P<0.05) differences

Table 3 shows the carcass characteristics of broilers on dietary treatments. The control birds had 1,960g dressed weight, 70.76% dressing percentage, and 1,460g eviscerated weight but the inclusion of BLM, GRM, and BLM+GRM caused an insignificant reduction (P<0.05) in these parameters. The ranges of values in the treatments were 1,800-1830g dressed weight, 67.67-68.28% dressing percentage and 1,300-1,360 g eviscerated weight. The birds on BLM had the least dressed weight and dressing percentage. The dressing percentages are similar to the values reported by Eltazi (2014) but lower than those obtained by Oleforuh-Okoleh *et al*. (2015).The prime cuts did not show significant (P>0.05) differences among the treatments but the birds on BLM+GRM had the lowest prime cuts while the values of thigh and back weights were higher for those on GRM supplementation. The values obtained are within the ranges previously reported following bitter leaf or ginger supplementations in broiler diets (Valiollahi *et al*., 2013; Eltazi (2014). The reduction in prime cuts following spice supplementations in this study is contrary to the results obtained by Eltazi (2014) and Oleforuh-Okoleh *et al*. (2015) that showed improved prime cuts.The abdominal fat was significantly (P<0.05) reduced in the birds fed diets supplemented with

the spices. This result is similar to observations that spices have hypolipidaemic effects which ensure the development of lean meat desirable by consumers (Yalçin *et al*., 2012). The lipid-lowering effects of spice products have been found to be associated with the reduction of 3-hydroxy-3-methyl-glutaryl-CoA reductase (HMG-CoA reductase), the rate-controlling enzymes for lipid synthesis in the liver by active compounds in the spice (Ghasemi and Taherpour, 2015).

Table 3: Carcass characteristics of broilers as influenced by dietary treatments

Parameters	Control	BLM	GRM	(BL +GR)	SEM
Dressed weight (g)	1,960^{a}	1,800^{b}	1,830^{b}	1,830^{b}	0.14
Dressing percentage (%)	70.76^{a}	67.67^{b}	67.78^{b}	68.28^{ab}	0.08
Eviscerated weight (g)	1,460^{a}	1,360^{b}	1,300^{b}	1,300^{b}	0.16
Cut-up parts (%)					
Breast	26.40	26.00	26.31	25.20	0.03
Thigh	9.82	9.50	10.00	8.50	0.05
Back	28.01	26.82	26.94	27.04	0.31
Drumstick	12.31	12.09	12.29	12.22	0.21
Abdominal fat	0.75^{a}	0.25^{b}	0.25^{b}	0.23^{b}	0.03
Wings	4.30	4.11	4.14	4.32	0.08
Neck	3.86	4.02	4.01	3.79	0.05

$^{a, b \text{ and } c}$ Means with different superscripts across row indicate significant (P<0.05) differences

Table 4 shows the haematological properties of the broilers fed the diets supplemented with spices. The effects on the haematological parameters measured are significant (P<0.05). Haemoglobin, packed cell volume and red blood cell and white blood cell counts were significantly (P<0.05) increased following spice supplementation compared to the control. These observations are similar to the findings of Toghyani *et al*. (2010) in broilers fed spice seeds. BLM supplementation depressed white blood cell count and neutrophils but increased the values for eosinophils and lymphocytes compared to the control group. These observations are similar to those reported by Owen and Amakiri (2011) in birds fed bitter leaf meal and that the presence of some phytochemicals in the leaves was implicated for the variation in haematological parameters. The values obtained for the haematological parameters are within the normal range reported for healthybroiler birds.

Table 4: Haematology of broilers as fed dietary bitter leaf and ginger meals

Parameters	Control	BLM	GRM	(BL +GR)	SEM
Haemoglobin (g/dl)	12.30^{d}	15.00^{b}	16.50^{a}	13.50^{c}	0.05
Packed Cell Volume (%)	37.00^{d}	45.00^{b}	55.00^{a}	40.00^{c}	0.09
RBC(x10^{12}/l)	2.90^{d}	4.00a	3.60b	3.40c	0.05
WBC(x10^{12}/l)	10.00^{c}	9.20^{d}	12.50^{a}	11.30^{b}	0.25
MCV(fl)	127.50^{b}	112.50^{d}	152.70^{a}	117.60^{c}	0.05
MCHC (g/l)	33.24^{b}	33.33^{a}	30.00^{c}	33.25^{b}	0.05
MCH(pg/l)	42.41^{b}	37.50^{d}	45.80^{a}	39.10^{c}	0.51
Neutrophils (%)	56.00^{b}	48.00^{d}	50.00^{c}	58.00^{a}	0.53
Lymphocytes(%)	40.00^{c}	44.00^{b}	46.00^{a}	38.00^{d}	1.72
Eosinophils (%)	1.00^{c}	3.00^{a}	1.00^{c}	2.00^{b}	0.02
Basophils(%)	1.00^{b}	2.00^{a}	2.00^{a}	1.00^{b}	0.02
Monocytes(%)	2.00^{b}	3.00^{a}	1.00^{c}	0.80^{c}	0.04

The impacts of dietary BLM, GRM, and BLM+GRM on some serum characteristics in broiler chickens are shown in Table 5. All the parameters measured were significantly (P<0.05) influenced by the dietary treatments. Total protein (2.30-3.20 g/dl) increased by 9.06% in birds fed GRM, reduced by 28.13% in those fed BLM whereas birds on BLM+GRM had similar values comparable with the control. Similar trends were observed for albumin and globulin concentrations. The total protein and its fractions in the blood are used in evaluating the nutritional and health status of animals, with low levels of a protein indicating disease incidence relating to the kidney or liver. The birds on GRM had higher total protein implying that ginger rhizome maintains the nutritional and health status of birds while BLM appeared to have compromised their health status on account of the lowered protein content.

The supplementation of broiler diets with spices significantly (P<0.05) lowered the serum urea, creatinine and cholesterol contents. Creatinine was, however, higher in birds on GRM compared to the control diet. This study, thus, confirms the lipid-lowering effects of spices and herbs in broilers. The medicinal properties of bitter leaf and ginger rhizome could be the main cause for the lowering effect and improved protein content. There were no synergistic effects of BLM and GRM mixture observed in all parameters measured. These results are in line with earlier reports on the blood characteristics of broilers following bitter leaf or ginger products supplementations (Zomrawii, 2012; Oleforuh-Okoleh *et al*., 2015). The hypocholesterolemic activity observed could be due to the de-conjugation of gall bladder acids in the small intestine, thus preventing the absorption of cholesterol. These free gall bladder acids can also attach to bacteria and fibers, thereby causing an increased bacteria excretion.

Table 5: Serum profile of broilers as fed dietary bitter leaf and ginger meals

Parameters	Control	BLM	GRM	(BL +GR)	SEM
Total protein (g/dl)	3.20[b]	2.30[c]	3.49[a]	3.10[b]	0.05
Albumin (g/dl)	1.70[b]	1.30[c]	2.10[a]	1.60[b]	0.05
Globulin (g/dl)	1.50[a]	1.00[b]	1.40[a]	1.50[a]	0.01
Urea (g/l)	10.38[a]	0.90[c]	0.90[c]	9.49[b]	0.12
Creatinine (g/l)	42.40[b]	37.30[c]	82.90[a]	31.80[d]	0.16
Cholesterol (mg/100ml)	2.50[a]	1.70[bc]	1.60[c]	1.80[b]	0.05

Conclusion

This study has shown that 0.25% supplementation of broiler diets with bitter leaf meal (BLM) and ginger rhizome meal GRM) and 0.125% each of BLM and GRM in a mixture did not affect the final weight, feed intake, feed conversion ratio, carcass, eviscerated weight and relative proportions of the prime cuts. The diet supplementation of the birds increased blood parameters and blood serum characteristics which effects boosted the immune status and health of broiler chickens.Diet supplementation with spices is not detrimental to the performance of birds, improves meat quality through the lipid-lowering effects and should be recommended for broiler production.

References

Agiang, E. A.,Oko, O. O. K. and Essien, G. E. (2011). Quails response to aqueous extract of bush marigold (*Aspilia africana*) leaf. *American Journal of Animal and Veterinary Sciences*6(3):130-134.www.thescipub.com/pdf/10.3844/ajavsp.2011.130.134pdf.

Castanon, J. I. R. (2007). History of the use of antibiotic as growth promoters in European poultry feeds. *Poultry Science* 86:2466-2471. doi:10.3382/ps.2007-00249.

Dieumou, F.E., Teguia, A., Kuiate, J. R., Tamokou, J. D., Fonge, N. B. and Dongmo, M. C.(2009). Effects of ginger and garlic essential oils on growth performance and gut microbial population of broiler chickens. *Dev*. 21: 25-34.

Dorman, H. D. J. and Deans, S. G. (2000). Antimicrobial agents from plants: Antibacterial activity of plant volatile oils.*J. Appl. Microbiol*. 88: 308-316.

El-Deek, A. A., Attia, Y. A., Maysa, M. and Hannfy, M. (2002). Effect of anise (Pimpinella anisum) ginger (Zingiber officanale Roscoe) and fennel (Foeniculum vulgare) and their mixture on performance of broilers. Archive Geflügelkd 67: 92-96.

Eltazi, S. M. A. (2014). Effect of using ginger powder as natural feed additive on performance and carcass quality of broiler chicks. *Assiut Vet. Med. J*. 60(141): 87-95.

Ghasemi, H.A. and Taherpour, K. (2015). Comparison of broiler performance, blood biochemistry, hematology and immune response when feed diets were supplemented with ginger essential oils or mannan-oligosaccharide. *Iranian Journal of Veterinary Medicine* 9(3): 195-205.

Great, H. (2003). Plants and plant extracts for improving animal productivity. *Proc. Nut. Soc*. 62: 279-290.

Hashemi, S.R. andDavoodi, H. (2011) Herbal plants and their derivatives as growth andhealth promoters in animal nutrition. *Vet Res. Commun*. 35: 169-180.

Igbakin, A. P.(2009). Comparative studies on the hypoglycaemic, hypoproteinaem, hypocholesterolaemic and hypolipidaemic properties ethanolic and normal saline extracts of the root of *V. amygdalina* in diabetic rats. *Advances in Environmental Biology* 3 (1): 33-38.

Kafaru, E. (1994). Immense Help for Natures Workshop. Publication of Elkaf Health Services Ltd, Benin-city, Nigeria: 54-58.

Kececi, O., Oguz, H., Kurtoglu, V. andDemet, Ö.(1998). Effects of polyvinyl-polypyrrolidone, synthetic zeolite and bentonite on serum biochemical and haematological broiler chickens during aflatoxicosis. *Br. Poult. Sci*. 39: 452-458.

Lucas, A.M. and Jamroz, C. (1961) Atlas of Avian Hematology. Agriculture Monograph. USDA, Washington, DC, USA.

Mohammed, A. A. and Zakariyàul, A. S. (2012). Bitter leaf (*Vernonia amygdalina*) as feed additives in broiler diets. *Research Journal of Animal Sciences* 6(3): 38-41.

Oko, O. O. K. and Agiang, E. A. (2011). *Aspilia africana* leaf meal as an egg booster and yolk colourant in quails. *International Journal of Agriculture. 3(1): 103-108.*

Oko, O. O. K. and Etukudo, N. M. (2011). Effects of single leafy spices on growth and carcass characteristics of broilers. *Nigerian Journal of Animal Science* 13: 123- 132. www.ajol.info/index.php/tjas/article/view/80099.

Oko, O. O. K., Agiang, E. A. and Osim, E. E. (2014). Pharmacognosy of *Aspilia africana* plant: Phytochemistry and activities. *Bioactive Phytochemicals: Perspectives for Modern Medicine* 2: 383-409.

Oko, O.O. K., Agiang, E. A., Agwunobi, L. N., Eyoh, G. D., Ozung, P. O. and Asuquo, B. O. (2014). Effects of feed form on dietary *Aspilia africana* leaf utilization by broilers. Science into Practice, Conference on Animal Science. BSAS/AVTRW/EBLEX/WPSA/ KTN, Jubilee Campus Nottingham University, April14-19, Nottingham, UK. Paper 203. *Journals. Cambridge.org/article _ S2040 470 0 1 4- 000016.*

Oleforuh-Okoleh, V. U., Olorunleke, S. O. andNte, I. J. (2015). Comparative response of bitter leaf (*Vernonia amygdalina*) infusion administration on performance, haematology and serum biochemistry of broiler chicks. *Asian Journal of Animal Science* 9(5): 217-224.

Owen, O.J. and Amakiri, A.O. (2011). Serological and haematological profile of broiler finishers fed graded levels of bitter leaf (*Vernonia amygdalina*) meal. *Adv. Agric. Biotechnol.* 1: 77-81.

Owen, O.J., Amakiri, A.O., and Karibi-Botoye, T. A. (2011). Lipid-lowering effects of bitter leaf (*Vernonia amygdalina*) in broiler chickens fed finishers' mash. *Agriculture and Biology Journal of North America* 2 (6): 1038-1041. doi:10.5251/abjna.2011.2.6.1038.1041.

Ravindran, P.N. and Babu, K.N. (2005) Ginger the Genus Zingiber, CRC Press. Florida, USA

SAS Institute (2001). SAS/STAT User's guide for personal computer release 6.12. SAS Institute, Inc., Cary, N. C., USA.

Seifi, S. (2013). An investigation of the effects of using an enzyme-probiotic combination on broilers performance. *Iran J. Vet. Med.* 7: 299-304.

Toghyani, M., Toghyani, M.,Gheisari, A., Ghalamkari, G. and Mohammad rezaei, M. (2010). Growth performance, serum biochemistry and blood hematology of broiler chicks fed different levels of black seed (*Nigella sativa*) and pepper mint (*Mentha piperita*). *Livest. Sci*. 129: 173-179.

Valiollahi, M. R., Rahimian, Y., Miri, Y. and Rafiee, A. (2013). Effect use ginger (*Zingiber officinale*), black pepper (*Piper nigrum* L) powders on performance, some blood parameters and antibody titer against new castle vaccine on broiler chicks. *Scholarly Journal of Agricultural Science* 3(12): 535-540.

Yalçin, S., Yalçin, S., Uzunoglu, K., Duyum, H. M. and Eltan, O. (2012). Effects of dietary yeast autolysate (*Saccharomyces cerevisiae*) and black cumin seed (*Nigella sativa* L.) on performance, egg traits, some blood characteristics and antibody production of laying hens. *Livestock Sci*. 145: 13-20.

Zomrawii, W. B., Abdel, A. K. H. A.,Dousa, B. M. and Mahala, A. G. (2012). The effects of ginger root powder (*Zingiber officinale*) supplementation on broiler chicks' performance, blood and serum constituents. *Online J. Animal and Feed Res.* 1(6): 457-460.

Relationships between growth indices and grain yields in three maize genotypes under different planting densities in the tropics

A. B. Olaniyan
Department of Agronomy, Faculty of Agriculture and Forestry, University of Ibadan, Nigeria
Email: abolaniyan@yahoo.com

Abstract: The relationships between four groups of growth indices and grain yield were assessed in commercial maize genotypes grown at four planting densities in the early and late seasons of 2014 at Ibadan, Nigeria. The growth indices considered were morphological parameters, growth rates, dry matter and yield components. The results indicated that significant correlations existed between grain yield and number of leaves, stem girth, leaf area index, leaf area duration and yield components in both seasons. Grain yield is no doubt a complex quantitative trait that depends on a number of factors, however, in the selection for increased grain yields, growth indices that are consistently correlated with grain yield should be of high priority.

Keywords: Commercial, genotype, morphological parameters, quantitative

Introduction

In Nigeria, as in other tropical countries, maize is grown mainly for the grain. A high grain yield, has a salutary effect on the farmer's income and, therefore, his well-being. At present, the maize grain yield in farmers' plot is low compared to grain yields obtained by farmers in temperate regions. The dramatic improvements in maize grain yields documented for the United States, Argentina, Canada, France and Germany have been attributed largely to genetic gains made by plant breeders, superior agronomic management practices increasingly adopted by growers and the interaction between these two.

In selection for improved grain yield in these temperate countries, maize breeders had placed much emphasis on grain yield and/or beneficial morpho- physiological traits for optimum production in the commonly encountered environments for commercial maize production (Duvick, 2005; Tollenaar and Lee, 2002; Lee and Tollenaar, 2007). Many morpho-physiological traits that were directly or indirectly selected for by maize breeders are now the characteristics of today's commercial genotypes in developed countries (Boomsma *et al*., 2009). In Nigeria and other sub-Saharan countries, apart from the perfunctory attention given to cultural practices such as appropriate density of planting, rate and frequency of fertilizer application, disease and pest control which individually and collectively influence grain yields, the genetic composition of the maize also contributes significantly to the yield of maize. Breeding programmes geared towards improving the genetic composition of maize had been given some attention but which mainly involved breeding for disease resistance to ensure stable high yield, the evolution of early maturing varieties and production of hybrids adapted to different ecologies (Kim *et al*., 1997, Fajemisin, 2015).

The programme omitted to breed for varieties with some desirable growth indices. This study is therefore designed to examine the growth indices in maize which have direct relationships to increased grain yield and which can be selected by plant breeders in their breeding programmes for increased maize grain yield.

