THE RELEVANCE OF LOCAL AND INDIGENOUS KNOWLEDGE FOR NIGERIAN AGRICULTURE [1]

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ABSTRACT

This paper presents the results of a pilot study on agricultural practices in Nigeria, commissioned by the United Nations Environment Programme (UNEP). The aim of the study was to compare indigenous knowledge (IK) about farming practices *vis-à-vis* modern technology in sustainable crop production.

The agricultural sector plays an important role in Nigeria's economy, contributing 37 percent of the Gross Domestic Product (GDP) and employing 65% of the adult labour force. Over 90% of Nigeria's agricultural output is by small-scale (less than 5 ha) resource-poor farmers who have, for centuries, sustained the national food supply through a considerable wealth of IK about how to harness both natural and socio-economic factors of production. The study found that despite the introduction of agro-chemicals, many farmers continued to rely on indigenous farm practices, either on their own or in combination with modern technologies. The study concludes that small-scale, resource-poor farmers have good reasons for sticking to their local knowledge and farming practices attendant thereto, and that modern technologies can only be successful and sustainable if the interplay of local knowledge of cultural, social and ecological systems are taken into consideration. In so stating, it is suggested that, given the pervasive scenario of rapid population growth (2-3% per annum) and the attendant domestic food demand deficits, there is the emergent need to balance the sustaining IK of the production system with modern technology, through a systematic hybridization strategy.

1. INTRODUCTION

1.1 Indigenous Knowledge and Agricultural Productivity

Third world agriculture is characterized by fragile and difficult environments (Chambers *et al* 1989). According to the Brundtland Commission categorization of agricultural systems (WCED 1987), three systems are recognized: First, *Industrial Agriculture*, characterized by large farm units, high capitalization, high input-independent and oftentimes subsidies-supported; second, *Green Revolution Agriculture*, characterized by a mixture of small and large farms which exploit high-yielding varieties with complementary inputs; and third, *Low Resource or Resource-Poor Agriculture*, characterized by small farm units, fragile soils, rain-dependency and minimum inputs. It is to the third category that Nigerian agriculture belongs.

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1. Presented at the International Conference on *Bridging Scales and Epistemologies: Linking Local Knowledge with Global Science in Multi-Scale Assessments*; March 16-19, 2004, Alexandria, Egypt.
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Despite the dominance of mineral oil exploitation as the current mainstay of the Nigerian economy in terms of foreign exchange earnings, the agricultural sector remains the largest, contributing 37% of the GDP and employing 65% of the adult labour force (Falusi 1997). Apart from its pivotal role in meeting the food and fibre needs of a large and growing population of 12 million (2-3% growth rate), it provides the raw materials for the agro-industrial sector and is the largest contributor (88%) to non-oil foreign exchange earnings. Over 90% of Nigeria's agricultural output is by small-scale (less than 5 ha), resource-poor farmers who have, for ages, sustained the national food supply (Falusi 1997, Olayide *et al* 1980), through a considerable wealth of environment-related IK in the harnessing of natural, and in the manipulation of socio-economic, factors of production.

Despite this "seemingly sustainable" resource-poor farming, the Nigerian economy, like those of most African nations, is characterized by poor performance due to low agricultural productivity (FAO 1996, Goldman and Block 1993, Adedipe *et al* 1997a, Adedipe *et al 1997b,* Adedipe 1998, Spencer and Kaindaneh 1998). It is in this context that, in 1996, the FAO (1998) adopted the Rome Declaration on World Food Security and World Food Plan of Action.

It is against the overall milieu of the "confusion" as to the way out for third world agriculture, that the issue of the relevance of IK is now receiving more objective techno-professional assessment and policy attention, world-wide (Chambers *et al* 1989, Gilbert *et al* 1980, Johnson 1972, Rhodes and Babbington 1988, Silitoe 1998, Sumberg and Okali 1988, Swift 1979, von Lieberstein and von Marrewijk 1998, Titilola 1990, Titilola 1994) and more specifically in Nigeria (Fasunwon and Mabawonku 2000, Nnodu 2000, Ogunyemi 2000, Ogboire 2002, Ogunyemi and Fadina 2000).

