Afr. J. Trad. CAM (2004) **1**: 4- 14

Invited Review

Afr. J. Traditional,
Complementary and
Alternative Medicines
www.africanethnomedicines.net

CONSERVATION OF PLANT GENETIC RESOURCES

Omotoye Olorode

Department of Botany, Obafemi Awolowo University
Ile-Ife. Nigeria. E-mail:omotoopo@yahoo.com

Abstract
Survey, collection and conservation are important starting points in the genetic resources impact chain and in sustainable environmental protection strategies. Collection of plant genetic resources provides materials for herbaria, field gene banks, seed banks and *in vitro* conservation which are all important and crucial for characterisation and evaluation of plant genetic resources for various human needs. Because only a small spectrum of genetic variability is apprehended during collections, *in situ* conservation is crucial for optimizing biodiversity conservation programmes.

Keywords: Conservation, germplasm, cultivated plants, genetic resources

Introduction
This contribution is being made at the conjuncture of sustained national, and especially international, build-up concerning the antecedents, regarding the growing awareness on environment and biodiversity include the preservation of environment and conservation of plant and animal genetic resources and biodiversity generally. The origins of this concern and the contributions by scientists and institutions towards this concern were reviewed by Olorode (1995, 1995a). Some of the relevant work are the ones by Hardin (1968), Iltis (1968), Iltis *et al.* (1970), Odum (1971), Ophuls (1977), Hawkes (1990), Kokwaro (1994) and Lesser (1994).

Since man started domesticating plants and animals about 10,000 years ago, technology and increased human population have put consistent pressure on the habitats of plants and animals. This had resulted in progressive diminution of biodiversity. More importantly, the growth of population, agriculture and industry in Europe and the Americas in the last millennium not only destroyed habitats (and biodiversity), it narrowed down the genetic diversity of crops. Great political and economic events that since had significant global impact such as the voyages of discovery, the search for the sea route to the east, the slave trade, colonialism, major population movements, wars ("hot" and "cold"), were influenced, triggered or accompanied by the ascendancy of certain crops. The major ones among these crops were rubber, cotton, tobacco, sugar cane, cocoa, breadfruit, bananas, various spices, coffee, maize, wheat, Irish potato and oil

Afr. J. Trad. CAM (2004) **1**: 4- 14

palm. Major and long-distance germplasm movements were involved (Drodziak, 1982; Juma, 1989). Similarly, contemporary global events such as commercial large-scale agriculture, corporate control of agriculture and food, corporate control of agricultural inputs, the major crop successes and crop failures, also have their roots in the control of genetic resources and biotechnology (Fedder, 1976; George, 1970; Mooney, 1983; Juma, 1989; Lesser, 1994; Sachs, 1995).

The events and developments referred to above occurred and are occurring within the context of the dialectics of the imperatives of international cooperation and the reality of the sovereignty of individual nation states and peoples whose interests may conflict or coincide. These conflicts (contradictions) or identities have become heightened by the increasing resource gap between the rich countries and the poor countries of the world. In this regard, the areas of the exploitation of genetic resources, technological capacity for their conservation and utilization, and the controversies surrounding intellectual property rights (IPR's) and the ownership of genes in natural populations (Juma, 1989; Crespi, 1990; Lesser, 1994; Olorode, 1995a) must form appropriate background for all our deliberations.

In concluding this introduction, the clarification, if not apologia, needs to be made *ab initio* about the generalized character of this contribution given the specific thrust of the *African Journal of Traditional Complimentary and Alternative Medicines*. The main reason for this approach is simply that most plants used in "traditional" medicine remain wild and are sourced, therefore, from their natural habitats which are disappearing rapidly. To give an example, in a most recent collection of plant species (Hollist, 2004) used by the Yoruba (of Nigeria) in oral and dental medicaments, only 37 out of the entire 138 species (i.e. about 25%) mentioned are *cultivated* or *protected* (i.e. not deliberately cultivated) in farm lands or home gardens; the overall percentage of *cultivated* 'traditional medicine' plants are certainly much lower. In any case, even when some of these plants are cultivated or protected, most of the herbal supply of traditional medicine is still from the wild.