Materials and Methods

The density experiments were carried out in the early and late seasons of 2014 on the Teaching and Research Farm, University of Ibadan, Nigeria (7° 20'N, 3°54'E). The experiment in each season was a randomized complete block design comprising of three maize genotypes: one hybrid (Oba Super 1) and two open pollinated genotypes (Suwan-1 and Suwan-2) and four densities: 37,000 plants/ha (90×30 cm); 53,333 plants/ha (75×25 cm); 66,667 plants/ha (60×25 cm) and 80,000 plants/ha (50×25 cm) replicated three times. The land was cleared, ploughed and harrowed before planting and plot size was 6×4 m. The three maize varieties were sown at two seeds. hole^{-1} and thinned to one seedling. hill^{-1} two weeks after sowing. Weeds were controlled by application of herbicide and supplemented manual weeding. Fertilizer was applied at the rate of 90 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha. The N was split applied at two weeks after planting and tassel stage. From each experimental plot, data were taken on morphological

parameters which include plant height, the number of leaves/plant and stem girth on five competitive plants tagged for data collection. Single-photon avalanche diode (SPAD) measurements were taken on all tagged plants using a Konica Minolta SPAD-502 Chlorophyll meter. Leaf area was measured using the LICOR 3000 leaf area meter. Destructive sampling began at five weeks after sowing and continued bi-weekly until 13 weeks after sowing. At each sampling, 4 plants were harvested per plot and separated into leaves, stem, root, tassel and ear depending on the stage of growth. Dry weights were determined after the plant parts were dried for 48 hours at 80°C in a force drought oven to constant weight. From the dry weights and the leaf area measurements, crop growth rate (CGR), net assimilation rate (NAR), leaf area index (LAI), leaf area ratio (LAR) and leaf area duration (LAD) were computed based on the formulae used by Watson (1952) and Radford (1967). Grain yield at maturity and yield components were determined. Correlation coefficients were determined between grain yield and morphological parameters using Generalized Linear Model (GLM) procedure (SAS Institute 2012).

Table 1: Correlation coefficients of the relationship between grain yield and some morphological traits of three maize varieties grown under different density levels in Ibadan, Nigeria.

	Early season	Late season
Plant height	0.16ns	0.20ns
No of leaves	0.47**	0.35*
Stem girth	0.58**	0.30*
Plant aspect	-0.26ns	-0.15ns
Anthesis -silking	0.05ns	0.21ns

*, **, = significant at p=0.05, and 0.01 respectively, ns=not significant.

Results and Discussion

Correlation studies provide a better understanding of the association of different characters to grain yield. Any growth parameter or index that is highly related to grain yield which is the final product the farmer wants in his maize crop will no doubt increase the grain yield. In the morphological parameters examined, the number of leaves and stem girth were positively correlated with grain yield in both seasons while no significant correlation existed between plant height and anthesis-silking interval with grain yield (Table 1).

Plant aspect gave negative non-significant values with grain yield. Positive correlations between stem girth, the number of leaves and grain yield obtained in this study are similar to earlier results reported by Lucas (1981). The leaves being the main photosynthetic site for production of assimilates if present in ample number will no doubt have a salutary effect on assimilate partitioning for the grain development. Significant positive correlation between grain yield and stem girth indicated that assimilates could be deposited in the stem which will be later remobilized to the grain at the critical grain filling period when assimilates from leaves are dwindling due to leaf senescence. Remobilization of stem assimilates to grain in maize had been found to be important in increased grain yield of maize in the temperate and tropical regions (Daynard *et al.,* 1977; Osafo 1976; Lucas, 1981). Generally, the negative relationship between plant aspect and grain yield is expected because the plant aspect is the visual scoring of plants on scale of 1 to 10 where 1 is the best for vigorous, appealing, no lodging nor disease symptom with the plant carrying the first ear at the middle of the plant while 10 is allocated to the worst. With regards to the relationship between grain yield and growth rates, leaf area, LAI, LAR, CGR LAD, NAR were generally consistent in both seasons (Table 2)

Table 2: Correlation coefficients of the relationship between grain yield and growth rates of three maize varieties grown under different density levels in Ibadan, Nigeria.

	Early season	Late season
Leaf area	0.03ns	0.13ns
LAI	0.52**	0.68**
LAR	0.03ns	0.13ns
CGR	0.16ns	0.17ns
LAD	0.58**	0.56**
NAR	-0.57**	-0.51**
SPAD	0.07ns	0.01ns

*, **, ***= significant at p=0.05, 0.01 and 0.001 respectively, ns=not significant.

At each season, leaf area, LAI, and LAD were correlated significantly with grain yield. This result emphasizes the importance of photosynthetic capacity of leaves as measured by LAI and its duration by LAD. LAI describes the size of the assimilatory apparatus of the plant stand and serves as a primary value for calculating other growth parameters. LAI is the primary factor that determines crop growth rate in crop communities and the two growth indices have been described as the major determinants of grain yield (Sun *et al*., 1999; Richards, 2000).

No significant correlations were obtained between LAR, CGR and grain yield. A significant negative correlation existed between NAR and the grain yield. NAR is largely the net result of carbon gain (photosynthesis) and carbon losses (respiration, exudation, and vitalization) expressed per unit leaf area. NAR has been shown to be negatively correlated with LAI and all factors that bring about increase in LAI (Lucas, 1981; 1986).

No significant relationship was found between SPAD readings and grain yield in this study, Studies in maize have indicated that SPAD readings can provide a rapid accurate indirect indication of leaf N (Dwyer *et al*., 1991) and chlorophyll content and also can serve as a measure of leaf absorbance (Earl and Tollenaar, 1997). The result obtained in this study probably may be due to the fact that the plants received the same amount of fertilizer which reflected in the duration of the leaves because of population differences but did not correlate with the grain yield.

Optimum total dry weight was found to be correlated with final grain yield (Table 3).

Table 3: Correlation coefficients of the relationship between grain yield and constituents dry weight of three maize varieties grown under different density levels in Ibadan, Nigeria.

	Early season	Late season
Total dry weight	0.44**	0.71**
Leaf dry weight	0.55**	0.69**
Root dry weight	0.38*	0.49**
Stem dry weight	0.58**	0.55**
Tassel dry weight	0.47**	0.29*
Ear weight	0.51**	0.38*

*, **, ***= significant at p=0.05, 0.01 and 0.001 respectively, ns=not significant.

The results also revealed significant positive correlation between dry weights of all the plant parts and the grain yield per plant. A maize plant which is sturdy will no doubt have enough reserve of assimilates to translocate to the grain and thereby produce high harvest index as found out by Lucas (1981) in some maize varieties. Correlation coefficients among the yield components considered were significant in both seasons (Table 4).

Table 4: Correlation coefficient of the relationship between grain yield and components of the yield of three maize varieties grown under different density levels in Ibadan, Nigeria.

	Early season	Late season
Cob length	0.77**	0.71**
Cob diameter	0.66**	0.77**
Kernel rows	0.55**	0.43**
No of kernels/row	0.69**	0.78**
Seed mean weight	0.41*	0.55**
Cob weight	0.81**	0.85**

*, **, ***= significant at p=0.05, 0.01 and 0.001 respectively, ns=not significant.

Generally, the relationships between the yield components and grain yield were positive and significant. Numerous studies have revealed the strong and highly significant relationships between grain yields and yield components not only in maize but in other cereal crops like wheat (Sokoto *et al*., 2012). Therefore, in the selection for grain yield, these yield components should be major traits to consider (Bocanski *et al*., 2009). It has been observed that the morphological parameters such as a number of leaves and stem girth; physiological traits like NAR, CGR, LAI as well as components of yield are not usually considered when plant breeders select maize plants for high yield because they need to be measured. From this study, these indices have strong positive significant relationships with grain yield and are, therefore, recommended for consideration by plant breeders in the breeding programme.

Acknowledgment: The author wishes to thank Miss Enoobong Udo of Maize Improvement Program, IITA, for her help in the field, laboratory, and statistical analysis. The editorial assistance of Prof E.O. Lucas, Department of Agronomy, Faculty of Agriculture and Forestry is highly appreciated.

References

Bocanski, J., Sreckov, Z. and Nastasic, A. (2009). Genetic and phenotypic relationship between grain yield and components of grain yield of maize (*Zea mays* L). *Genetica*, 41 (2): 145-154.

Boomsma, C.R., Santini, J.B., Tollenaar, M. and Vyn, T.J. (2009). Maize morphophysiological responses to intense crowding and low nitrogen availability: An analysis and review. *Agronomy Journal*, 101(6): 1426-1452.

Daynard, T.B., Tolleenar, M. and Edmeades, G.O. (1977), Ontario research on maize physiology. *Annals of Applied Biology* 87: 245-250.

Duvick, D.N. (2005). The contribution of breeding to yield advances in maize (*Zea mays* L). *Advances in Agronomy*, 86: 83-145.

Dwyer, L.M., Tollenaar, M. and Houwing, L. (1991). A non-destructive method to monitor leaf greenness in corn. *Can. J. Plant Science* 71: 505-509.

Earl, H.J. and Tollenaar, M. (1997). Maize leaf absorbance of photosynthetically active radiation and its estimation using a chlorophyll meter. *Crop Science* 37: 436-440.

Fajemisin, J.M. (2014). The revolutionary trend of maize in Nigeria. My Memoir. Published in Nigeria by Phalory Book Works 176pp

Kim, S. K. (1997). Achievement, challenges and future direction of hybrid maize research and production. In: Badu-Apraku, B., Akoroda, M.O., Oedraw, M. and Quin, F.M (eds). *Proceedings of Hybrid Maize Workshop, May 29th-June 2nd 1995. IITA, Cotonou*, Benin Republic.

Lee, E.A. and Tollenaar, M. (2007). Physiological basis of successful breeding strategies for maize grain yield, *Crop Science*, 47 (S3): S202-S215.

Lucas, E.O. (1981). Potentials of physiological parameters in maize yield in humid tropics. Paper presented at the 4th AAASA General Conference, Cairo-Mariut, October 23-31, 1981.

Lucas, E.O. (1986). The effect of density and nitrogen fertilizer on the growth and yield of maize (*Zea mays* L) in Nigeria. *Journal of Agricultural Science* (*Cambridge*) 177: 573-578.

Osafo, D.M. (1976). Weather conditions and the growth of maize in Kumasi area of Ghana 3: The distribution of shoot dry matter. *Ghana Journal of Agricultural Science* 9: 35-41.

Radford, P.J. (1967). Growth analysis formulae-their use and abuse. *Crop Science*, 7: 171-175.

SAS Institute (2012). SAS User's guide: Statistics, SAS Institute Amazon.com.

Sokoto, M.B., Abubakar, I.U. and Dikko, A.U. (2012). Correlation analysis of some growth, yield, yield components and grain quality of wheat (*Triticum aestivum*). *Nigerian Journal of Basic and Applied Science* 20 (4): 349-356.

Richards, R.A. (2000). Selectable traits to increase crop photosynthesis and yield of grain crops. *Journal of Experimental Botany* 51(1): 447-458

Sun, Y.F., Liang, J.M., Ye, J. and Zhu, W.Y. (1999). Cultivation of super high yielding rice plants. *China Rice* 5: 38-39.

Tollenaar, M. and Lee, E.A. (2002). Yield potential, yield stability and stress tolerance in maize. *Field Crops Research*, 75: 161-169.

Watson, D.J. (1952). The physiological basis of variation in yield. *Advances in Agronomy*, 4:101-145.

The Avifauna Distribution and Diversity in the Northern Region of Cross River State, Nigeria.

*** [1]O.O. Ogunyemi,[1]J. O. Orimayeand [2]E. F.Okosodo,**

[1]Department of Forestry, Wildlife and Fisheries Management, Ekiti State University, P. M. B. 5363, Ado-Ekiti. Nigeria

[2]Department of Ecotourism and Wildlife Management, The Federal University of Technology, Akure

*Corresponding author: e-mail: olumideogunyemi80@yahoo.com

Abstract: The diversity and abundance of bird species inhabiting the northern region of Cross River State were investigated from January to December 2012. Three vegetation types within the region: tropical high forest, derived guinea savanna, and montane/grassland vegetation types were evaluated for analysis of the association of the bird species. Transect count method was used to collect data on bird species composition and abundance in 30 plots randomly and equally distributed and established in the three vegetation types. Fifty-seven (57) bird species belonging to fifteen (15) orders and nineteen (19) families were identified. The highest species richness was recorded in the tropical high forest with 47 compared to 42 in the derived guinea savanna and 30 in the montane/grassland vegetation type. The Order Passeriformes constituted the predominant group representing 36.84% of families (n=7) and 18.75% of species (n=9). Most of the bird species were resident (87.72%) and based on relative abundance value, fall into rare and uncommon bird species. Species abundance and diversity varied between the three vegetation types. The tropical high forest vegetation had the highest species abundance and species richness compared to derived guinea savanna and montane/grassland. Shannon diversity index indicated that the derived savanna vegetation had species diversity (H=3.18) than the other two vegetation types.

Introduction

Cross River State in Nigeria is one of the remaining most forested states endowed with high biodiversity. Keay (1959) classified the vegetation of the state as forest eco-climate consisting of mangrove forest freshwater swamp, lowland rain forest, derived guinea savanna and montane/grassland vegetation. The avifauna content of the vegetation hasa great potential for tourism and recreation, serves as a good indicator for monitoring environmental changes and can be used for environmental impact assessment studies because of the sensitivity to changes in the environment.

Despite the considerable interest shown in the conservation of Nigerian ecosystems in recent years, little attention has been focused on the associated bird life, its inventory monitoring, distribution, and abundance. Although, bird life resources continue to sustain the rural dwellers in Cross River State, the danger in it is the decimation of these valuable resources almost at the point of extinction. Elgood (1982) asserted that the ecosystems in Nigeria support a larger diversity of biomass of birds which is traditionally exploited and largely unmanaged except when some species are set aside as sacred.

Under proper management, birdlife is an important resource to mankind's existence through the roles it plays in the balance of ecosystems, as a preferred material for research and a major base for the recreation and tourism industry. This paper reports an evaluation of the species abundance and diversity of bird resources inhabiting the vegetation zones of the northern region of Cross River State, Nigeria.

Materials and Methods

The study was conducted in the northern part of Cross River State, Nigeria. Cross River State lies within the tropics and is located between latitude 4° 24', and 6° 53' North and longitude 7° 50' and 9° 28' East. The climate of the state is tropical with an average temperature of 26°C all the year round and high relative humidity. The rainy season has an average of 180days in the northern part of the state. The mean annual rainfall varies from about 2,500 mm to 4,000 mm with a dry season between November and March. The vegetation of the study area is diverse and has been described by Keay (1959) to fall into the forest eco-climate vegetation, where the forest is a mixture of pure forest stands (55%), grassland and secondary forest. The dominant tree species include fruits and seeds producers such as Oil palm *(Elaeis guineensis)*, African pear (*Dacroydes edulis*), African oil bean *(Pentaclethra macrophylla)*, African star apple (*Chrysophyllum albidum)*, African mahogany*(Afzelia africana)*, African walnut *(Cola edulis)* and African pearwood *(Baillaonella toxisperma).*

Survey of Avifauna

The census method was used to survey the abundance and diversity of avifauna species of the northern Cross River State. The survey was conducted on monthly basis from January to December, 2012 using 10plots distributed in approximately 60 hectares (ha) in each of the three vegetation types: tropical high forest, montane/grassland and derived guinea savanna using the transect count method described by Burnham *et al.* (1981). The stratified random sampling technique (Thakur *et al.* 2003) which involved the division of sites into different strata based on vegetation types was adopted. The relative value for attracting different bird species was determined by the establishment of one transect of 1kilometer (km) length in each of the 10 plots. The birds were observed by walking along the established transects for three consecutive days every month. Data collection commenced about 30 minutes after dawn and was carried out for five hours daily from 6:30 to 10:00am in the morning and 4:30 to 600pm in the evening to coincide with the time the activities of birds were prominent (Jones 1998).

A record was made of all the types and the group number of bird species through direct observation. The birds were observed with the aid of binoculars (Olympus 10 x 42) to the species level and categorized to the taxonomic groups based on Field Guides to Birds of Western Africa (Borrow and Demey, 2004) and Field Guides to Birds of Africa (Mackworth-praed and Grant, 1970). Other materials employed in the study were a compass equipped with a sighting mirror and Global Positioning System (GPS).

Data analysis

The cumulative list of bird species recorded in each vegetation zone was used as a basic measure of avian richness. The relative abundance of avian species was determined using the encounter rate that gives crude – ordinal scales of abundance (abundant, common, fairly common uncommon and rare) (Bibby *et al.*, 1998). Encounter rate incorporates the field hours of observation and the number of individuals of each species observed. This allows encounter rate to be calculated for each species by dividing the number of birds recorded by the number of hours spent searching, giving a figure of birds per hour for each species.

The abundance categories ≤ 1.0, (rare) 1.1-2.0, (uncommon) 2.1-10.0, (fairly common) 10.1-40.0 (common) and >40 (abundant) was employed. Birds' diversity was calculated using Shannon-Weiner and Simpson's diversity indices.

One-way analysis of variance (ANOVA) was used to analyze the variation in bird species composition between vegetation types. The General Linear Model (GLM) procedure of SAS (2003) package was used. Differences were considered statistically significant at 5% level. The data were further analyzed to calculate species richness index, species evenness index, Sorensen index of similarity, Margalef diversity index and Simpson's index of dominance.

Results

Table 1 shows the avian distribution in the different vegetation zones of northern Cross River State. A total of fifty-seven (57) bird species belonging to fifteen (15) orders and nineteen (19) families inhabited the varying vegetation types.