1.2 The Meaning and Status of Indigenous Knowledge in Agriculture

There is no standard definition of indigenous knowledge (IK). However, there is a general, understanding as to what constitutes IK. Broadly, it is variously regarded as ethno-science, folk knowledge, traditional knowledge, local knowledge, people's knowledge, among others. Warren (1987) defined IK as a local knowledge that is unique to a given culture or society. According to Rajasekaran (1993), IK is the systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments and intimate understanding of the environment in a given culture. To Haverkort and de Zeeuw (1992), IK is the actual knowledge of a given population that reflects the experiences based on traditions and includes more recent experiences with modern technologies. It is also described as a non-conventional body of knowledge that deals with some aspects of the theory, but more of the beliefs, practices and technologies developed without direct inputs from the modern, formal, scientific establishment; in this case, towards the management of farms (Chambers *et al* 1989, Gilbert *et al* 1980). IK has, therefore, evolved through "unintended experimentation", fortuitous mistakes and natural selection by farmers, and arises from the practical judgement and skill needed to survive in a fragile soil system (Aina 1998, Moss 1988) by a number of environmental challenges (Adedipe 1983, Adedipe 1984). What is clear from all of these perspectives is that, over centuries, farmers are knowledgeable about their resources and the environment in so far as these govern their farming practices, and cultural heritage (Opefeyitimi 1998), as well as traditional governance and leadership structures (Akinbode *et* al 1986) and that some of these are verifiable by scientific enquiry methodologies. A socio-psychological analysis has been provided by Fasuwon and Mabawonku (2002). What modern science and technologies would need to do is to continue to find ways and means of accommodating and using the multi-dimensional framework of IK.

This, to us, is the essence of the important recognition being accorded IK in the Millennium Ecosystem Assessment.

Chemicals in Nigeria have been variously examined in terms of environmental issues and consequences (Adedipe 2000, Adedipe 2001, Adedipe 1994); production issues and considerations (Okuneye *et al* 2002), and farm enterprise matters relating to the Nigerian export crop sector for cocoa and rubber (Okuneye *et al* 2003), as well as for banana in Equador and cotton in China (Abaza and Jha 2002).

2. ESSENTIALS OF AGRO-ECOSYSTEMS IN RELATION TO INDIGENOUS KNOWLEDGE APPLICATION

As stated in Section 1.2 above, the essence of the Millennium Ecosystem Assessment is to give deserving recognition to IK in order to improve sustainability and environment-friendliness in the promotion of overall human well-being. This has to be done, first, with an improved understanding of the essential attributes of agro-ecosystems as they relate to the application of IK. The following are only a few examples of the practical applications of indigenous practices which serve to illustrate how well farmers in third world agriculture have learned to manipulate the environment and to thereby derive utilitarian values therefrom. The major ones, according to a classification by Reijntjes (1992), are:

2.1 Indigenous Landuse Systems

Forest Gardens

In many parts of the humid tropics, indigenous systems of forest gardening (silvi-horticulture) have been developed. For example, village agro-forests have existed in Java since, at least, the 10th century and comprise, today, 15-50% of the total cultivated village land. They represent permanent types of landuse which provide a wide range of products with high food value (fruits, vegetables, etc.), and non-food products (firewood, timber and herbal medicines). In their small plots, often less than 0.1 ha, Javanese peasants mix a large number of different plant species. Within one village, up to 250 different species of diverse biological types may be grown. Similar methods of conservation and biodiversity protection have been widely reported for India (Sinha 1994, Sinha 1998) and Latin America (Periera 1991), a host of African nations (Baidu-Forson 1999) including Nigeria (Fagbemi 1998, Adebisi and Bada 2001).