As we emphasize below, even for those cultivated or protected species or taxa, only a limited segment of the genetic variability can be so conserved! The second reason for the generalized approach of this contribution is that hitherto-unknown or little-known traditional medicinal properties of Nigerian (African) plants are disseminated and popularized quite frequently. Consequently a generalized conservation strategy is a sort of "comprehensive insurance" that will forestall the complete loss of these potential remedies. Thirdly, a conservation strategy that preserves the plant communities (the evolutionary milieu) of our target species is more scientific and more rational (Janzen, 1980; Daniels *et al*., 1996; Jones *et al*., 1994)

Conceptualising Collection and Conservation

The twin processes of collection and conservation can be conceived in different ways depending on the biological material concerned or the priorities that are set. We need to clarify these nuances.

Afr. J. Trad. CAM (2004) **1**: 4- 14

One consequence of collection and conservation is to remove (collect) genetic material from the milieu in which it evolved and perpetuate it in a different milieu (in laboratories, *ex situ* field gene banks, botanical gardens etc). This is perhaps the most common consequence (and goal) of most crop germplasm collections and expeditions and collections of medical culture and general microbial germplasm collections (Hawkes, 1990; Dasilva, Kalakoutskii and Da-Kang, 1990; Seeliger 1990; Ng, 1991; Ruredzo and Hanson, 1991; Okoli, 1991).

In the case of medical culture collections and general microbial germplasm collections and conservation, the consequence (and the goal) identified above is given. This is because the original sources of the materials are sporadic and the germplasms are, almost invariably, not amenable to *in situ* conservation because of economic and other considerations. It seems however that the attitudinal and practical basis of collection and conservation (*ex situ*) of crop (or any 'useful' plant) germplasm is more complex. The threat of genetic erosion is a real one arising from destruction of habitats and biodiversity necessitating a "rescue strategy" for germplasm collection and *ex situ* conservation. The main conceptual concern here is that collection and conservation in the way "gene hunters" understand them may become the pivot for neglect of *in situ* conservation and promotion of the illusion that we have a store of biodiversity in our 'gene banks' (Moore, 1990; DaSilva *et al*., 1990; Ng, 1991)

It is on the basis of the above that Olorode (1995a) conceptualized the scope, priorities and strategies for dealing with the task of conservation of plant genetic resources in developing nation states like Nigeria and the role of national institutions like NACGRAB, national research institutes, FEPA, the universities, communities and NGO's. The aim of the present paper is to dilate on these issues in respect of the specific areas of collection and conservation of plant genetic resources.

Collection of plant Genetic Resources

As we noted above, collection and conservation are not separate processes in collection of medical cultures and microbial germplasm. Consequently Seeliger (1990) stated that:

> "The main aim of collection is the deposition of comparative material under proper conditions in order to prevent its destruction, decay, decomposition, morphological change, alteration or loss of biochemical ….. serologic and toxic properties, or change in its susceptibility to biostatic and biocidal agencies…. kept under the exact condition of its first isolation".

On the contrary collection of materials of higher plants of different ecological or utilitarian categories may be either for purposes of record in herbaria, for rehabilitation in field gene banks or botanical gardens or for long-term preservation as seeds or *in vitro* cultures.

In this presentation, emphasis is on collection of higher-plant genetic resources. The most cost-effective strategy for carrying out the task of collection and exploration is to do so with the aim of collecting herbarium materials, live specimens and propagules (seeds, tubers, suckers, etc)

Afr. J. Trad. CAM (2004) **1**: 4- 14

What is to be collected?

Olorode (1995a) noted the tendency for PGR collectors (Okojie and Okali 1993, Attere *et al*. 1991) to concentrate almost exclusively on the germplasms of crops and their relatives (or the so-called useful plants). It was emphasized, as some other workers did (Juma, 1989; Lusigi, 1991; Ndambuki, 1991), that from a scientific and ecological point of view, such tendencies are short-sighted. We hasten to admit as Hawkes (1990) did, that these tendencies are forced on researchers partly because of the conceptual limitations and impatience of policy makers and funding agencies.