The order Passeriformes constituted the predominant group with 7 families and 9 species at 36.84% and 18.75% respectively. The families with the largest number of species were Accipitridae (n=8) and Columbidae (n=7) (Fig 1).

The bird species were unequally distributed within the three vegetation types. Forty-seven (47) bird species belonging to 15 orders and18 families were recorded in the tropical high forest, with 43 species resident and 4. In the derived guinea savanna, 42 bird species belongings to 15 orders and 19 families were observed (Table 2). Out of these,38were residents while 4 were migratory. The montane/ grassland vegetation recorded 30 bird species belonging to 11 orders and 15 families out of which 26 bird species were residents and 4 migratory (Figure 2). The species composition of birds observed in the different vegetation types was not significantly different (F = 0.2011, P> 0.05). The study revealed that the number of species, order, and families recorded was higher in the tropical high forest and derived guinea savanna vegetation types than in montane/grassland vegetation. The bird species exclusively observed were 7(14.89%) 3 (7.14%), and 5 (16.67%), in the tropical high forest, derived guinea savanna and montane/grassland vegetation respectively (Table 2).

One thousand and forty-one (1,041) individual birds were recorded in the study area with the highest number of sightings in the tropical high forest (434) followed by derived guinea savanna (366) while the montane/ grassland vegetation had the least(241) (Table 3).

Also, the number of individual bird species observed in the vegetation types were not significantly different (F2, 168 =S 1.392, P>0.05). The highest species diversity (D) was recorded in tropical high forest. Also, the highest species evenness was registered in montane/grassland vegetation type (Table 4). Based on the Margalef diversity index (H^1), the tropical high forest with index value of 7.57 had the highest species diversity followed by the derived guinea savanna with 6.95 while the montane/ grassland had the least species diversity.

Table 1: Avian Distribution based on family, order and species in the varying vegetation types of Northern Region of Cross –River State.

S/N	Name of the Bird	Scientific Names	Order	Family	Status
1.	Tawny Eagle	*Aquila rapax*	Falconiformes	Accipitridae	R
2.	African marsh Harrrier hawk	*Circus ranivorus*	Falconiformes	Accipitridae	R
3.	Black kite	*Milvus migrans*	Falconiformes	Accipitridae	R
4.	Black Sparrow hawk	*Accipiter melanoleucus*	Accipitriformes	Accipitridae	R
5.	Grey-headedking fisher	*Halcyon leucocephala*	Coraciifoemes	Alcedinidae	R
6.	Little African Swift	*Apus afinis*	Apodiformes	Apodidae	R
7.	Common Swift	*Apus apus*	Apodiformes	Apodidae	R
8.	Cattle Egret	*Bubulcus ibis*	Pelecaniformes	Ardeidae	R
9.	Little Egret	*Egretta garzetta*	Pelecaniformes	Ardeidae	R
10.	Grey – cheeked Hornbill	*Bycanistes subcylindricus*	Ciconiiformes	Bucerotidae	R
11.	Black casqued Hornbill	*Ceratogymaatrata*	Ciconiiformes	Bucerotidae	R
12.	Red – billed Dwaf Hornbill	*Tockus camurus*	Ciconiiformes	Bucerotidae	R
13.	Long – tailed Hornbill	*Tropicranus albocristatuscassini*	Ciconiiformes	Bucerotidae	R
14.	Naked faced Barbet	*Gymnobucco calvus*	Piciformes	Ramphastidea	R
15.	Yellow Spotted Barbet	*Buccanodon duchaillui*	Piciformes	Ramphastidea	R
16.	Red – rumped Tinked bird	*Pogoniulus atroflavus*	Piciformes	Ramphastidea	I
17.	Yellow – billed Barbet	*Trachylaemus purpuratus*	Piciformes	Ramphastidea	R
18.	Standard-winged Nightjar	*Maccrodipteryx longipennis*	Caprimulgiformes	Caprimulgidae	R
19.	African Green pigeon	*Treron calvus*	Columbiformes	Columbidae	R
20.	Blue – headed wood Dove	*Turtur brehmeri*	Columbiformes	Columbidae	R
21.	Tambourine Dove	*Turtur tympanistria*	Columbiformes	Columbidae	R
22.	Pied crow	*Corvus albus*	Passeriformes	Corvidae	R
23.	Senegal cocial	*Centropus senegalensis*	Cuculiformes	Cuculidae	R
24.	Black cuckoo	*Cucuilus clamosus*	Cuculiformes	Cuculidae	I
25.	Common cuckoo	*Cuculus canorus*	Cuculiformes	Cuculidae	R
26.	Lanner	*Falcon biarmicus*	Falconiformes	Falconidae	I
27.	Common kestrel	*Falco tinnunculus*	Falconiformes	Falconidae	I
28.	Black Bee-eater	*Merops gularis*	Coraciiformes	Meropidae	R
29.	Little Bee-eater	*Merops pusillus*	Coraciiformes	Meropidae	I
30.	Olive sunbird	*Cyanomitra olivacea*	Passeriformes	Nectariniidae	R
31.	Superb sunbird	*Cinnaris superbus*	Passeriformes	Nectariniidae	R
32.	African Yellow Warbler	*Chloropeta natalensis*	Passeriformes	Sylviidae	I
33.	Scaly Francolin	*Francolinus squamatus*	Galliformes	Phasianidae	R
34.	Black-headed weaver	*Ploceus melanocephalus*	Passeriformes	Ploceidae	R
35.	Village weaver	*Ploceus cucullatus*	Passeriformes	Ploceidae	R
36.	Yellow-billed Turaco	*Tauraco macrorhynchus*	Musophagiformes	Cuculidae	R
37.	Long-tailed hawk	*Urotriorchis macrourus*	Accipitriformes	Accipitridae	R
38.	Shikra	*Accipiter badius*	Accipitriformes	Accipitridae	R
39.	African Harrier Hawk	*Polyboroides typus*	Accipitriformes	Accipitridae	R
40.	Lizard Buzzard	*Kaupifalco monogrammicus*	Accipitriformes	Accipitridae	R
41.	Palmnut vulture	*Gypohierax angolensis*	Falconiformes	Accipitridae	R
42.	Lemon Dove	*Aplopelia larvata*	Columbiformes	Columbidae	R
43.	Red-eyed Dove	*Streptopelia semitorquata*	Columbiformes	Cocumidae	R
44.	Laughing Dove	*Streptopelia senegalensis*	Columbiformes	Cocumbidae	R
45.	Africa pygmy kingfisher	*Ceyx pictus*	Coraciiformes	Alcedinidae	R
46.	Shining – blue kingfisher	*Alcedo quadribrachys*	Coraciiformes	Alcedinidae	R
47.	Africa grey hornbill	*Tockus nasutus*	Bucerotiformes	Bucerotidae	R
48.	Grey woodpecker	*Dendropicusgoertae*	Piciformes	Picidae	R
49.	Forest swallow	*Petrochelidon fuliginosa*	Passeriformes	Hirundinidae	R
50.	Yellow wagtail	*Motacilla clara*	Passeriformes	Motacillidae	R
51.	Common Bulbul	*Pycronotus barbatus*	Passeriformes	Pycnonotidae	R
52.	Africa Blue Crested fly catcher	*Elminialongicauda*	Passeriformes	Stenostiridae	R
53.	Splendid sunbird	*Nectarinia coccinigaster*	Passeriformes	Nectariniidae	R
54.	Black-billed weaver	*Ploceus melanogaster*	Passeriformes	Ploceidae	I
55.	Africa pied Hornbill	*Tockus fasciatus*	Bucerotiformes	Alcedinidae	R
56.	Western Grey Plantain-eater	*Crinifer piscator*	Musophagiformes	Musophagidae	R
57.	African Pipit	*Anthus cinnamomeus*	Passeriformes	Motacillidae	R

R = resident, I =immigrant

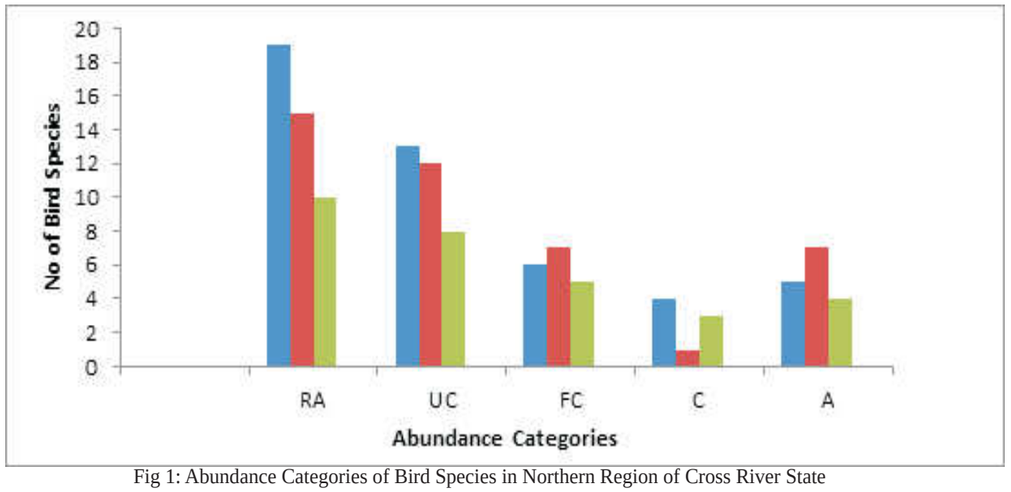


Fig 1: Abundance Categories of Bird Species in Northern Region of Cross River State

RA – Rare, UC – Uncommon, FC-Fairly Common, C-Common, A-Abundant

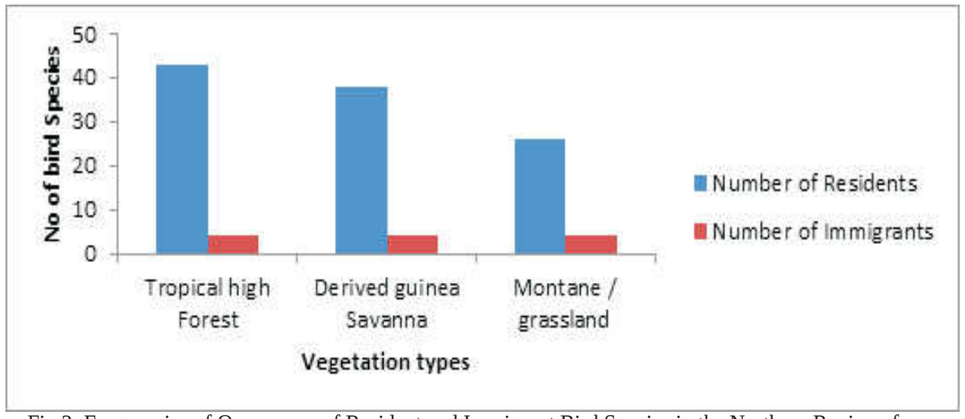


Fig 2: Frequencies of Occurrence of Resident and Immigrant Bird Species in the Northern Region of Cross River State.

Table 2: Order, family and species composition of birds in different vegetation types of the northern region of Cross River State

Vegetation	Order	Family	Species	Exclusive species	Percentage of Exclusive species
Tropical high forest	15	18	47	7	14.89%
Montane/grassland	11	15	30	5	16.67%
Derived guinea savanna	15	19	42	3	7.14%

Table 3: Species richness and abundance of bird species observed in the different vegetation types of the northern region of Cross River State

Vegetation	Species composition	No of sightings	% Abundance
Tropical high forest	47	434	41.69
Montane/grassland	30	241	23.15
Derived guinea savanna	42	366	35.16

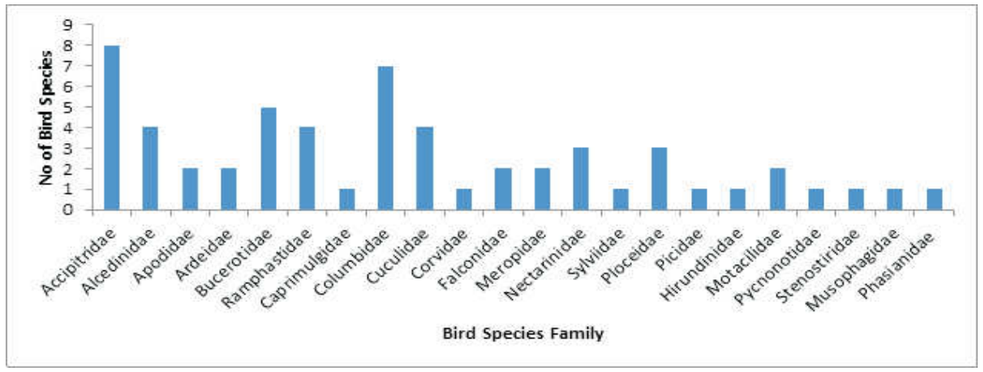


Fig 3: Family composition of bird species in Northern Region of Cross River State.

The Shannon-Wiener and Simpson diversity indices were highest in the derived guinea savanna (3.18, 0.94) followed by tropical high forest (3.16,0.93) while the montane/grassland had the least (2.96, 0.92) respectively. With regard to species evenness indices, the montane/grassland vegetation registered more even distribution of bird species followed by that of derived guinea savanna while the tropical high forest had the least even indicating that some species were more abundant than the others. This reflects on the differences that exist in the efficiency of different bird species to utilize the habitat. Simpson's index of dominance had the highest value in the montane/grassland with the value 0.077, followed by tropical high forest (0.074) while the derived guinea savanna recorded the lowest value (0.064).

Further analysis of the relative abundance of the bird species indicated that out of the bird species inhabiting the vegetation types, 19,15 and 10 were rare, 13,12 and 8 were uncommon, 6,7 and 5 were fairly common, 4,1 and 3 were common, while 5,7 and 4 were in abundant category in the tropical high forest, derived guinea savanna and montane/grassland respectively (Fig 1).

The Sorensen's similarity index for comparing bird species between vegetation types ranked highest between the derived guinea savanna and montane/ grassland vegetation types (97:22%) followed by tropical high forest and montane/ grassland (93.52%) while the lowest was recorded between the tropical high forest and derived guinea savanna vegetation (Table 4).

Table 4: Species richness, diversity indices andevenness for bird species in different vegetation types in the northern region of Cross-River State

Vegetation types / diversity indice s	Tropical high forest	Derived guinea savanna	Montane/Grassland
Species Richness	2.26	2.20	1.93
Total number of individuals (N)	434	366	241
Sorensen index of similarity	0.85 (F & D^S)	0.94(F &MG)	0.97(DS & M/G)
Shannon diversity index	3.16	3.18	2.96
Evenness	0.50	0.57	0.65
Margalef	7.57	6.95	5.29
Simpson diversity index	0.93	0.94	0.92
Dominance	0.074	0.064	0.077

Discussion

Habitat physiognomy transformation is a significant factor that erodes bird species diversity in any given area. Hence bird species diversity is often used to make quick assessment and comparison of different habitats (Wiens, 1989). Very little is known about the diversity, dispersion of birds across the varying vegetation types that constitute the habitats of the northern Cross River State, Nigeria (Ogunyemi and Agbelusi, 2002). The record of fifty-seven (57) bird species during this study shows that bird species diversity in the different vegetation types was low. Also, the bird community was dominated by few species, most of which had a low frequency of occurrence, probably due to the small population size.

The vegetation types also comprised wide ranges of resident bird species. Similar results were found by Melles *etal.* (2003) that forests near urbanized landscapes formed resource areas for resident birds. The variation in bird species composition and abundance among the vegetation types may be due to vegetation heterogeneity which would bring about the variation in food, cover availability, microclimaticvariation, and

The tropical high forest that supports the largest population of bird species comprises of numerous flowering plants whose fruits might be responsible for a high number of bird species recorded. The relative abundance estimates differed and the differences are dependent on vegetation structures. Thus, the tropical high forest and derived guinea savanna contained more bird species, order, and families than the montane/ grassland. Cody (1985); Igi and Ballard (1999) noted that the relative abundance of bird species was higher in habitats dominated by woody vegetation or habitats that are structurally and floristically more diverse. Also, the structural complexity of habitats and diversity of vegetation forms showed significant correlation with fauna species diversity (Gardner *et al.*,1995).

Walwert *et al.* (2004) reported that the higher number of birds in terrestrial habitats may be attributed to the availability of resources providing food and nesting sites. The higher abundance of individual birds in the tropical high forest could also be due to the composition of the vegetation that forms the main element of the habitat (Lee and Rotenberry, 2005; Chapman and Reich, 2007, Salah and Idris, 2013) whereas the lower number of individual birds recorded in the montane/grasslandcould be attributed to the open nature of the vegetation. The differences between the bird species observed and the abundance of individual birds recorded in the vegetation types were not significant even though there were differences in a number of bird species observed and the number of individual birds recorded.

Species richness and diversity indices for derived guinea savanna vegetation and tropical high forest suggest that the bird species observed are different in terms of composition. The tropical high forest and derived guinea savanna showed the highest number of shared bird species (17 species) because these vegetation types had many plant species in common. However, these vegetation types had higher human interferences and the colonization has diversified the food resources available to bird species of different feeding guilds as well as the availability of varied micro-habitats. The highest numbers of rare and uncommon bird species occurring in the tropical high forestare typical of such forests (Lovejoy, 1975). Giller, (1984) had noted that historical and ecological factors influence species richness in a habitat. The identified historical factors are mainly speciation and supply of colonists while the ecological factor relates to mortality from predation by the birds of prey. The highest index of dominance recorded in the montane/grassland is because more of bird species had higher relative abundance values. The dominance of these bird species reveals their survival superiority over other species and hence the high encounter rates, the presence of favourable habitats for certain bird species and high defense against predations.

The study has established that birds' communities exhibit variations among different vegetation types. In the northern region of Cross River State, the physiognomy of the vegetation types played a major role in avifauna distribution and diversity.

References

Afolayan, T.A. and Ajayi, S.S. (1983): The influence of seasonality on the distribution of large mammals in Yankari Game Reserve, Nigeria: *African Journal of Ecology* 18 (1): 87-93.

Bibby, C.J.M. Jones and Marsden, S. (1998): Expedition field Techniques: Bird surveys. Expedition Advisory Centre, Royal Geographical Society, London.

Borrow, N. and Demey, R. (2004): Birds of Western Africa, C. Black Publishers Ltd., 37 Soho Square, London WSD 3 AZ.

Burnham, K.P., Anderson, D.R. and Laake, J.L. (1981) Line transect estimation of bird population density using a fourier series. In: Ralph, C.J. and Scott, M.J. (eds) Estimating the Number of Terrestrial Birds. Studies in Avian Biology No 6. Cooper Ornithological Society.

Champan K.A. and Reich, P.B. (2007). Land use and habitat gradients determine bird community diversity and abundance in suburban, rural and reserve landscapes of Minnesota, U.S.A.*Biol. Conser.* 135:527-541.

Cody, M.C. (1985): Habitat Selection in Birds. Academic Press Inc; California.

Crowel, C.M., Schif, J.C. and Gubb, A.A (1981): Effect of rainfall variation fire vegetation and habitat physiognomy on Northern Animal Community. *South Africa Wildlife Resources* II: 87-104.

Elgood, J.H. (1982): Birds of Nigeria. B.O.U. Pub. England. 246pp

Giller, P.S. (1984): Community Structure and the Niche. Chapman and Hall, 58pp.

Igi, L.O. and Ballard, B.M. (1999): Habitat associations of migrating and overwintering grassland birds of southern Texas. *Condor* 101: 771-782.

Jones, M. (1998). Study design. In: Bibby, C., Jones, M. and Marsden, S. (eds). Expedition Field Techniques, Bird Surveys. Royal Geographical Society with the Institute of British Geographer, London: 15-34.

Keay, R.W.J. (1959): An Outline of Nigerian Vegetation 3rd Edition. Federal Ministry of Information, Lagos.

Lee, P.Y. and Rotenberry, J.T. (2005): Relationships between bird species and tree species assemblages in forested habitats of Eastern North America. *Journal of Biogeogr.* 32: 1139-1150.

Lovejoy, T.E. (1975): Bird diversity and abundance in Amazon forest communities. *Living Bird* 13: 127 - 191

Mackworth-Praed, C.W. and Grant, C.H.B. (1970): The Birds of the West Central and Western of Africa. Vol. 1 and II, Longmans, Green and Company, London, New York.

Margalef, R. (1958): Information theory in ecology systematics 3:36-71.

Melles, S.J. (2001): An Examination of Urban Bird Communities in Relation to the Impact of Urbanization and the Availability of Park Space in the Lower Mainland, BC. Ph. D. Thesis. The University of British Columbia, Vancouver, British Columbia, Canada. pp 201

Ogunyemi O.O. and Agbelusi, E.A. (2002): Avifauna distribution of Cross River State, *Nigerian Journal of Applied Tropical Agriculture* 7(1 and 2): 1-5.

Salah O. and Idris, E. (2013): A note on the bird diversity of two sites in Khartoum, Sudan-Egypt. *Acad. J. Biol. Sci.* 5(1): 1-10.

SAS (2000): SAS User's Guide. Statistical Analysis System (SAS) Institute, Inc, Cary, North-Carolina, U.S.A.

Shannon, C.E. and Weaver, W. (1949): The Mathematical Theory of Communication. University of Illinois Press, Urbana, Illinois.

Simpson, E. H. (1949): Measurement of diversity. *Nature* 163: 688.

Sorenson, T.A. (1948): A method of establishing agroup of equal amplitude in plant sociology based on similarity of species content and its application to analyses of the vegetation on Danish Commons. *Kongelige Danske Videnskabernes Selskabs Biologiske Skrifter, 5, 1–34.*

Thakur, M.L.R., Paliwal, P.C. T. and Maltu, V.C. (2003): Birds of Balh Valley, DistrictMandi, Himachal. Pradesh, India. *Annals of Forestry* 11(1): 113-126.

Walwert, M. A. and Muhlenberg, M. (2004): Effects of land use on bird species richness in Sulawesi, Indonesia. *Conserv. Biol.* 18:1339-1346.

Wiens, J.A. (1989): The Ecology of Bird Communities. Cambridge University Press, Cambridge. 539pp.

Threats to Conservation and Management Effectiveness of Osse River Park, Ondo State, Nigeria

***O.O. Oyeleke, and A. O. Ajayi**
Ecotourism and Wildlife Department
The Federal University of Technology, P.M.B. 704, Akure, Nigeria
E-mail: oooyeleke@futa.edu.ng.

Abstract: Osse River Park falls within the transition between forest and derived savanna zone on the northern edge of Ondo State. A study on the management effectiveness of the park was carried out using Rapid Assessment and Prioritization of Protected Area Management Questionnaire (RAPPAM), observation and oral interviews to assess the threats and pressures facing the reserve and its management effectiveness. Results show that the threats facing the protected area include logging, hunting, expanding human population, forest clearing for agricultural activities and cultivation of Indian hemp (*Cannabis sativa)*. Inadequate staff, ineffective communication, and information, few infrastructure and ineffectively protected area policies affected management effectiveness. Although the social importance of the reserve was high, the contribution to the local economy and its influence on the local and regional economy were low. Boundary demarcation, equipping of staff, provision of transport, communication, and other facilities, as well as employment of enough protection staff to adequately protect the area against encroachment, are among the recommendations made. It is also necessary to create more awareness on the need for biodiversity protection through conservation education. Continuous collaboration and networking with the Nigerian Conservation Foundation and the Nigeria National Park Service will further enhance the status of the reserve.

Keywords: protected area, management, effectiveness, conservation, biodiversity.

Introduction

The last two decades have witnessed tremendous growth in the establishment of protected areas worldwide as a result of the recognition of the many benefits that protected areas can provide. There are over 161,000 protected areas, covering 12.7% of the world's terrestrial area and 1.6% of the global ocean area (Phillips, 2000; CBD, 2008 and Bertzky *et al.,* 2012). Although, protected areas have increased in number by 58% and in their extent by 48% since 1990, yet many of them face management, governance, and financial challenges and half of the world's most important sites for biodiversity are still unprotected (Bertzky *et al.* 2012). Despite the growth in the number of protected areas, issues regarding their effective management have raised concerns among conservation practitioners. Hence, one of the main questions in biodiversity conservation is how effective protected areas are in conserving the species, habitats and other biodiversity features they contain.

The Convention on Biodiversity (CBD) in 2006 encouraged member countries to assess the management effectiveness of at least 30% of their total protected areas by 2010. At the end of 2010, a review of the target achieved revealed that most countries have not yet achieved the goal of assessing at least 30% of their protected areas (Bertzky *et.al.* 2012).

Management effectiveness of protected areas

Protected areas can only be successful tools for biodiversity conservation if they are effectively managed. Management effectiveness of protected areas was of much importance that the IVth and Vth World Park Congresses (1993 in Bali, Indonesia and 2003 in Durbar, South Africa respectively) and the World Forestry Congress included it in their agenda. Also, the World Wide Fund for Nature (WWF), the world's largest environmental organization included the assessment of protected areas as one of its five major goals. Aichi Target 11 and the Convention on Biodiversity (CBD, 2012) Programme of Work on Protected Areas (PoWPA) highlighted the need for effectively and equitably managed protected areas. Also, the CBD encouraged its parties to expand and institutionalize, with the full and effective participation of stakeholders, management effectiveness assessments to cover 60% of the total area of protected areas by 2015.

Management effectiveness evaluation (MEE) is defined as the assessment of how well the protected area is being managed, that is, the extent to which it is protecting values and achieving goals and objectives. The term management effectiveness reflects three main themes: (i) design issues relating to protected area systems (ii) adequate and appropriateness of management systems and processes and (iii) delivery of protected area objectives including conservation of values (Hockings *et al.,* 2006). Effective management ensures that a protected area safeguards its values and achieves the objectives for which it is established (Hockings *et al*., 2006). Effectiveness may also mean that management is tailored towards the particular needs of the area and the ability to adapt to changing needs. Dudley (2008) stated that effective management may also demand certain minimum levels of intervention, for example, in large wilderness areas or "intensive care" and in small habitats or species management areas. According to Bertzky (2012), effective management usually involves a wide range of stakeholders including government agencies, non-governmental organizations (NGOs), private entities, indigenous peoples and local communities. Whatever the means, it is clear that implementing appropriate management for a protected area is fundamental for its effective conservation of biodiversity.

According to Margules and Pressey (2000), management effectiveness assessments are essential components of systematic conservation planning processes. They can help policy makers to identify the discrepancies between design considerations such as protected area representativeness and actual ground conditions, especially forest intactness (Jepson *et al.* 2002). They can identify broad trends in management strengths and weaknesses; indicate areas of high biological and social importance; and reveal the scope, severity, prevalence, and distribution of an array of threats and pressures. By doing so, system-wide protected area assessments can enable policy makers to refine their conservation strategies, re-allocate budget expenditures and develop strategic system-wide responses to the most pervasive threats and management weaknesses (Ervin, 2003).

The importance of adequate management plans must be stressed to take care of the several factors which affect the effectiveness of protected areas. These include their size and location, anthropogenic and other pressures, governance, management and enforcement arrangements in place. The management challenges posing threats to conservation areas such as land encroachment, illegal grazing, poaching, logging, unsustainable agricultural practices and farming in the buffer zones coupled with inadequate manpower especially the protection staffs have made these areas vulnerable. With 30% of Nigeria's protected areas yet to be assessed and lack of adequate information on the effectiveness of the protected areas, there is the need to assess the effectiveness of these protected areas. There are very few protected areas in the south and indeed southwest Nigeria among which is the Osse River Park (formerly Ifon Games Reserve). This study was therefore designed to assess the effectiveness of management in the Osse River Park and identify the various threats and pressures affecting its operations and sustainability.

Materials and Methods

Study area

Osse River Park is located in Osse Local Government Area of Ondo State, Nigeria, in the transition between forest and derived savanna zone found on the north-eastern edge of the state. The Osse River Park was managed as a Forest Reserve (Ifon Forest Reserve), originally gazetted by Notice No. 24 Order of 1930 and Government Gazette No. 2 of 14/01/1951. The potentials of the reserve were first identified in 1963 as a Wildlife Sanctuary for the conservation of certain endemic species noticed in the area. With the creation of Ondo State, the status changed to a Games Reserve for the objective of wildlife conservation and development. Thus, the inventory and survey of wildlife species commenced with the probability of upgrading the Games Estate into a National Park (Afolayan 1990) but this is yet to materialize.

Osse River Park occupies a total land area of 282.70 km^2 and situated between latitude 6^o 40' and 7^o 15'N and longitude 5^o 43' and 5^o 55' E (NCF, 2008; Ondo State Ministry of Natural Resources, 2003). It is bounded by four major towns: Ipele, Idoani, Ifon, Ikaro and several villages among which are Agodaji, Igbojeun, Oke-Ogun, Olabafe, Ago-Igbira, Omolege, Ori-Ohi, Elegbeka, Ofale, Omi-alafa, Ago Alao, Igbo-Nla, Ago Ajeje, Ago Asaboro and Ago Asabia.

Osse River Park is drained by Rivers Osse and Uwesse with their tributaries. The terrain is relatively flat except for some forms of undulating topography in the northern sector. The area experiences two marked seasons: the rainy season (April-October) and dry season (November-March). The annual rainfall ranges between 1270-2000 mm (NCF, 2008).

The park has three major vegetation types: tropical rain forest (high forest) (including the riverine forests along the courses of the major rivers draining the reserve) which covers over 50% of the reserved area (152.22 km^2); woodland of forest-savanna mosaic which covers an area of 130.58 km^2. The savanna woodland consists of trees below 15 m in height and has only three layers: the emergent tree, shrub, mainly *Chromolaena odorata*, and the underground herb layer dominated by grasses. The dominant wood species in the savanna woodland are *Khaya senegalensis, Daniella oliverri, Afzelia africana, Terminalia laxiflora, Anogeissus leiocarpus, Burkea africana, Uapaca togonensis, Parkia biglobosa* etc. The forest zone is characterized by tall trees most of which are emergent trees and above 15 m tall; these include: *Milicia excelsia, Mansonia altissima, Cola gigantia, Terminalia ivorensis, Terminalia superba, Sterculia rhinopetala, Khaya gradifoliola, Brachystegia* spp, *Alstonia* spp, *Kigelia africana* etc (Afolayan, 1990; NCF, 2007). Faunal species of Osse River Park include: African forest elephant (*Loxodonta africana cyclotis*), forest buffalo (*Syncerus cafer nanus*), red river hog (*Portamocerus porcus*), and bushbuck (*Tragelaphus scriptus*), four different species of duikers: black duiker (*Cepahlophus niger*), grey duiker (*Silvicapra grimmia*), red-flanked duiker (*Cephalophus rufilatus*) and Maxwell duiker (*Cephalophus maxwelli*). Others include five different species of long-tailed monkeys, one ape species (Nigerian chimpanzee-*Pan troglodytes vellerosus*) and 117 species of birds including the endemic and globally threatened Ibadan malimbe (*Malimbus ibadanensis*) (Afolayan, 1990; NCF, 2007).

Data Collection

The research was conducted using questionnaire, oral interviews, and field observation techniques. The Rapid Assessment and Prioritization of Protected Area Management (RAPPAM) questionnaire developed by the World Wide Fund for Nature (WWF) (Ervin, 2002) for assessing protected area management effectiveness was used for the study. The questionnaire assessed effectiveness through the following indicators: objectives, legal status and security, site design and planning, biological importance, social importance, regional and local influences, staffs ,communication and information, transportation and facilities, management planning, management practices, research monitoring and evaluation, protected area system design, protected area policies.

Twenty copies of the questionnaire were administered to the workers and retrieved. Assistance was rendered to the few workers who were unable to interpret the questions. The major threats to the area were stated in the questionnaire by the workers without any bias. Also, questions were asked about the key threats and pressures. The degree of each pressure and threat was measured using a 4-point scale adapted from (Ervin, 2003) using the numerical values. A degree of 1 to 3 was considered mild, 4 to 9 moderate, 12 to 24 high, and 27 to 64 severe. In addition to the questionnaire survey, workers of the park were orally interviewed to obtain more information on the management strategies and practices for the park. The staffs were asked about pressures on the park and the factors hindering effective management of Osse River Park. Field assessment was done to have first-hand information on the situation of the park and support zones during which observations were made on intactness and extent of threats (human habitation, poaching, encroachment, and hunting), pressures on the park and to corroborate answers to the questionnaire by the staff.

Data analysis

Information extracted from the questionnaire and the data collected were pooled together. Threat magnitude was assessed for each key value in terms of severity and extent and then compiled into an overall threat summary table (per TNC CAP methods and rules). Protected area values were described in terms of size, condition and landscape context (TNC, 2000). Following this, potential indicators were identified and a threat ratings determined (low to very high), noting the current situation (TNC, 2000). The overall threat rank was established as a means to identify and communicate the degree and nature of threats affecting key values, and the protected area overall. In addition, the overall threats and status were presented in a table to assist in communicating results of the evaluation. Indicators for assessment were analyzed with multivariate analysis using SPSS 18.0.

Results and Discussions

The major threats and pressure on the protected area were: habitat destruction, encroachment, poaching, illegal logging, clearing of forest for agricultural activities, a collection of non-timber forest products (NTFPs) (Table 1). Habitat destruction for agricultural production was severe in the buffer areas of the park. This is an indication that the area is still experiencing the destruction of

land which in no time would be difficult to control even in the park area. Ajayi (1986) had submitted that habitat destruction results from the degradation of land and water ecosystems which includes mass-scale clearing, over-harvesting and the burning of forests for agriculture, mining and development. Afolayan *et al*. (1990) and NCF (2008) identified uncontrolled logging, slashing and burning for agriculture, poor management plan and implementation as the causes of the transformation of the once high forest to the present degraded state.

Table 1: Major threats and Pressures on Osse River Park

Threat	Severity
Habitat destruction	Severe
Encroachment	High
Poaching	High
Illegal logging	Severe
Drug cultivation	High
Hunting	High
Mining	Mild
Harvesting of non-Timber Forest products	High

Source: Field Survey, 2013

Land encroachment into the buffer are of the park was high due to expanding the human population. Legal status and security of the protected area were low (Table 2) because of the absence of any law prohibiting the surrounding communities and villages from access to the area. Moreover, the surrounding communities still lay claims to part of the area. Despite the official information that the protected area had been demarcated, no clearly defined boundaries were observed during the guided assessment/tour.