A comprehensive approach to the question needs to be adopted. Consequently the approach to what is to be collected must be environmentally sound. It must focus attention not only on germplasm that have potential use but those that sustain the habitats in which the "useful" plants evolved. Seven categories of the target groups were identified by Olorode (1995): cover crops for soil protection and reclamation including grasses, shrubs and trees; dominant species especially in the savanna (*Daniellia oliveri* (Rolfe) Hutch. and Dalz., *Anogeisus leiocarpus* (DC) Guill. and Perr. , *Terminalia* L. *spp*., *Combretum* Loefl. *spp*., *Pilliostigma* Hochst. *spp*. etc.); fodder species and range grasses; wild fruits; wild leaf vegetables; cultivated plants and their wild relatives (van Soest, 1990); ornamental and decorative plants. The collection of dominant species as suggested herein should provide material for studies in their phenology, regeneration and reproductive biology all of which will be crucial for the habitat rehabilitation programme which is proposed below as part of conservation strategy.

Where and how to collect?

For every category of germplasm that is adjudged to be desirable for collection, the guiding principles are that collections be exhaustive in populations and comprehensive in their range of geographical and eco-geographical distribution. Collection in the entire range of geographical distribution ensures that the totality of the genetic response of organisms to the environments they have confronted are sampled while exhaustive collections in populations ensure that the responses of genetic systems in local populations are apprehended.

It should be quite easy to appreciate the fact that explorations, for practical reasons, have *traditional routes* and that collections tended to be done largely along those routes: this limits the range of collections. Consequently collection efforts need to be directed towards the areas in which considerable vegetation fragmentation have not taken place and from which collections have been rare. In the present situation of Nigeria in which previous collections have been for herbaria rather than conservation, collection along traditional routes and more obscure routes need to be undertaken.

As a general rule, we can adopt a strategy in which collections are done in each vegetation belt, in as many ecosystems as practicable and in representative communities. At the level of

Afr. J. Trad. CAM (2004) **1**: 4- 14

individual species populations, attention needs to be paid to population size as this affects genetic variability and the consequences of stochastic population processes (Lusigi, 1991).
As noted above collections need to be done so that many purposes are satisfied–herbaria records, life *ex situ* gene banks and seed bank requirements. The traditional records for collections must accompany each collection–collector, collector(s)' number, latitude/longitude, locality, soil, community composition, prevalent fauna (if data is available), soil and edaphic condition, local uses, flowering period, fruiting period etc., abundance of the specimen etc. In the case of cultivated plants, name of donour (s), size (acreage) of farms and for how long the germplasm had been sustained, original source of materials need to be ascertained (Martin, 1995).

Before collection and exploration

Explorations and collection strategies and plans can profit considerably from preliminary surveys. Indeed surveys represent the starting point of genetic resources impact chain (Hawkes, 1990).

Once target groups to be collected are identified, a survey of previous collections from flora, herbaria, monographs and other published works should be done. This provides baseline information on what is known – what variations exist, what localities had been explored, time of flowering and fruiting, abundance, origins of the materials, genetic structure of populations, taxonomic problems etc.

In general regard to the above it is necessary to state a point made elsewhere (Olorode 1995a) that various fragmental but important information exist at various levels of work already done on Nigerian flora, but which are mutually unknown to workers in different parts of the country. Some insight into this issue can be gained from published work on various topics (Nwankiti, 1976; 1976a; Olorode and Baquar, 1976; Omidiji, 1980; Morakinyo and Olorode, 1984; Omaliko and Ene-Obong, 1988; Faluyi, 1990; Faluyi & Nwokeocha, 1993; 1993a; Okojie and Okali, 1993). Some of these will be useful as part of preliminary survey towards profitable collection and exploration efforts.

Conservation of Plant Genetic Resources

Earlier on in this paper, the two main strategies of conservation (*in situ* and *ex situ* strategies) have been identified and partly appraised. These issues are further addressed in this section.
But because of the urgency of needs, commercialization and profit, conservation of plant genetic materials tends to be driven almost entirely by raw utilitarianism. Consequently, conservation programmes are generally selective in terms of target taxa or groups of taxa. One consequence of this tendency is that the conception of the conservation of the so-called useful plants go the way of dominant crops and domestic animals. Monocultures are encouraged with all the debility of progressively narrowed genetic base.

An issue that is closely related to the dominance of utilitarianism is the question of the production and expansion of broad knowledge base in plant collection, identification, herbarium management, and general taxonomic studies. The acquisition and expansion of knowledge in

Afr. J. Trad. CAM (2004) **1**: 4- 14

these areas are pivotal long-term imperatives for scientific and forward-looking policies in conservation of plant genetic resources. The training of scientists (the so-called "pure" scientists) and technical personnel in these areas are therefore necessary for *understanding and conserving taxa whose use-values may exist only in the future*.