Poaching on wildlife resources was high. NCF (2008) found that indiscriminate trapping, capturing and killing of wildlife species occurred at an alarming rate in Osse River Park as their range areas and natural habitats had been greatly diminished. Logging was severe in the area and a major threat to the Osse River Park. The impacts include loss of habitat, modification of fire regimes, soil compaction and erosion of soil. Besides, logging may be a precursor to so many other threats (Ervin, 2003). NCF (1997) found that logging is a major cause of forest loss in Osse River Park. The staff of the Ondo State Forestry Department had indicated that illegal logging activities were rampant in and around the park.
Hunting was a major threat to Osse River Park. The park is surrounded by many villages whose socio-economic activities and well-being are tied to the bounties of the forests. Mining activities were mild in the area while harvesting of non-timber forest resources was high. The effects of these activities pose a great threat to the area surrounding Osse River Park.

One of the uses to which the area was put after deforestation of the park is illicit cultivation of Indian hemp (C*annabis sativa*). The Punch, a Nigeria newspaper on 27th August, 2014 reported that "The National Drug Law Enforcement Agency rekindled its war against the growing of cannabis in the South West as it destroyed over 50 hectares of cannabis plantation in Epele Forest Reserves, Ondo State" This corroborates the report of NCF (2007) that vast areas of the reserve have been cleared for this purpose and it is widely believed that most of the Indian hemp farmers emigrated into the reserve from the neighbouring Edo State.

Interview with the staff revealed that the Nigeria Conservation Foundation (NCF) collaborates with Osse River Park in terms of research and monitoring of endangered wildlife species especially the African forest elephant (*Loxodonta africana cyclotis*) and Chimpanzee (*Pan troglodytes*).

Management effectiveness of Osse River Park

Table 2 shows the indicators used to assess the management effectiveness of the Osse River Park. The legal status and security were very low (7.00±2.45) and a weakness. The site design and planning was high (6.20±2.11) and was consistent with the management objectives. The park had high biological importance (6.70±1.48). The site is known for its conservation of the endemic and globally threatened Ibadan malimbe (*Malimbus ibadanensis*) and African forest elephant (*Loxodonta africana cyclotis*). The social importance of the protected area was high (6.20±1.47) reflecting strength. However, the contribution of the park to the local economy (7.70±2.01), as well as the influence of the protected area on the local and regional community, were rated low (12.00±0.00) and represented weaknesses.

The staff strength of the reserve was low (6.00±2.32) reflecting it as weakness and insufficient to effectively manage Osse River

Park. The staff of the Ministry of Agriculture and Forestry Resources often came on secondment to the reserve while the collaboration with Nigerian Conservation Foundation had also resulted in some staff being seconded to the park to strengthen the workforce. Brandon *et al.* (1998) and Terborgh *et al.* (2002) had observed that inadequate staffing was widespread in many protected areas.

Table 2: Indicators used in assessing the management effectiveness of Osse River Park

Report Indicators for assessing the management effectiveness	Yes	Mostly yes	Mostly no	No	Unlikely
Objectives	7.80±1.32^{a}	5.80±0.73^{ab}	0.80±0.80^{de}	0.60±0.60^{d}	0.00±0.00
Legal status and Security	3.60±1.86^{abcd}	1.60±0.68^{cde}	2.80±1.02^{bcde}	7.00±2.45^{ab}	0.00±0.00
Site design and Planning	6.20±2.11^{abc}	4.00±1.34^{abcde}	1.80±1.80^{cde}	3.00±3.00^{bcd}	0.00±0.00
Biological importance	6.70±1.48^{ab}	3.70±0.99^{abcde}	1.70±0.88^{cde}	2.50±1.30^{bcd}	0.50±0.50
Social importance	6.20±1.47^{abc}	4.30±1.16^{abcde}	0.30±0.30^{e}	3.80±1.94^{bcd}	0.44±0.44
Local contributing factors	3.40±1.57^{abcd}	2.00±1.26^{cde}	1.90±0.71^{cde}	7.70±2.01^{ab}	0.00±0.00
Regional and local influence	1.20±0.73^{d}	0.60±0.60^{e}	1.20±0.73^{cde}	12.00±0.00^{a}	0.00±0.00
Staff	2.80±1.32^{bcd}	2.00±0.89^{cde}	4.20±1.36^{abc}	6.00±2.32^{bcd}	0.00±0.00
Communication	3.60±2.40^{abcd}	1.80±0.73^{cde}	2.40±1.17^{bcde}	7.20±2.40^{ab}	0.00±0.00
Transportation	3.00±0.95^{bcd}	1.20±0.73^{de}	3.60±0.81^{abcde}	7.20±1.53^{ab}	0.00±0.00
Community relations	1.20±0.73^{d}	0.60±0.60^{e}	1.20±0.73^{cde}	12.00±0.00^{a}	0.00±0.00
Management planning	3.20±0.92^{abcd}	6.40±1.63^{ab}	2.60±1.21^{bcde}	3.00±1.38^{bcd}	0.00±0.00
Management practices	2.00±0.84^{bcd}	3.40±1.44^{abcde}	5.40±0.51^{ab}	4.20±2.06^{bcd}	0.00±0.00
Research, Monitoring and Evaluation	2.00±0.84^{bcd}	7.60±2.50^{e}	3.20±1.36^{bcde}	2.20±1.02^{bcd}	0.00±0.00
Protected area system	2.40±0.98^{bcd}	5.30±1.4^{abcd}	6.40±1.00^{e}	0.90±0.41^{cd}	0.00±0.00
Protected area policies	1.80±0.49^{cd}	2.70±0.88^{bcde}	3.80±0.95^{abcd}	6.70±1.36^{abc}	0.00±0.00
Protected area system design	4.30±0.83^{abcd}	3.90±0.66^{abcde}	0.60±0.34^{de}	6.20±1.05^{bcd}	0.00±0.00

*The variables with the same subscript are significant, while the variables with different subscripts are not significant.

There were no effective means of communication and information between the staff in the park and the administrative office of the park (7.20±2.40) hence this was a weakness. The means and equipment for transportation (7.20±1.53) were also inadequate for effective management and monitoring of the protected area, therefore, was a weakness.

Community relations were weak with 12.00±0.00. Due to the importance of support zone communities in the achievement of conservation objectives, their cooperation, participation, and involvement are not negotiable. Oyeleke *et al.* (2014) stated that participation of the local communities in the management of Osse River Park had been passive and very low. The staff confirmed that some of the communities had been hostile to conservation efforts with the park staff quarters burnt on several occasions.

Management planning was rated high with 6.40±1.63 and represents strength to the protected area. Osse River Park has a comprehensive written management plan. The management practices in the game reserve were very low (5.40±0.51). Site observations also revealed that there was no programme in place for the effective policing of

the park through anti-poaching patrols. Research, monitoring, and evaluation were rated high 7.60±2.50 and strength. This was usually in conjunction with the Nigerian Conservation Foundation.

Conclusion and Recommendations

There have been threats and pressures brought about by a multiplicity of factors including expanding human population on Osse River Park and these continue to threaten the biodiversity status of the protected area. Widespread poverty in the support zone communities (SZCs) of the park has led to uncontrolled exploitation of the natural resources. Lack of awareness of the overall economic values, significance, and potentials of the reserve is contributing to the deplorable state of the renewable natural resources of the reserve. The threats identified in Osse River Park include unsustainable logging, a collection of non-timber forest products (NTFPs) regime without any replacement, poaching, increased hunting due to expanding the human population, Indian hemp (*Cannabis sativa*) cultivation and mining. Inadequate funding, staffing, and equipment in addition to poor community relations have affected the effective operations of the park; these in addition to other pressures have hindered the effective management of the park. Management effectiveness showed weakness in five areas: these are legal security, funding, communication and information, ineffectively protected area policies, staffing, and community relations. Concentrating on these weaknesses would go a long way towards improving the effectiveness of the park in achieving conservation objectives.

In view of the above, the following recommendations are made:

The boundary of Osse River Park needs to be properly demarcated; this would deter the communities from encroaching into the park and avoid conflicts between the park and the surrounding communities. More protection staff should be employed and adequately equipped in terms of transportation, communication and other facilities for proper protection of the area against poaching and land encroachment. Facilities such as rangers' quarters, transportation/ vehicles, communication and information equipment for patrol need to be provided for staff to further enhance efficiency. Some of the threats on the protected area could be reduced by providing alternative means of livelihood for the support zone communities (SZCs). There is need to improve the relationship between the support zone communities and Osse river park management for the sustainability of the protected area.

Ondo State Government should create conservation awareness to sensitize the community on the need to protect biodiversity. We suggest continued collaboration and networking with the Nigerian Conservation Foundation and the Nigeria National Park Service to further enhance the status of the reserve and possible upgrading of the area to a National Park.

References

Afolayan, T.A., Agbelusi, E.A. and Balogun, A.M. 1990: Wildlife Inventory of the Proposed Game Reserve. A conservation document prepared for Ondo State Government Ministry of Agricultural Resources, Akure, Ondo-State. 63pp

Bertzky,B., Colleen, C., James, K. Siobhan, K. Corinna, R., Charles, B. and Neil B. 2012: Protected Planet Report 2012: Tracking Progress Towards Global Targets for Protected Areas. IUCN, Gland, Switzerland and UNEP-WCMC, Cambridge, UK.

Brandon K., Redford K.H.and Sanderson S.E, eds. 1998. Parks in Peril.Washington (DC): Island Press

CBD 2008: Protected Areas in Today's World: Their Values and Benefits for the Welfare of the Planet, Secretariat of the Convention on Biological Diversity (2008) Montreal Technical Series 36 i-vii + 96pp

CBD 2012: Protected Areas: Progress in the Implementation of the Programme of Work and Achievement of Aichi Biodiversity Target 11. Document UNEP/CBD/COP/11/26. Secretariat of the Convention on Biological Diversity, Montreal, Canada.

Dudley, N. (ed.) 2008: Guidelines for Applying Protected Area Management Categories. IUCN, Gland, Switzerland.

Ervin, J. 2002: WWF Rapid Assessment and Prioritization of Protected Area Management (RAPPAM) Methodology. Gland (Switzerland): World Wide Fund for Nature.

Ervin, J. 2003: Rapid Assessment of Protected Area Management Effectiveness in four countries. *Bioscience* 53: 833-841

Hockings, M. 2003: Systems for assessing the effectiveness of management in protected areas. *BioScience* 53: 823–832.

Hockings,M., Stolton S., Dudley N., Leverington F., and Courrau, J.2006: Evaluating Effectiveness: A Framework for assessing the management of protected areas. Second

edition (IUCN: Gland Switzerland and Cambrige ,UK)

Jepson P, Momberg F, van Noord H. 2002: A review of the efficacy of the protected area system of East Kalimantan Province, Indonesia. *Natural Areas Journal* 22: 28–42.

Margules, C. R., Pressey, R. L. 2000: Systematic conservation planning. *Nature* 405: 243–253.

Nigerian Conservation Foundation 2007: Biodiversity Survey Of Osse River Park, Ondo State. Submitted to Fisheries and Forestry Department.MANR, Akure. March, 2007

Nigerian Conservation Foundation 2008: Blueprint for the development of Conservation and Ecotourism in Osse River Park. Ondo State, Nigeria'Technical presentation 86 pp.

Ondo State Government (ODSG) 2008:Blue Print For the Development Conservation and Ecotourism in Osse River Park Pp14

Oyeleke, O.O., Ogunjemite, B.G. and Akinpeloye, F. 2014: Communities Participation In Protected Area Management: Case of Osse River Park, Ondo state, Nigeria. Proceedings of the 4th Biennial National Conference of the Forest and Forest Products Society held at Federal University of Agriculture, Abeokuta, 22nd -24th April 2014. Pp 222-226

Phillips, A. 2000. Caring for the Assets-the Effectiveness of Protected Area Management in The Design and Management of Forest Protected Areas. Rana D, Edelman L, eds. Conference Proceedings for Beyond the Trees Conference, Pp 189–204, 8–11 May 2000, Bangkok, Thailand. Gland (Switzerland): World Wide Fund for Nature. Punch- Nigeria Newspaper on the 27th August 2014.

Terborgh, J. and van Schaik, C. 2002b: Why the world needs parks in Making Parks Work: Strategies for Preserving Tropical Nature Terborgh, J.,van Schaik, C.,Davenport, L., and Rao, M., eds.. pp 3-14 Washington (DC): Island Press.

TNC (2002) 'Assessment of Target Viability.' (The Nature Conservancy: Arlington, Virginia).

Distribution and Abundance of African Green Pigeon in Ekiti State, Nigeria

B. A. Owolabi[1], O.S. Odewumi[1] and E.A. Agbelusi[1]
Ecotourism and Wildlife Management Department,
[1]Federal University of Technology, Akure
E-mail: owolabibibitayo@gmail.com

Abstract: The distribution and abundance of African Green Pigeon (*Treron calvus*) in Ekiti State, Nigeria was investigated between 2013 and 2014. Point count method, through direct observation, was adopted for the study. Five (5) locations: Aramoko/Ijero Ekiti, Isan-Ekiti, Ikogosi Ekiti, Awo/Igede Ekiti and Iyemero Ekiti were selected for the study. The number of counting points established at each station was based on the size of the forest. African Green Pigeon was present in seven out of the 20 locations visited. The total mean number of birds counted was 42 during the dry season and 60 in the wet season. Aramoko/Ijero-Ekiti had the highest mean bird number (9±4.24 and 15±1.14 in the dry and wet seasons) while Iyemero-Ekiti had the least mean number (8±0.70 birds in the dry and 9±2.82 birds in the wet season). The elevation of the habitats ranges between 330 to 569 m above the sea level. The study shows that the population of African Green Pigeon had greatly reduced due to the level of anthropogenic activities in the state. Therefore, for sustainability and to avoid the loss of biodiversity, urgent conservation measures in habitat management would reduce the rate at which the population size of African Green Pigeon has been declining including that of other fauna and flora species of the forests in Ekiti State.

Keywords: Habitat, African Green Pigeon, Population decline, Conservation

Introduction

Birds are a useful group of organisms that indicate the richness of species and biodiversity because of the narrow link between species and habitat properties (Bibby *et al.,* 2000). In addition, avian communities are very dynamic and sensitive to ecological changes. Farmland birds have undergone an evident population decline in last decades. According to the combined multi-species index of farmland birds in Europe, the decline was a 29% in the last 22 years (Gregory *et al.,* 2005).

African Green Pigeon (*Treron calvus*) occurs and breeds in high densities but is prone to regular local movements. The bird is resident in the sub-Saharan region of West Africa and occupies a variety of habitats including closed evergreen forest, woodland, mixed woodland, coastal dune forest, parks and gardens (Hockey *et al.,* 2005). Although the population size has not been quantified, it is not approaching the threshold for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations or with a specified population structure) and the species is evaluated as Least Concern (BirdLife International, 2010). However, the species has been observed to be locally rare and gradually diminishing in number such that safeguarding it should be a priority.

Considering the fact that the population status of African Green Pigeon (AGP) in the wild is globally unknown, it might be facing a serious threat from habitat loss and hunting pressures (Del Hoyo *et al*., 1997; Gibbs *et al.*, 2001 and Walker, 2007). This is due to human activities which had rapidly altered ecosystems throughout the planet in the past century and these activities are still on-going and the process will continue, forcing a decline in the population and threatening the number of species with extinction (Gibbs *et al.,* 2001). The objective of this work is to examine the abundance and distribution of African green pigeon in Ekiti State

Materials and Methods

Study Area

The study was conducted in Ekiti State, Nigeria. The state is located between latitude 7° 30' and 8° 15' N and longitude 4° 47' and 5° 40' E, bounded in the south and southeast by Ondo State, north by Kwara State, north-east by Kogi State, and west by Osun State (Ogundele *et al.,* 2011).

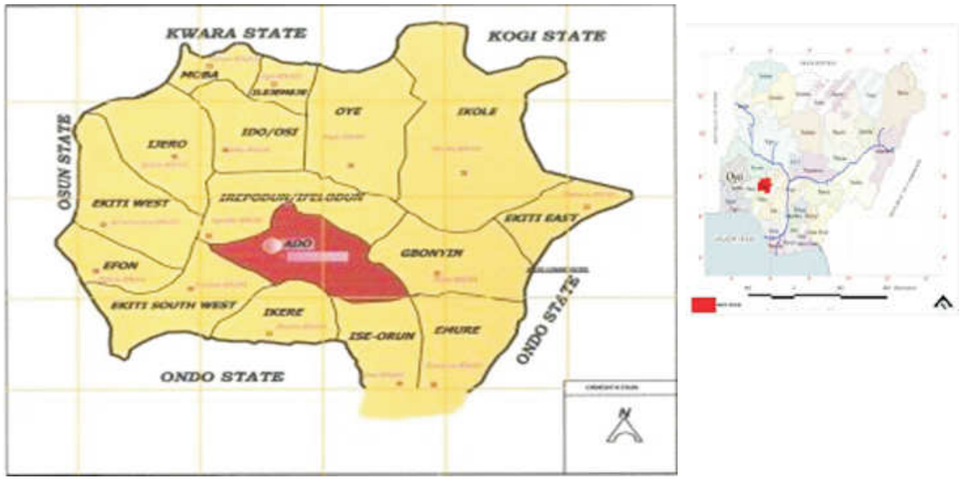


Figure 1: Ekiti State showing its 16 Local Govt. Areas. Source: Ekiti State Ministry of Lands and Physical Planning, 2014.

Climate and Vegetation

The climate is of the Lowland Tropical Rain Forest type characterized by distinct wet and dry seasons. Ekiti State has a total annual rainfall of about 1,400 mm with a low coefficient of variation of about 30% during the rainfall peak months (Adebayo, 1993). The vegetation of evergreen high forest and secondary forest in the south and central portions is composed of many species of hardwood timber: *Terminalia superba, Khaya ivorensis, Melicia excelsa* and *Antiaris africana*. The northern part has a forest-savanna mosaic in which feature such tree species as *Blighia sapida, Parkia biglobosa, Adansonia digitata* and *Butyrospermum paradoxa*. The natural vegetation has been very much degraded as a result of human activities especially slash-and-burn bush fallow farming systems (Ogunjemite, 2004).

Distribution of African Green Pigeon in Ekiti State

The extensive forest reconnaissance "Recce Survey" (Walsh and White, 1999) was used to assess AGP distribution in 20 locations: Awo, Isan, Ikere, Igede, Ilawe, Ikogosi, Ifaki, Ilupeju, Afao, Iworoko, Iyemero, Aramoko, and Ijero. Each location was visited four times (twice both in the wet and dry season) of 2014. At each site, the villagers, especially the farmers, were interviewed.

Population Size of African Green Pigeon in Ekiti State

The Point Count Method described by Redman *et al.* (2009) and Knapp and Keeley (2001) was used in collecting information on the abundance of AGP in five locations: Aramoko/Ijero Ekiti, Isan-Ekiti, Ikogosi Ekiti, Awo/Igede Ekiti and Iyemero Ekiti where the species was observed during the reconnaissance survey. A total of 15 counting points were established in five counting locations/stations. Counting points had a fixed radius of 20 m which was permanently marked and visited on each counting occasion. The study lasted for 6 months- 3 months in the dry season (February-April 2014) and 3 months in the wet season (May-July 2014). The counting of birds was done twice daily: in the morning from 0600 to 0930 h and in the afternoon from 1600 to 1800 h. Bird survey was carried out for 5 days in a week by allocating a day to a counting station. The actual counting lasted for 20 minutes during which birds that were seen or heard (calls/song) were recorded. The observation was aided by a pair of Olympus binoculars (10 × 50) while the field guide book on "Birds of Western Africa" by Borrow and Demey (2013) was used for proper identification of African Green Pigeon where necessary.

Data/Statistical Analysis

Data obtained were analyzed using descriptive statistics (frequency of occurrence and percentage) and analytical statistics (diversity index, abundance, and T-test analysis). The student's t-test analysis was adopted to compare sightings between the wet and dry season using PAST software (Hammer *et al.*, 2001).

Results and Discussion

Distribution of African Green Pigeon in Ekiti State

African Green Pigeon (*Treron calvus*) was sparsely distributed across Ekiti State being

present in 7 locations (Isan, Ikogosi, Iyemero, Igede, Awo, Aramoko, and Ijero) and no longer found in 6 of the areas visited (Ikere, Ilawe, Ifaki, Afao, Ilupeju, and Iworoko). Fig 2 shows the spatial distribution of the bird in the study areas of Ekiti State.

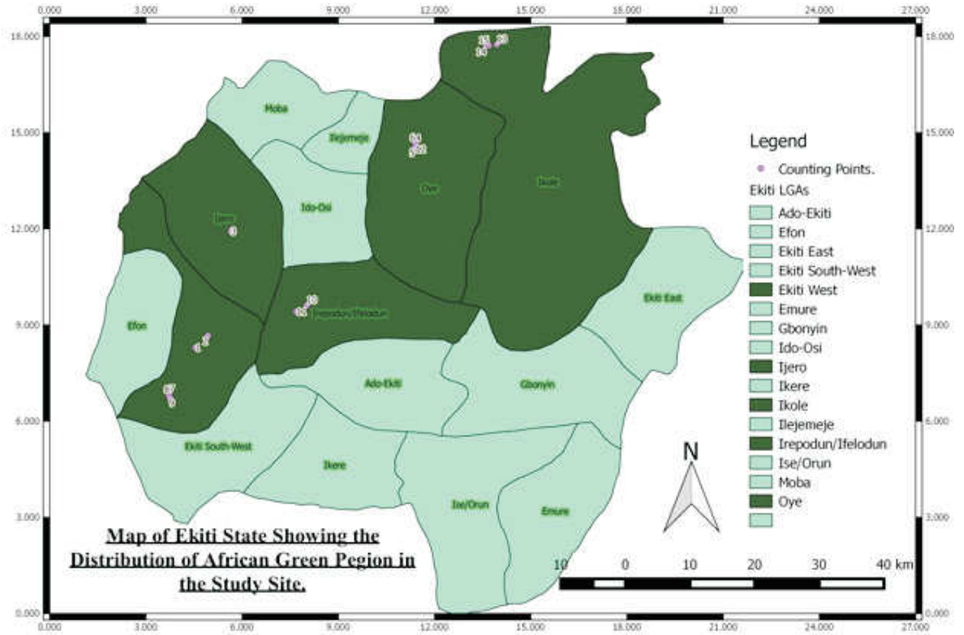


Figure 2: Spatial distribution of African Green Pigeon across the study site.
Source: Fieldwork, 2015.

Abundance of African Green Pigeon

The mean total number of birds counted during the study was 102.8±5.70 consisting of 43 and 60 during the dry and wet seasons respectively. The mean number of birds in Igbo Efun (Isan Ekiti) in the dry season was 9 ± 4.24 and 15 ± 1.14 in the wet season. Ikogosi Ekiti had a mean of 9 ± 0.25 birds in the dry and 14 ± 4.28 in the wet period, Both Aramoko and Ijero Ekiti had 8 ± 2.23 birds in the dry and 12 ± 6.57 birds recorded in the wet season, while both Awo and Igede Ekiti had a mean of 8 ± 2.82 birds in the dry and 10 ± 0.70 birds in the wet season. Iyemero Ekiti had a mean of 8± 0.70 birds in the dry and 9± 2.82 birds in the wet season. The species richness and abundance varied between the five counting station possibly due to the influence of the variations in altitude and the types of vegetation as suggested for forest birds (Aerts *et al.*, 2008; Simons *et al.*, 2006). The test of variability conducted to determine the variation of seasonal sightings reveals a significant difference between the wet and dry season sightings (Table 1). This means that season is a determinant factor when considering the population of the bird. African Green-pigeon being a frugivore solely depends on forest tree species which produce the fruits and seeds that serve as its food**.** The fruiting period of most forest trees occurs in the wet season and this will have a significant effect on the population of African Green Pigeon observed on a seasonal basis (Meehan *et al.*, 2005).

Table 1: Mean number of African Green Pigeon Sighted in Ekiti State

Location	Mean (Wet)	Mean (Dry)
Isan Ekiti	15 ± 1.14	9 ± 4.24
Ikogosi Ekiti	14 ± 4.28	9 ± 0.25
Aramoko Ekiti	12 ± 6.57	8 ± 2.23
Ijero Ekiti	12 ± 6.57	8 ± 2.23
Awo Ekiti	10 ± 0.70	8 ± 2.82
Igede Ekiti	10 ± 0.70	8 ± 2.82
Iyemero Ekiti	09 ± 2.82	8 ± 0.70

± Standard Error
Source: Fieldwork 2015

Relative abundance of African Green Pigeon in Ekiti State

Isan-Ekiti had the highest value at 24% (Fig. 3). This is due to the fact that tradition plays a major role in the conservation of natural biodiversity. “Igbo Efun” in Isan Ekiti is a small piece of forest land reserved for cultural and traditional purposes and in which farming and mining activities had been forbidden from time immemorial. This has ensured the abundance of several tree species for nesting and fruit production which are some of the reasons for the presence of more birds. Ikogosi-Ekiti had 23% which can be attributed to the development of the Ikogosi Warm Spring Park whose enclave is on a hilly terrain with lush tropical forest trees conserved to increase the potential for tourism. This has made the area to have an abundance of tree species for nesting and fruit production, one of the reasons for the presence of more number of African green Pigeon in the area population and abundance, according to Hiwot (2007). Aramoko/Ijero-Ekiti had 20% while Awo/Igede and Iyemero had 18 and 17% respectively.

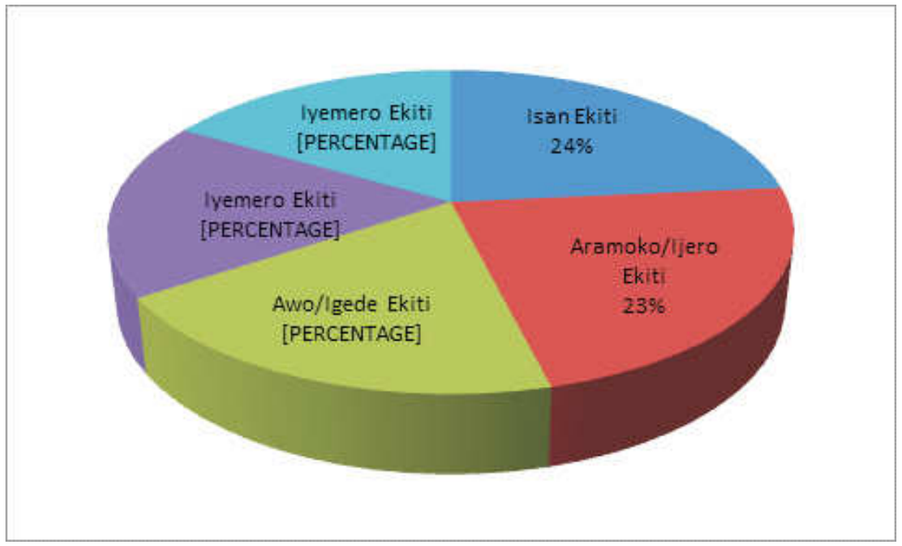


Figure 3: Relative abundance of **African Green Pigeon in** Ekiti State.
Source: Fieldwork 2015

Altitudinal Distribution of the African Green Pigeon in Ekiti State

The bird species were seen at high altitudes throughout the period of the study. Table 2 shows the various elevations at which African Green Pigeon was observed in Ekiti State. The elevation of the habitats ranges between 330 to 569 m above the sea level. Mallet-Rodrigues *et al.* (2010) had observed variation in the altitudinal distribution of birds in a mountainous region of south-eastern Brazil with more bird species recorded from the low altitudes compared to the mid and high altitudes. Although the result from the present study does not fully support their claim which concerned birds generally but the variation in agro-climate and the mid to high elevation of the study sites appeared to make a difference in African Green Pigeon population and abundance.

Table 2: Altitudinal Distribution of the African Green Pigeon in Ekiti State

Counting Station/Point	Longitude	Latitude	Elevation	Location
A1	5.016953	7.660876	518	Aramoko Ekiti
A2	5.03446	7.677542	497	Aramoko Ekiti
A3	5.066569	7.823949	525	Ijero Ekiti
B1	5.325356	7.946876	547	Isan Ekiti
B2	5.324005	7.941888	539	Isan Ekiti
B3	5.324796	7.947342	330	Isan Ekiti
C1	4.980472	7.595592	495	Ikogosi Ekiti
C3	4.980261	7.594128	486	Ikogosi Ekiti
C2	4.980333	7.591465	479	Ikogosi Ekiti
D1	5.172766	7.719857	541	Awo Ekiti
D2	5.158356	7.711252	569	Igede Ekiti
D3	5.32535	7.946839	559	Awo Ekiti
E1	5.439198	8.085675	390	Iyemero
E2	5.424369	8.083296	421	Iyemero
E3	5.364569	7.959117	456	Iyemero

Field Work 2015

Conclusion

Habitat type and the resources generally dictate the distribution and abundance of bird species. Thus, bird-specific requirements are the sets of conditions that the habitats must possess. The remaining forests patches are favourable places habitats for birds because they will have good access to food resources. The present study showed that the forests in Ekiti State supported more numbers of African Green Pigeon and other bird species, including other wildlife species, in the time past compared to what the forest patches left now can support. There are a gradual decline and reduction in the population status of African Green Pigeon due to the level of anthropogenic activities in the state. Therefore, for sustainability and to avoid loss of biodiversity, urgent conservation measures of habitat management would help to conserve the declining population size of African Green Pigeon as well as other fauna and flora species of the forests in Ekiti State. This can be achieved through environmental and wildlife education, stiffer penalties for perpetrators of environmental crimes, most especially in areas of deforestation and poaching, and encouraging well-articulated avian research that supports conservation.

References

Adebayo, W. O. (1993) Weather and Climate. In Ebisemiju, F.S. (ed) Ado-Ekiti Region: A Geographical Analysis and Master Plan. Alpha Prints, Lagos: 11-14.

Aerts, R., Lerouge, F., November, E., Lens, L., Hermy, M. & Muys, B. 2008. Land rehabilitation and the conservation of birds in a degraded Afro-montane landscape in northern Ethiopia. *Biodiversity and Conservation* 17: 53-69.

Bibby, C.J., Burgess, N.D. and Hill, D.A. (2000). Bird Census Techniques. Academic Press, London.

BirdLife International (2010). Species factsheet: *Treron phoenicopterus*. Downloaded from http://www.BirdLife.org on 14.09.2010.

Borrow, N. and Dempey, R. (2013). Birds of Western Africa. London: Christopher Helm

Del Hoyo, J. (1997). Handbook of the Birds of the World, vol. 4: Sand grouse to Cuckoos. Lynx Edicions, Barcelona, Spain.

Gibbs, D. (2001). Pigeons and Doves: A guide to the Pigeons and Doves of the World. Pica Press, Robertsbridge, U.K.

Gregory, R.D., Van Strien, A.J., Vorisek, P., Gmelig Meyling, A.W., Noble, D.G., Foppen, R.P.B. & Gibbons, D.W. 2005. Developing indicators for European birds. Phil. Trans. R. Soc. Lond. B. 360: 269–288.

Hammer, Ø., Harper, D.A.T. and Ryan, P.D. (2001). PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica, 4(1): 9. http://palaeoelectronica.org/2001_1/past/issue1_01.htm.

Hiwot, H. (2007). Species Composition, Abundance and Activity Pattern of Birds of Addis Ababa. Abattoirs Enterprise: 28-37.

Hockey PAR, Dean WRJ, Ryan PG (eds) 2005.

Roberts Birds of Southern Africa. VIIth edn. John Voelcker Bird Book Fund, Cape Town.

Knapp, E. and Keeley, J. (2001). A National Study of the Consequences of Fire and Fire Surrogate Treatments. Sequoia National Park Site Study Plan.

Mallet-Rodrigues, F., Parrini, R., Pimentel, S.L. and Bessa, R. (2010). Altitudinal distribution of birds in a mountainous region in southeastern Brazil. Zoologia 27: 503-522.

Ralph, C. J., Geupel, G. R., Pyle, P., Martin, T.E. and DeSante, D.F. (1993). Handbook of Field Methods for Monitoring Land Birds. General Technical Report PSW-GTR-144. Pacific Southwest Research Station, Forest Service, US Department of Agriculture, Albany, California

Redman, C.J., Johnes, M. and Marsden, S. (2009). Expedition Field Techniques: Bird Surveys. Expedition Advisory Center. *Royal Geogr. Soc*. 1: 134-137.

Simons, T. R., S. A. Shriner, and G. L. Farnsworth. 2006. Comparison of breeding bird and vegetation communities in primary and secondary forests of Great Smokey Mountains National Park. Biological Conservation 129:302–311

Walker, J.S. (2007). Geographical patterns of threat among pigeons and doves (Columbidae). *Oryx* 41(3): 289–299.

Walsh, P.D., White, L.J.T., Mbina, C., Idiata, D., Mihindou, Y., Maisels, F. and Thibault, M. 2001. Estimates of forest elephant abundance: projecting the relationship between precision and effort. Journal of Applied Ecology 38:217–228.

Rural Residents' Awareness and Attitude Towards Protection of Osun Osogbo Sacred Grove for Ecotourism Development in Osun State

F. M. Oladipo, N.O. Tijani and [1]F. C. Arowosafe,
National Institute for Hospitality and Tourism, P.O. Box 2475, Osogbo, Osun State
[1]Department of Ecotourism and Wildlife Management,
Federal University of Technology, Akure, P.M.B 704, Ondo State
e-mail:femimoladipo@yahoo.com

Abstract: Awareness of protection objectives and the attitude towards protected area by the local residents are important issues germane to the success of ecotourism projects. This study examined the awareness and attitude of the rural residents near Osun Osogbo Sacred Grove (OOSG), a world heritage site, towards protection for ecotourism development. A multi-stage sampling technique was used to select respondents from five rural communities near the grove. Structured questionnaire and key informants were used to elicit information from 125 respondents. Data obtained were analyzed using descriptive statistics. The results show awareness of protection objectives was high in 51.6% of the respondents and the same proportion (51.6%) had a favourable attitude towards the grove in spite of having to cope with poor infrastructure like unpaved roads and lack of potable water. More than 80% of respondents would prefer government management of ecotourism in the area rather than the community for maximum benefits. The OOSG management must take advantage of the desire expressed by the residents for more information on ecotourism to educate them on its importance for the long-term sustainability of benefits derived from the grove.

Keywords: Osun Osogbo Sacred Grove, attitude, awareness, rural dwellers.