In situ Conservation

Genetic materials are conserved *in situ* when they are maintained in their original self-perpetuating populations (Moore, 1990). The importance of *in situ* conservation even within narrow utilitarian apprehension of enthusiasts of crops improvement, is captured succinctly in the surmise by Ingram (1990) that:

> "Even if all the optimistic predictions of bioengineers are correct and virtually all genetic material can eventually be easily synthesized, we will need to be studying and learning from successful populations in diverse ecosystems on an on-going basis"

and by Moore (1990) that:

> "*Ex situ* storage in gene banks, botanic gardens and zoos can only provide a tiny proportion of data and material derived from self-perpetuating populations and demands for new genetic diversity outstrip the breeders' ability to produce".

But beyond serving as a means of replenishing and augmenting the genetic system of agricultural crops and other categories of useful plants, the complexity of natural biomes and ecosystems ensure the stability of terrestial ecosystems including that of agricultural ecosystems. Clearly complexity and stability are best maintained through *in situ* conservation (see Lusigi, 1991).

Conservation in reserves and parks

In implementing the programmes of *in situ* conservation, the question is about how much human interference or "management" will be permitted or allowed. The capacity of policy-makers to implement conservation strategies will depend on social, political and economic factors. The point consequently is to balance these factors.

According to Lusigi (1991) ten categories of protected areas (natural ecosystems) are recognized according to a system developed by the International Union for Conservation of Nature and Natural Resources (IUCN). These categories represent various levels of protection from human interference. In the case of biosphere reserves for example, areas of representative terrestrial and coastal environments are recognized for purposes of protection under the UNESCO Man and Biosphere (MAB) Programme. Strategies of conservation in the MAB Programme combine "conservation and sustainable use of natural resources" (Ingram 1990) i.e. it involves human management of these reserves (Sanford *et al*. 1982).

From what we have said about the importance of *in situ* conservation, it is obvious that very definite effort must be made to appraise the status of various nature reserves and natural parks in

Afr. J. Trad. CAM (2004) **1**: 4- 14

Nigeria with a view to strengthening them as conservation areas. Similarly various assaults on natural vegetation by emergency large-scale commercial farmers have destroyed large acreages of natural vegetation all over Nigeria. Many species and varieties of plants and animals are probably lost for ever. In the oil-producing areas, the tragedy is beyond description. It is a pity of incredible proportions that in the face of irresponsibility of political decision-makers, scientists have either kept quiet or they are actively collaborating. The questions of Environmental Impact Assessments of projects and Industries need to be popularized and ingrained in public consciousness; scientists and conservationists must lead this process. Some sorts of reparation scheme may have to be put in place against organizations and individuals that have destroyed massive amounts of natural vegetation.

Public Institution lands as nature reserves and germplasm rehabilitation centres

It should be possible to utilize undisturbed and unused land spaces in certain public institutions at national, state and local government levels as conservation and rehabilitation centers. Local communities can, and should, be variously mobilized to participate in, and even initiate and design, these processes.

The idea of rehabilitation of natural vegetation in certain locations may sound strange but the concept is viable. In all locations in our country naturalists have some idea of the history of the vegetation. With institutional support and systematic mobilization of Community Based Organisations (CBOs), the plant materials that have been removed or have disappeared can be sourced and replaced. This is possible with some ideas of the history of the vegetation structure and cover patterns in these areas.

Ex situ *Conservation*

Ex situ strategies of conservation involve preservation of genetic resources outside their natural habitats. These strategies are more attractive to plant breeders and plant improvement organizations. They are usually plant genetic materials with immediate or near immediate use value in plant improvement.

Ex situ germplasm conservation is done in live gene banks (botanical gardens, home gardens, horticultural centres and field gene banks in research stations), as stored seeds in conventional seed banks, or as *in vitro* storage of plant tissue (buds, meristems, calluses etc). In Nigeria, apart from educational institutions (universities etc) and research institutions and centers (with specific crop mandates), life *ex situ* gene banks in form of botanical gardens hardly exist although in city centers, commercial horticultural outfits dot road sides in some big urban centers selling largely introduced ornamental plants.