Introduction

Tourism is regarded as one of the top sectors that can be used to address the problems of unemployment and poverty in many countries on the African continent (DBSA, 2009). There are mass and alternative forms of tourism. Mass tourism is seasonal, high volume and high impact with negative effects on destination areas whereas the alternative form has many disadvantages but can produce great revenues during the high seasons and, therefore, cannot be ignored (Christou, 2012). Ecotourism, as a particular form of alternative tourism, is growing rapidly out of the need to remedy mass tourism's negative effects on the environment and society. Wallace and Pearce (1996) described ecotourism as travelling to relatively undisturbed natural areas for study, enjoyment or volunteer assistance. It is travel that concerns itself with the flora, fauna, geology and ecosystems of an area as well as the people (caretakers) who live nearby, their needs, their culture, and their relationship to the land. It views natural areas both as home to all of us in a global sense ('eco' meaning home) but 'home to nearby residents specifically. It is envisioned as a tool for both conservation and sustainable development especially in areas where local people are asked to forgo the consumptive use of resources for others. Ecotourism is, thus, best among the tourism options to meet the sustainable development for rural areas because it aspires to meet sustainability development results (Dabour, 2003).

Most of the highly-demanded tourism destinations in less developed countries are located in the rural areas in the form of Protected Areas (PA) such as cultural sites, biosphere reserves, national parks, wilderness areas and mountainous zones with rich ecosystem and biodiversity. They are established over occupied landscapes with the intent of seeking ways to incorporate the development and resources needs of the people with the conservation of the natural environment (Kamuaro, undated). Neth (2008) observed that introducing ecotourism to such rural areas offers many advantages to the people: it helps them to take ownership of their resources and operate business enterprises; it also helps them to participate in the development of their locality.

The most important issue of the rural area and tourism development relationship is the utilization of rural land and the resources attached to it. Conventionally, protection of land resources is effected by government and her agencies through restrictions and prohibitions placed on local people from traditional resources usage in favour of nature/culture conservation and tourism (Fennel, 2008). The effective removal of

resources such as land for farming, game animals and plant resources from use and control by local people is considered good reason for the consistent destruction of protected resources in many developing countries because of their high dependence on them for livelihood (Tijani, 2005; Neth, 2008). This is catalyzed by low knowledge of protection objectives leading to poor results in the management of ecotourism projects in Nigeria (Eneji *et al.*, 2009; Adetoro *et al.*, 2012)

Osun Osogbo Sacred Grove (OOSG) is a collection of natural and man-made heritage features set in a riparian vegetation of the fast disappearing rain forest zone in southwest Nigeria. In recognition of the benefits associated with tourism development, the Federal Government of Nigeria and Osun State Government got the UNESCO enlistment for the OOSG as a World Heritage Site in 2005 (NCMM, 2010). This status ensured that strict protection regulations were enforced which completely deprived the neighboring communities of the use of these resources for farming, hunting, lumbering, and many other daily socio-economic activities. Thus, the resident communities near the grove would constitute a challenge to the sustainability of the grove through encroachment on the grove resources (NCMM, 2011).

The Doxey's irritation index model is often engaged in the analysis of residents' attitude towards tourism development (Harril, 2004). The model suggests that resident communities experience a sequence of reactions as victims or beneficiaries of the changes that occur in their locality as a result of increasing levels of mass tourism. These reactions are indications of their desire for further development or not. The model opines that at the onset of visitations to a new destination, the reaction is first of euphoria, then as the number of visitors increase, the reaction becomes that of apathy, annoyance and antagonism. Studies in Nigeria show that the expectation of developmental benefits from ecotourism projects also generates an initial positive attitude from rural communities which later gradually turns negative and antagonistic due to actual benefits in terms money and infrastructural development being far lower than expectations (Tijani 2005, Adetoro, 2008 and Eneji *et al.*, 2009). Improved awareness has been suggested as the major panacea to such negative attitude of the rural dwellers towards ecotourism development in Nigeria (Adetoro, 2008; Eneji *et al.*, 2009; Adetoro et al., 2011, 2012). The UNESCO/UNEP document tagged Tbilisi Declaration of 1978 had shown environmental education as the panacea to low awareness on environmental issues if adopted in developing countries. Awareness is having the knowledge of the existence of something and it indicates that someone is conscious, fully appreciating the importance of the thing and being mindful of the need to take cautious sensible decisions as a result. Awareness is a function of exposure to relevant information within the existing environment and it helps to develop the necessary skills and expertise to address the challenges, and foster attitudes, motivations, and commitments (Tang *et al*., 2012; Ojong *et al*.**, 2013)**. Awareness is a function of the learning acquired by age, education and other socio economic characteristics (Adetoro *et al*., 2012). This paper, therefore, seeks to investigate the awareness and attitude of the residents' around the sacred groove on the protection of osun osogbo sacred grove for ecotourism development.

Materials and Methods

Study area

The study was carried out in the communities adjoining the OOSG, a UNESCO-listed World Heritage site. It is a sacred forest grove located along the banks of Osun River outside the Osogbo the capital of Osun State and located on latitude 7°30'N and longitude 4°30'E south west Nigeria (NCMM, 2010). The grove consists of exceptionally-rich flora and fauna population with over 400 species of plants, some endemic, out of which 200 are known for their medicinal values and 15 species of primates and small mammals and a large variety of birds, reptiles, amphibians, fishes and insects. The grove is one of the last remnants of primary rain forest in south west Nigeria and regarded as the abode of the goddess of fertility, one of the pantheons of Yoruba gods. The landscape of the grove and its meandering river is dotted with sanctuaries and shrines, sculptures and art works in honour of Osun and other deities (UNESCO, undated). The grove is situated within Ward 1 (Ataoja) in Osogbo Local Government Area and surrounded by several rural villages and compounds.

A multi-stage sampling consisting of purposive sampling and convenience sampling procedures was adopted because of the unstructured nature of the study population. The 15 identified communities and compounds were stratified into rural and urban. Five (5) rural villages were purposely selected from amongst 10 rural villages in the ward based on their proximity to the grove.

These are Irepodun, Lasinmi, Agric Community, Aiisu, and Ajenisua Villages. Twenty-five (25) persons were selected from each ward to make a total of one hundred and twenty-five (125) respondents for the survey. A structured questionnaire supplemented with oral interview with key informants was utilized to elicit information from respondents. The reliability of the instrument was determined by administering 20 copies of the questionnaire to individuals outside the study population. A Guttman Split-Half Coefficient of 0.776 was obtained.

A team of four, made up of the lead researcher, an assistant and two officials of the Community Development Office from Osogbo Local Government Area were involved in the data collection. Interpretation into Yoruba language of each item in the questionnaire was discussed. The team visited each village centre after soliciting the consent of the traditional head or the representatives (they also served as key informants). Selected illiterate individuals were assisted minimally to understand the questions and key informants were engaged for deeper understanding of critical issues.

Data Analysis

Data in the retrieved questionnaire were analyzed using the Statistical Package for Social Science (SPSS). Descriptive statistics were used to summarize the respondents' socio-demographic characteristics as well as the items adapted to measure their awareness of the objectives of protection and the attitude towards the development of ecotourism of OOSG.

Results and Discussion

Socio-demographic characteristics

The average age of the respondents was 41.19 years and 57.3% was male while the people were predominantly Muslims (69.4%) and married (62.9%) with almost half having primary education (49.2%) and 15.3% did not have any form of education (Table 1).

Table 1: The social-demographic characteristics of respondents in the study area

Variable	Frequency	Percentage	Mean
Age (years)			**41.19**
<30	24	19.4	
31-40	37	29.8	
41-50	30	24.2	
51-60	13	10.4	
61-70	10	8.1	
>70	10	8.1	
Total	124	100	
Sex			
Male	71	57.3	
Female	53	42.7	
Total	124	100	
Religion			
Christianity	35	28.2	
Islam	86	69.4	
TAR	3	2.4	
Total	124	100	
Marital Status			
Single	29	23.4	
Married	78	62.9	
Divorced	6	4.8	
Widow	11	8.9	
Total	114	100	
Education			
No formal education	19	15.3	
Primary education.	61	49.2	
Secondary education	29	23.4	
Tertiary education	15	12.1	
Total	124	100	

Awareness of the objectives of protection of Osun Osogbo Sacred Grove

Table 2 shows that majority (96.0%) were aware of the objectives for the protection of the grove such as to preserve Osun shrines. Also 92.8% agreed that the protection of the grove would prevent the destruction of plants and trees while 87.8% agreed that it would protect wild animals from being destroyed. This shows the consciousness and the value the people place on the protection of cultural heritage were high. A high proportion (81.4 and 69.4%) of the respondents disagreed that the protection was to preserve fire wood for future use and provide water for domestic purpose. This implies that respondents had a clear understanding of sustainable usage of natural resources and conservation objectives.

With respect to tourism, 91.9% of respondents agreed that the protected area would attract more visitors to Osogbo but that the protection was not for attracting people for the annual Osun Osogbo Festival alone (70.2%). However, respondents expressed mixed opinions in respect of people sitting under the trees for relaxation as a reason for protection of the grove.

Table 2: Respondents' awareness of the objectives of protection of Osun Osogbo Sacred Grove

Items	SA	A	UN	D	SD	
	F (%)	F (%)	F (%)	F (%)	F (%)	Mean
The grove is protected to preserve the Osun shrines from destruction	87(70.2)	32(25.8)	2(1.6)	3(2.4)		4.6371
The grove is protected to prevent the plants and trees from being destroyed.	56(45.2)	59(47.6)	3(2.4)	5(4.0)	1(0.8)	4.3226
The grove is protected to prevent wild animals from being destroyed	46(37.1)	63(50.8)	4(3.8)	6(4.8)	5(4.0)	4.121
The grove is protected so people can kill wild animals for food	9(7.2)	7(5.6)	5(4.0)	39(31.5)	64(51.6)	1.8548
The grove is protected for people to sit and relax under trees.	10(8.1)	28(22.6)	45(36.3)	30(24.2)	11(8.9)	2.9677
The grove is protected to allow the historical relics of Osogbo to be destroyed destruction	8(6.5)	13(10.5)	4(3.2)	44(35.5)	55(44.4)	1.9919
The grove is protected to provide enough fire wood for future generation	4(3.2)	3(2.4)	16(12.9)	52(41.9)	49(39.5)	1.879
The grove is protected to allow people easy use of water for domestic purposes.	6(4.8)	13(10.5)	19(15.3)	56(45.2)	30(24.2)	2.2661
The grove is protected for Osun Osogbo festival alone.	5(4.0)	21(16.6)	11(8.9)	58(46.8)	29(23.4)	2.3145
The grove is protected to attract visitors to Osogbo on tourism	67(54.0)	47(37.9)	7(5.6)	1(0.8)	2(1.6)	4.4194

These responses show that although the people are knowledgeable of the groves potential to attract visitors to the destination en masse, they lacked the understanding of the activities involved in ecotourism such as attracting individuals or small groups to the quiet environment provided by the grove for spiritual meditation, relaxation or academic study

Table 3 is a summary of the level of respondents' awareness of the objectives of protection of the grove. It shows that more than half (51.6%) of the respondents had a high level of awareness whereas 48.4% of the respondents had a low awareness level. The nearness of the high and low levels implies that despite the exposure to certain reasons for protection such as conservation, the understanding of ecotourism was lacking. The low level of education of respondents is probably responsible for this low awareness as observed by Tang *et al*. (2012) that education is a limiting factor to participation in ecotourism projects in developing countries.

Table 3: Awareness of the objectives of protection of Osun Osogbo Sacred Grove

Level of Awareness	Frequency	percentage	Mean	SD	Min	Max
Low	60	48.4	29.8871	6.35560	5.00	46.00
High	64	51.6				
Total	124	100				

Attitude of residents to the protection of Osun Osogbo Sacred Grove

Table 4 shows the distribution of the respondents' attitude towards the protection of the grove. Most of the respondents (71%) agreed that the community has benefited much from the protection in terms of employment while 69.6% disagreed that further tourism development of the grove will be a disadvantage to the community. There was disagreement by 81.5% of the respondents to the assertion that more visitors should not be attracted to the grove. However, most respondents (67%) displayed a negative attitude towards the grove because of the belief that only few people share the benefits from it. Most of the respondents disagreed (72.6%) that the protection of the grove has made provision of pipe born water and light possible public toilets possible (71.6%) in the community. More than half (55.6%) and 63.7% of the respondents have expressed agreement that protection has reduced farmlands and taken up the land needed for expansion of the community respectively.

More than half of the respondents (52.4%) believed that the management of the grove by the community will not ensure benefits to them whereas 81.5% believed that government should control the development of the grove to maximize the benefits. Most of the respondents (68.5%) also disagreed with the suggestion that the resources (land) should be shared amongst the community members. The respondents also expressed a strong desire for knowledge as 71.8% disagreed with whether further enlightenment was not required on the importance of the grove. This appetite for enlightenment is an expression of their expectation of more benefits to be derived from the grove which corroborated the opinion expressed by some village heads.

Table 4: The respondents' attitude towards protection of Osun Osogbo Sacred Grove

	SA	A	UN	D	SD
Items	F (%)	F (%)	F (%)	F (%)	F (%)
Protection of the Grove has made provision of pipe born water and light possible in community.	8(6.5)	9(7.3)	17(13.7)	57(46.0)	33(26.6)
Protection of the Grove has made provision of public toilets possible	3(2.4)	12(9.7)	20(16.1)	67(54.0)	22(17.7)
The protection of the Grove have reduced our farm lands	17(13.7)	52(41.9)	17(13.7)	24(19.4)	14(11.3)
Osun Grove has taken up the land need for expansion of the community	15(12.1)	64(51.6)	16(12.9)	19(15.3)	10(8.1)
The community has benefited much from the protection in terms of employement.	25(20.2)	63(50.8)	19(15.3)	12(9.7)	5(4.0)
The resources (land) should be shared amongst the community members	3(2.4)	14(11.3)	22(17.7)	50(40.3)	35(28.2)
The Grove is only beneficial to few members of this community	27(21.8)	56(45.2)	10(8.1)	23(18.5)	8(6.5)
Further tourism development of Osun grove will disadvantage the community and should be discouraged	3(2.40	10(8.1)	24(19.4)	42(32.9)	45(36.3)
The community should control the development of Osun Osogbo in order to maximize benefit	23(18.5)	20(16.1)	16(12.0)	49(39.5)	16(12.9)
Government should control the development of the Grove to maximize benefit	46(37.1)	55(44.4)	14(11.3)	5(4.0)	4(3.2)
We should not try to attract more visitors to the Grove.	8(6.3)	4(3.2)	11(8.9)	56(45.2)	45(36.3)
The management of the Grove is not clearly nunderstood	7(5.2)	17(13.7)	46(37.1)	35(28.2	19(15.3)
Further enlightenment is not required on the importance of the Grove	7(5.6)	9(7.3)	19(15.3)	48(38.7)	41(33.1)

Table 5 shows that 51.6% of the respondents have expressed favourable attitude towards the protection of the grove while 48.4% of the residents have an unfavourable attitude towards the protection of the grove. The result shows that the community has not rejected the protection in its entirety. In the words of Harrill (2004), these people may be called a tourism-realized community, tolerant, in-between, cautious romantics and adjusters. They have a conflict in their feeling towards tourism development because of their inadequate knowledge of the benefits that would accrue to them or other reasons relating to tourism impact. They, therefore, do not accept nor reject tourism development effort in its entirety. This result is not unexpected since the residents could not attach provision of infrastructure such as light, potable water and public toilet to the protection of the grove. The community recognizes that the government has the obligation to provide all these amenities to them. This, according to Tijani (2005), calls to question the effectiveness of the methods used by the relevant agencies in enlisting the support of the neighboring communities in ecotourism projects.

Table 5: Summary of respondents' attitude towards the protection of Osun Osogbo Sacred Grove

Attitude	Frequency	Percentage	Mean	SD	Min	Max
Favourable	64	51.6	41.8226	5.41	30.00	57.00
Un-favourable	60	48.4				
Total	124	100				

Conclusion and Recommendation

The majority of rural residents' near the OOSG are aware of the objectives of protecting ecotourism projects in their area and have a favourable attitude towards its protection in-spite of their low education, uneven distribution of benefits to them and lack of infrastructure such as public toilets, potable water and paved roads. The nature of the rural residents at OOSG can be described as in-betweens, that is, people with moderate opinions about the prospects of ecotourism considering that many are showing euphoria while others have apathy towards the development and continued growth of the industry. Since they have expressed desire for further enlightenment on the importance of the grove, there is ample opportunity for re-enforcement of their positive attitude towards conservation as well as educating them on the various activities of ecotourism and its benefits to the sustainability of the grove.

The management of OOSG must enhance the social well-being of residents near the grove through the provision of paved access roads, supply of potable water and housing schemes so as to further improve on their positive attitude towards the grove. Children/youths should be taught biodiversity conservation and associated ecotourism benefits in primary schools. The communication forum between the management and surrounding residents can be utilized to clear grey areas and enhance understanding in matters that pertain to tourism benefits especially fair sharing of financial benefits accruable from tourist visitations and festivals.