In addressing the importance of *in situ* germplasm conservation above, we have pointed at the limitation of *ex situ* conservation. This has been done without prejudice to the major promises which inhere in *ex situ* conservation (van Soest 1990; Heywood, 1990; DaSilva *et al*., Ng 1991).

Afr. J. Trad. CAM (2004) **1**: 4- 14

Comparatively, *ex situ* conservation in field gene banks, botanical gardens and home gardens is not as capital or technology-intensive as other categories of *ex situ* conservation. Consequently *ex situ* (field) gene banks can be established or promoted with modest resources and public/community mobilization and participation. But it is equally important to build capacity for conventional seed bank and *in vitro* conservation in educational institutions and research centres. The area of microbial collections and the biotechnology relating to them also hold particular promise and they are also relatively inexpensive to husband. Capacity building in this area should be pursued.

Introductions, afforestation and conservation

Introductions and afforestation are veritable paradoxes in the business of conservation for two very important reasons. Introduction and afforestation programmes (whether of indigenous or introduced species) have the essential characteristics of monocultures or oligocultures with the attendant consequences of simplification of ecosystems, particularly instability. Secondly the experiences of introduction as exemplified by the story of *Endothea parasitica* (the Asiatic chestnut blight) on American Chestnut *Castaenea dentata* is a well-ingrained one (Elton, 1958) in the consciousness of students of the ecology of plant introductions.

One is not sure whether the environmental impact on genetic resources of native plants have been assessed in afforestation programmes that centre on introduced species such as *Pinus, Gmelina, Tectona, Eucalyptus* etc. or even on indigenous species such as *Triplochyton scleroxylon* K. Schum., *Terminalia* L. spp and *Milicia excelsa* (Welw.) C.C.Berg. While a lot of work is known on provenance trials, selection, improvement and diseases and pests of forest trees (Howland and Bowen, 1977; Ladipo, 1986), quite a lot of attention was paid to straight commercial viability and productivity of silvicultural enterprises (Ward, 1973; Oseni and Abayomi, 1973). The business of silvicultural plantations involving single species or a few species need to be appraised from the point of view of their potential for genetic erosion in natural habitats.

Conclusion

Various questions on the issues of theoretical foundations, policy conceptions and strategies and priorities on the conservation of genetic resources remain unsettled. The temptations are always there to simplify the questions, particularly when quick answers are demanded by policy makers and funding agencies (particularly those that undertake commercial investments). The task however is to balance this need for simplification of the problems with the need to provide a robust, long-term and environmentally-sound basis for the conservation of plant genetic resources.

It is also important that we emphasise the need for the acquisition of the knowledge and the skills of plant taxonomy, ecology and conservation beyond the immediate needs of utilitarianism. This is a condition for building the demands of the unseen future into the urgency of today’s needs.

References

Attere, F., H. Zedan, N.Q. Ng & P. Perrino. (eds) (1991). Crop Genetic Resources of Africa, Vol. 1. IBPGR, IITA, UNEP.

Crespi, R.S. (1990). The patenting of Genetic Resources. *Impact of Science on Society* No. 158. UNESCO (Paris) pp. 175-184.

Daniels, R.J.R., Vencatesan, J. and Anurahda, G. (1996). *Biodiversity Indexing in Agriculture*: *Landscapes to Species*. M.S. Swaminathan Research Foundation.

DaSilva, E.J., L.V. Kalakoutskii & S. Da-Kang. (1991). Microbial germplasm resources. *Impact of Science on Society* No. 158 UNESCO (Paris). Pp 155-166.

de la Perriere, R.A.B and F. Seuret. (2000). *Brave New Seeds*. Zed Books, London.

Drodziak, W. (1982). Tackling the Last Frontier. *Time*, October 18, 1982: pp. 48-55.

Elton, C.S (1958). *The Ecology of Invasion by Animals and Plants*. Methuen & Co. Ltd., London.

Fedder, E. (1976). *Strawberry Imperialism: An Inquiry into the mechanism of dependency in Mexican Agriculture*. Institute of Social Studies. The Hague.

Faluyi, J.O. (1990). Cytogenetic studies in the genus *Amaranthus* I. Occurrence of hybrids in natural populations. Nig. J. Bot. **3:** 169-177.

Faluyi, J.O. & C.C Nwokeocha, (1993). Occurrence and distribution of ploidy levels of *Oryza punctata* Kotschy ex Steud in Africa. Feddes Repertorium **104 (3):** 215-226.

_______(1993a). Agrobotanical studies of some populations of *Oryza sativa – O. glaberrima* complex of peasant agriculture. Nig. J. Bot. **6:** 1-11.

George, S. (1979). Feeding the Few: Corporate control of food. Institute for Policy Studies, Washinton D.C. USA.

Hardin, G. (ed). (1968). *Population, Evolution and Birth Control.* W.H. Freeman, San Fransisco.

Hawkes, G.J. (1990). What are genetic resources and why should they be conserved? *Impact of Science on Society* No. 158. UNESCO (Paris). pp.97-106.

Heywood, V. H. (1990). Botanic gardens and the conservation of plant resources. *Impact of Science on Society* No. 158 UNESCO (Paris). pp 121-132.

Hollist, N.O. (2004). *Akojo Oogun Ibile Yoruba fun awon Aisan Enu ati Eyin: A Collection of Traditional Yoruba Oral and Dental Medicaments*. Bookbuilders, Ibadan.

Howland, P & M.R. Bowen. (1977). *West African Hardwoods Improvement Project Research Report 1971-1977: Triplochyton scleroxylon* K. Schum and other West African Tropical Hardwoods. Federal Department of Forestry, Lagos Nigeria.

Iltis, H.H. (1968). The Optimum Human Environment and its relation to Modern Agricultural Preoccupations. *The Biologist L*. (3-4), 114-125.

______, O.L. Loukes & P. Andrews. (1970). Criteria for Optimum Human Environment. *Bulletin of Atomic Scientists* January, 1-6.

Ingram, G.B. (1990). Management of biosphere reserves for the conservation and utilization of genetic resources: social choices. *Impact of Science on Society* No. 158. UNESCO (Paris). pp 133-142.

Janzen, D.H. (1980). When is it coevolution? *Evolution* **34:** 611-612.

Jones, C.G., Lawton, J.H. and Schachak, M. (1994). Organisms as ecosystem engineers. *Oikos* 69, 373-386.

Juma, C. (1989). *The Gene Hunters: Biotechnology and the Scramble for seeds.* ZED Books Ltd., London & Princeton University Press, Princeton, N.J.

Kokwaro J.O. (1994). An overview of the Current State of Biodiversity in Africa. *Whydah* 3(9), 1, 3-9.

Ladipo, D.O. (1986). Pests and Diseases in Forest trees: potentials for selection and breeding for resistance in Nigeria. Paper presented at the 13th Annual Conference of the Genetics Society of Nigeria at FRIN, Ibadan.

Lesser, W. (1994). *Institutional Mechanisms supporting Trade in Genetic Materials: Issues Under Biodiversity Convention and GATT/TRIPs*. UNEP (Environment and Trade), Geneva.

Lusigi, W.J. (1991). The role of indigenous vegetation in the conservation and maintenance of ecological stability. In; F.Attere *et al.* (eds). *Crop Genetic Resources of Africa* Vol. IBPGR., IITA, UNEP. pp 171-176.

Martin, G.J. (1995). *Ethnobotany*: *A methods manual*. Chapman and Hall, London.

Mooney, P.R. (1983). The Law of the Seed: Another Development and Plant Genetic Resources. *Development Dialogue* 1-2. Dag Hammarskjold Foundation, Uppsala.

Moore, H.J. (ed) (1990). Editorial. *Impact of Science on Society* No. 158. UNESCO (Paris).

Morakinyo J.O. & O. Olorode, (1984). Cytogenetic and morphological studies on *Cola acuminata* (P. Beauv.) Schott. & Endl. And *Cola nitida* (Vent.) Schott. & Endl. And *C. acuminata – C. nitida* F_1 hybrid. *Café Cacao. The* XXVIII, 251-226.

Ndambuki, B.M. (1991). *In situ* Conservation and Monitoring of Rangeland Genetic Resources. In: F. Attere *et al*. (eds) *Crop Genetic Resources of Africa Vol. 1* pp. 177-184.

Ng, N.Q., P. Perrino, F. Attere & H. Zedan (eds.) (1991). *Crop Genetic Resources of Africa. Vol. II* IBPGR, IITA, UNEP.