References

Adetoro A. O. (2008). People's perceptions of Old Oyo National Park: Germane issues in park management, *Environmental Research Journal* 2(4):182-186

Adetoro, A.O., Lawal, M. S and Jenyo-Oni, A. (2011). Biodiversity conservation and community participation in Kainji Lake National Park, Nigeria. *Advances in Applied Science Research* 2(2): 218-226

Andriotis, K. (2000). *Local Community Perceptions of Tourism as a Development Tool: The Island of Crete.* PhD Thesis Bournemouth University, Greece. Retrieved from www.angelfire.com /ks../Chapter0.pdf on 24/7/2013

Christou, L. (2012). Is it possible to combine mass tourism with alternative forms of tourism: the case of Spain, Greece, Slovenia and Croatia *Journal of Business Administration* Retrieved from www.atu/edu/…/Is_it_possible_to_combine on 4/5/2013

Dabour, N. (2003). Problem and prospect of sustainable development in the OIC countries *Journal of Economic Coorporation* 24 (1): 25-62

DBSA. (2009). Local economic development, tourism and land use choices, *Development Planning Division Working Paper Series 4*, Development Bank of South Africa Retrieved from www.DPD_No4.pdf on 26/4/2013

Eneji, C.V.O., Gubo, Q., Umoren, G., Omoogun, A.C.,Oden, S.,Nicholas, S and Edet, D.B (2009). Social-economic impacts of the Cross River National Park, Nigeria. *Journal of Agriculture, Biotechnology and Ecology* 2(1): 57-68

Fennell, D (2008). Ecotourism, 3rd Edition, Routledge: New York

Harrill, R. (2004). Residents' attitudes towards tourism development: A literature review with implications for tourism planning. *Journal of Planning Literature* 18(3): 251-266.

Kamuaro. O. (Undated) Ecotourism:Suicide or Development UN-NGLS Banner(English) Retrieved from

Neth, B. (2008). Ecotourism as a Tool for Sustainable Rural Community Development and Natural Resource Management in the Tonle Sap Biosphere Reserve. University Press :Kassel

NCMM. (2010). 2010-2014 Conservation Management Plan, OOSG UNESCO World Heritage Site, National Commission, Museum and Monuments Abuja

NCMM. (2011). UNESCO World Heritage Site 2010-2014 Conservation Management Plan, *List of Declared National Monuments as at January 2011*.National Commission, Museum and Monuments Abuja. pp 83.

Ojong, F.E., Eja I. E., Undelikwo, V.A., and Agbor, E.A. (2013). Indigenous peoples' perception of ecotourism in Cross River State, Nigeria Part1: *Social Sciences and Humanities* 4 (1).Retrieved from www.savap.org.pk/111/2013(4.1-28).pdf on 4/4/2013

Tang, C., Zhong, L. and Cheng, S. (2012). Tibetan attitude towards community participation and ecotourism. *Journal of Resources and Ecology* 3 (1):8-15 DOI:10.5814 /j.issn.1674-764x.2012.01.002. Retrieved on 10/4/2013

Tijani, N. (2005).Challenges and imperatives of community based conservation in Old Oyo National Park, *Biological and Environmental Science Journal for the Tropics* 2(2):112-118

UNESCO (Undated). Osun-Osogbo Sacred Grove-UNESCO World Heritage Centre. Retrieved from http://whc.unesco.org /en/list/118 on 12/11/2013

Wallace, G.N., & Pierce, S.M. (1996). An evaluation of ecotourism in Amazonas, Brazil. Annals of Tourism Research, 23(4), 843-873.

Zhong, Z., Deng, J. and Xiang, B. (2007).Tourism development and tourism area life-cycle model: A case study of Zhangjianjie National Forest Park, China, *Tourism Management* (in Press). Retrieved from www.sciencedirect.com on 5/6/2013

Ziffer, K. (1989). *Ecotourism*: t*he uneasy alliance*. Working Paper Series, Conservation International, Washington, DC

Assessment of the use of Agro-chemicals Among Cocoa Farmers in Ekiti State, Nigeria

A.O. Adekunmi, S.O.W. Toluwase and F.M. Oluwatusin,
Department of Agricultural Economics and Extension Services,
Ekiti State University, Ado-Ekiti, Nigeria
adesoji.adekunmi@eksu.edu.ng,

Abstract: The study assessed the extent of the use of agrochemicals among cocoa farmers in Ekiti State, Nigeria. A multi-stage sampling technique was employed to select 120 respondents. Percentages, frequency counts, mean, standard deviation and Pearson Products Moment Correlation were used to analyze the data collected. The mean age of the respondents was 43.7 years, 77.5% was male and 73.3% was married while 80.84% had formal education ranging from primary to tertiary education. The household size was 6-10 in more than half (58.3%) while 1.7% had more than 10 members. The respondents received information on agrochemicals through different sources of information: extension contact (45.8%), fellow farmers (16.6%), friends and relations (11.7%), and Radio and Television (15.0%). The level of awareness for agrochemical was high at: fertilizers (100%), pesticides (95.8%), herbicides (99.2%), insecticides (65.8%) and fungicides (54.2%). The level of input use was very high at 98.3, 91.7 and 99.2% for fertilizers, pesticides and herbicides respectively. The major constraints identified were poor extension contact (40.8%), lack of awareness of some agrochemicals (22.5%), high costs of agrochemicals (18.3%) and lack of technical know-how (15.0%). Significant relationships existed between farming experience ($r = 0.244$, $p \leq 0.05$), farm size ($r = 0.119$, $p \leq 0.05$), external orientation ($r = 0.359$ $p \leq 0.05$) and the extent of agrochemical's use among the cocoa farmers whereas age, level of education and membership of social organizations had poor relationships. The institutional supports which emphasize awareness of the different agro-chemicals by cocoa farmers through regular contacts with extension services, farmers' groups, research institutes and NGOs are needed to tackle the constraints against high yields.

Keywords: Agro-chemicals, assessment, cocoa farmers.

Introduction

The roles of agriculture remain significant in the economy of Nigeria despite the strategic importance of the oil sector. Agriculture provides the primary means of employment for many Nigerians and accounts for more than one-third of the Gross Domestic Products (GDP) and labour force (FAO. 2003, World Bank, 2003). There is a consensus among policymakers, development partners and experts in Nigerian agriculture that the wealth of the country can substantially be derived from agricultural production (Opera, 2010). The agricultural economy is dominated by the small-scale farmers who constitute more than 80 percent of the farming population in Nigeria and reside in rural areas. The small farms they operate in are recognized as the focus for self-sufficiency in food and cultivation of export crops (Anaman, 1988). Thus, national programmes and international donors place a high priority on improving agricultural productivity and the economic well-being of the small-scale farmers to mitigate rising food deficits and alleviate poverty in many developing countries (Matteson *et al*., 1984). The strategies for raising farm productivity emphasized the procurement, promotion and use of external inputs which include pesticides, herbicides, fertilizers, farm machinery and improved varieties of crops.

The substances used to manage an agricultural ecosystem or the community of organisms in a farming area and protect it from diseases pests, and weeds are referred to as agrochemicals or crop protection products. The use of agrochemicals contributes to the healthy growth of crops and animals and improves farm work efficiency and stabilizes the supply of tasty agricultural produce (Kughur, 2012). Miller (2002) noted that the use of agrochemicals had increased 50-fold since 1950 and 2.3 million tonnes of industrial pesticides are now used annually. Although 75% of these pesticides are used in the developed countries, the use is increasing in developing countries and needs to be improved upon.

Many programmes or policies put in place have actually increased the level of agrochemicals' use by small-scale farmers in Nigeria. The pesticides are often used preferentially on cash crops and this is especially so for cocoa, which is predominantly grown in the forest zone of Ekiti State, Nigeria. However, the practice of intercropping staple food crops (cocoyam, yam, maize, rice, plantain etc) at various stages of plantation development has negative effects on cocoa output. The food crops deplete the soils of nutrients and the cocoa trees are susceptible to the diseases and pests to which these crops are alternate hosts thereby making the control and prevention difficult. It is against this background that this study seeks to assess the use of agrochemicals among cocoa farmers in Ekiti State. The specific objectives are to:

- describe the socio-economic characteristics of cocoa farmers in the study area;
- identify different sources of information on agrochemicals in the study area;
- determine the awareness of different agrochemicals among cocoa farmers in the study area;
- determine the relationships which exist between cocoa farmers' socio-economic characteristics and the extent of agrochemicals usage; and
- identify the constraints affecting adoption of agrochemicals in the study area.

Materials and Methods

The population for this research consisted of the cocoa farmers in Ekiti State, Nigeria and a multi-stage sampling procedure was use to select respondents to a structured questionnaire. At the first stage, two Local Government Areas (LGAs) were purposively selected from Ekiti South and Ekiti Central senatorial districts where cocoa is predominantly cultivated and which fall under forest and derived savannah vegetation zones respectively. At the second stage, four communities were randomly selected from each senatorial district. At the final stage, fifteen respondents were sampled from each community using a snow-all technique to arrive at 120 respondents. Data collected were analyzed using descriptive statistics of frequency counts, means, percentages and standard deviation. Pearson Products Moment Correlation was used to test the relationships between the farmers' socio-economic characteristics and the extent of agrochemicals usage.

Results and Discussion

Table 1 shows the socio-economic characteristics of the cocoa farmers in the study area. The mean age was 43.7 years while 31.67 percent of the respondents belonged to the 41-50 years age bracket. This shows that majority of the farmers were relatively young and agile. The male gender constituted 77.5% of the respondents reflecting cocoa as a male-dominated crop and 73.3 percent was married. The literacy level was high with 80.84 percent having at least primary education. This would have great advantage for the usage of agrochemicals that requires reading the labels and making accurate measurements for effective application. The households were large with 58.3 percent consisting of 6- 10 members while only 1.7 percent had more than 10 members. This higher household size would probably encourage the usage of agrochemicals because the farmers can rely on family labour for assistance during chemical application operations. Bamire *et al.,* (2002) had asserted that large family size is associated with greater labour force for timely operation of farm activities. The membership of social organizations was more concentrated in village community development (30.8%) followed by farmers' cooperative societies (20.8%) while farmers' group union and social groups have equal membership at 16.7%. The membership of these social organizations would probably stimulate the respondents in the usage of agrochemicals. The exposure of the respondents was in the form of travelling outside the state (41.7%), outside the LGA (29.7%) while only 0.8% had travelled outside the country. Most of the farmers had small holdings with 74.2% cultivating less than 5.0 ha plantations. More than half of the respondents (54.2%) had more than 20 years of farming experience.

Table 1: Socio-economic characteristics of cocoa farmers in Ekiti State

Characteristics	Frequency	Percentage (%)
Age (Years)		
21 – 30	02	1.6
31 – 40	06	5.0
41 – 50	38	31.67
> 50	74	61.67
Sex		
Males	93	77.5
Females	27	22.5
Marital Status		
Single	32	26.67
Married	88	73.33
Education background		
No formal education	23	19.16
Primary	53	44.17
Secondary	29	24.17
Tertiary	15	12.50
Household size		
1 – 5	48	40.00
6 – 10	70	58.33
> 10	2	1.7
Membership of Social Organization		
Village Community Development	37	30.8
Religious Group	18	15.0
Farmers' Group Union	20	16.7
Cooperative Societies	25	20.8
Social Groups	20	16.7
Characteristics	**Frequency**	**Percentage (%)**
External Orientation		
Within the village	20	16.7
Outside the village	14	11.7
Outside the LGAs	35	29.2
Outside the State	50	41.7
Outside the Country	1	0.8
Farm Size (Hectares)		
< 1	0	0.0
1.1 – 2.0	21	17.5
2.1 – 4.0	44	36.7
4.1 – 5.0	24	20.0
5.1 – 6.0	21	17.5
6.1 – 7.0	07	5.8
7.1 – 10.0	03	2.5
Farming Experience (Years)		
< 10	09	7.5
11 – 20	46	38.3
> 20	65	54.2

Source: Field Survey, 2014

Table 2 shows the different sources of through which respondents received information about the different agrochemicals: Extension agents (45.8%), fellow farmers (16.7%), friends and relatives (11.7%) while 15.0% got information from electronic media (radio and television).

Table 2: The relative distribution of the respondents' sources of information on agrochemicals

Sources of Information	Frequency	Percentage (%)
Ministry of Agriculture	08	6.7
Colleagues (Farmers)	20	16.7
Extension Agents	55	45.8
Radio	10	8.3
Television	08	6.7
Neighbours	05	4.2
Friends/Relatives	14	11.6
Total	120	100.0

Source: Field Survey, 2014

Table 3 shows the level of awareness of respondents about farm chemicals. The level of awareness was very high for fertilizers, herbicides and pesticides at 100, 99.2 and 95.8% respectively. Out of the pesticides, the awareness was highest for insecticides and fungicides at 65.8 and 54.2% respectively. Only small proportions of the respondents were aware of rodenticides and molluscides.

Table 3: Distribution of respondents' awareness of agrochemicals

Agrochemicals	Aware		Unaware	
	Freq.	Percentage (%)	Freq.	Percentage (%)
Fertilizers	120	100.0	00	0.0
Pesticides	115	95.8	05	4.2
Herbicides	119	99.2	01	0.8
Rodenticides	32	26.7	88	73.3
Insecticides	79	65.8	41	34.2
Fungicides	65	54.2	55	45.8
Molluscides	14	11.7	106	88.3

Source: Field Survey, 2014

Table 4 shows the levels of the respondents' use of the agrochemicals. Herbicides, fertilizers and pesticides were mostly used by 99.2, 98.3 and 91.7% of the respondents respectively. The high level of use related to the farmers' desires to improve farm work efficiency and obtain high yields for a steady supply of farm produce. Kughur (2012) had observed that the use of agrochemicals would not only contribute to the healthy growth of crops and animals but also improve farm work efficiency and ensure stable supply of tasty agricultural produce. The relatively lower use of insecticides (62.5%) and fungicides (64.2%) by the respondents might be due to the relatively poor financial status of cocoa farmers in the study area.

Table 4: Distribution of respondents' use of agrochemicals

Agrochemicals	Applied		Not Applied	
	Freq.	Percentage (%)	Freq.	Percentage (%)
Fertilizers	118	98.3	02	1.7
Pesticides	110	91.7	10	8.3
Herbicides	119	99.2	01	0.8
Rodenticides	04	3.3	116	96.7
Insecticides	45	37.5	75	62.5
Fungicides	43	35.8	77	64.2
Molluscides	02	1.7	118	98.3

Source: Field Survey, 2014

Table 5 shows the constraints identified by respondents in the use of agrochemicals.Poor extension contact was the major constraint encountered by 40.8% of the respondents, 22.5% identified the lack of awareness while others identified the unaffordable costs of different agrochemicals (18.3%) and lack technical know-how on the use of different agrochemicals (15.0%). Most of these problems cocoa farmers were associated with characterize the rural farmers who are predominantly poor and do not benefit substantially from many government policies and services meant for their socio-economic wellbeing (Youtl Oweri, 1987).

Table 5: Constraints encountered by respondents in the use of agro-chemicals

Constraints	Frequency	Percentage (%)
Lack of technical know-how	18	15.0
Cost of agro-chemicals	22	18.3
Lack of awareness	27	22.5
Poor extension contact	49	40.8
Conservativeness	04	3.3
Total	120	100.0

Source: Field Survey, 2014

Table 6 shows that significant relationships exist between farming experience ($r = 0.24$, $p < 0.05$), farm size ($r = 0.119$, $p < 0.05$), external orientation ($r = 0.36$, $p < 0.05$) and the extent of agrochemicals use. This implies that farming experience was a function of the extent to which agro-chemicals are used. Also, the larger the farm size of individual cocoa farmers, the larger is the quantity of agro-chemicals used. Furthermore, respondents' exposure in terms of external orientation would influence the awareness and utilization of these agro-chemicals. Age, education, and membership of social organization were not significant.

Table 6: Correlation coefficients of the relationships between socio-economic characteristics of cocoa farmers and the use of agro-chemicals

Socio-Economic Variables	Coefficient	P-value	Decision
Age	0.145	0.167	Non-significant
Education	0.143	0.184	Non-significant
Farming experience	0.244	0.008	Significant
Farm size	0.119	0.002	Significant
External orientation	0.359	0.035	Significant
Membership of social organization	0.150	0.163	Non-significant

Source: Field Survey, 2014

Conclusion and Recommendation

The contribution of cocoa production to the national economy cannot be over-emphasized but the output had declined since the oil boom era. The institutional supports to tackle the various challenges militating against high yields would emphasize the massive awareness of different types of agro-chemicals by cocoa farmers through regular with extension services, farmers' groups, research institutes and NGOs. The agro-chemicals should be subsidized by the government to make them affordable. The resultant increase in accessibility to the different agrochemicals will improve the adoption decision and use by the farmers so as to improve the production of cocoa. Also, the farmers should be trained on the technical know-how of application and safety strategies of these agro-chemicals.

References

Anaman K.A. (1988), African Farm Management. Ghana University Press, Accra.

Bamire, A.S., Fabiyi, Y.L. and Manyong, V.M. (2002) Adoption pattern of fertilizer technologies amongst farmers in the ecological zones of South Western Nigeria: A Tobit analysis. *Australian Journal of Agricultural Research* 53: 901-910.

FAO (2003) Food and Agriculture Organization FAOSTAT <http://faosata.fao.org/default.htm.

Kughur, J. V. (2012) Interrelations of vegetative and reproductive growth with special reference to indeterminate plants. *Botanical Review*, 28: 324-325

Matteson, P.C., Altieri, M. A. and Gagne, W.C. (1984) Modification of small farm practices for better pest management *Annals Hev. Entomol* 29: 383-102

Miller, G.T. (2002) Living in the Environment. 12th Edition. Praeger Publisher, London.

Opara, U.N. (2010), Personal and socio-economic determinants of agricultural information use by farmers in the Agricultural Development Programme (ADP) Zones of Imo State. *Nigeria Library Philosophy and Practice Journal.*http://unllib.unl.edu/LPP/IPP2010.htm

World Bank (2003) World Development Indicators Mimeo, Washington, D.C. CD-ROM.

Youtl-Oweri, G.D. (1987). Impact of weed science and agricultural chemicals on farm productivity in the 1980s. *Weed Sci*. 30: 426-429.