Ng. N.Q. (1991). Long-term Seed Conservation: In; F. Attee *et al*. (eds) *Crop Genetic Resources of Africa.* Vol. 1 IBPGR, IITA, UNEP. pp. 135-148.

Nwankiti, O.C. (1976). Cytogenetics of some Nigerina Peppers–Genus *Capsicum* I. Cytological Aspects *Nigerian J. Sci.* 10, 47-60.

_______. (1976a). Cytogenetics of some Nigerian Peppers – Genus *Capsicum*. II. Hybrid origin of *C. frutescens*. *Nigerian J.Sci.* 10, 61-75.

Odum, H.T. (1971). *Environment, Power and Society*. John Wiley, N.Y.

Okojie, J.A. & D.U.U Okali (eds.) (1993). *Lost Crops of Nigeria: Implications for Food Security*. University of Agriculture. Abeokuta.

Okoli, O.O. (1991). Yam germplasm diversity, uses and prospects for improvement. In: N.Q. Ng *et al*. (eds). *Crop Genetic Resources of Africa* Vol. II. IBPRG, IITA, UNEP. pp. 109-118.

Olorode, O. (1995). Genetic Resources, Biodiversity, Environment and Development. Invited Conference Paper presented at the 23rd Annual Conference of the Genetics Society of Nigeria, University of Uyo, May 1995.

________. (1995a). Conservation of Plant Genetic Resources in Nigeria: Conceptual Perspectives, Target Species and Implementation Strategies. *Genetic Resources Conservation* (Communicated).

Afr. J. Trad. CAM (2004) **1**: 4- 14

_______(1995b). Non-Governmental Organisation (NGO's): The Dialectics of Cooptation and Empowerment of popular Forces. Paper presented at the Friedrich Engels Centenary of the Mahmud Tukur Memorial Committee, ABU, Zaria. 7th August, (1995). Mimeo.

__. and Baquar, S. R. (1976). The *Hyparrhenia involucrate – H. subplumosa* (Gramineae) complex in Nigeria: morphological and sytological characterization. Bot. J. Linn. Soc. **72:** 212-222.

Olorode, O: (2002). Vegetation and Fauna. In*: Africa Atlases: Nigeria*. Les Editions J.A. aux du Jaguar. Paris; France. pp. 66-67.

Omaliko, C.P.E. & E.E. Ene-Obong. (1988). Biology of file grass (*Anthephora ampulaceae* Stapf and Hubb. Ife J. Sci. **3 (1 & 2):** 109-114.

Omidiji, M.O. (1980). Cytogenetic Studies in the F_1 hybrid between African eggplant *S. gilo* Raddi and *S. melongena* L. Hort. Res. **21:** 75-82.

Ophuls, W. (1977). *Ecology and the Politics of Scarcity*. W.H. Freeman & Co. San Francisco.

Ruredzo, T.J. & J. Hanson. (1991). *In vitro* conservation: In Attere, F. *et al* (eds). *Crop Genetic Resources of Africa.* Vol. I. IBPGR, IITA, UNEP. pp 157-164.

Sachs, I. (1995). *Searching for New Development Strategies: The Challenge of the Summit.* MOST Policy Paper 1, UNESCO.

Sanford, W.W., H.M. Yessufu & J.S.O. Ayeni (eds) (1992). *Nigerian Savanna MAB State of Knowledge Workshop Selected Papers.* Kainji Lake Research Nigerian MAB Committee & UNESCO, New Bussa.

Seeliger, H.P.R. (1990). The Medical Culture Collection. *Impact of Science on Society* No. 158, UNESCO (Paris). pp 167-174.

Swanson, T.M. and E.B. Barbier. (1992). *Economics for the Wilds: Wildlife, Wildlands, Diversity and Development*. Earthscan Publications Ltd., London.

Van Soest, L. J.M. (1990)a. Plant genetic resources: safe for the future in gene banks. *Impact of Science on Society:* No. 158. UNESCO (Paris). pp. 107-120.

Ward, D.M. (1973). Methods of Increasing Productivity and Efficiency in Plantation Work in Nigeria. *Nigeria Forestry Information Bulletin* (New Series) No. 27. Federal Department of Forestry, Ibadan.