In these systems, natural processes of cycling water, organic matter and nutrients are maintained and are sufficient to maintain soil fertility without the use of chemical fertilizers. Thus, the villagers are able to regulate or modify ecosystem dynamics and functioning.

Shifting Cultivation

Shifting cultivation has attracted the attention of agriculturalists, foresters, conservationists, economists, social scientists and administrators in third world countries, particularly Africa. To agricultural observers accustomed to the more stable and continuous farming systems of industrial countries and of the densely settled regions of Asia, it has seemed perverse and wasteful. On close study, it is found to be generally accepted as a reasonable and effective method of maintaining fertility and output under appropriate circumstances (Bunting and Bunting 1984). This is based on the fact that shifting cultivation is often characterized by a season-to-season progression of different crops which differ in soil nutrient requirements and susceptibility to weeds and pests. The specific crops and choice of succession may differ from country to country, but the general principle of the IK remain the same, although the essential character is being modified by emerging farming systems such as zero tillage and alley cropping (Kang *et al* 1981).

2.2 Soil Fertility Management Practices

Indigenous farmers have developed various techniques to improve or maintain soil fertility. For example, farmers in Southern Sudan and in Zaire noticed that the sites of termite mounds are particularly good for growing sorghum and cowpea. In Senegal, the indigenous agro-silvo-pastoral system takes advantage of the multiple benefits provided by *Faidherbia* (formerly *Acacia)* albida. The tree sheds its leaves at the onset of the wet season, permitting enough light to penetrate for the growth of sorghum and millet, yet still providing enough shade to reduce the effects of intense heat. The tree also fixes nitrogen for improving crop yield. This represents a good IK of the plant physiological principles of canopy structure, light penetration and nitrogen fixation in moderating photosynthesis and crop productivity (Adedipe 1984).

2.3 Pest Management Practices

Biological pest control has been of recent scientific interest, yet IK practices pertaining thereto have been in existence for over a century, particularly in China where citrus growers place nests of the predacious ant *Oecophylla smaragdini* in orange trees to reduce insect damage. In India, local farmers intentionally plant sunflower in wheat fields so as to aid the bio-control of rats by owls at the stage of grain development (Sinha 1994).

2.4 Weed Management Practices

Farmers in the Usambara Mountains of Tanzania developed a multi-storey farming system in which they practised fallowing, intercropping and selective weeding. Young crops do not provide ground cover. The farmers understood that, if weeds are left to grow, they cover the soil, prevent it from heating up or drying out excessively, induce a positive competition which simulates crop growth and reduce erosion during rainfall. Later in the season, when the farmers regarded weed competition as negative for crop growth, they did superficial hoeing, and left the weeds on the soil surface as protective mulch, to recycle nutrients and to allow nitrogen assimilation through the bacteria decomposing the plants. A similar situation in Nigeria is shown in Fig.1. As is patently clear, although they did not know the physiological scientific basis (Adedipe 1984) they knew that their practices sustainably improved yields.

2.5 Overaching Principles of the Agro -Ecosystems in Relation to IK Practices

The agro-ecosystems and farming practices briefly discussed above (Sections 2.1 – 2.4 are governed by some overaching principles of farming systems. The latter include both indigenous cropping systems and indigenous soil health practices as broadly classified by Rajasekaran (1993).

The indigenous cropping systems include sequential cropping, mixed cropping (including alley farming, Fig. 4), monocropping, intercropping and border cropping; while the indigenous soil healthcare practices are evident in crop rotation which prevents a build-up of common pests and diseases over the years. Consequently, these two sets of practices have been, and are likely to be, used for maintaining cost-effective and environment-friendly crop yields. Figs. 2 and 3 show inter-cropping in Ogun State of South-Western Nigeria.

Fig. 1. Stubble mulching on a vegetable farm in Ogun State, South-Western Nigeria.

Fig. 2. Intercropping of cereal with a legume in a local farm of Ogun State, South-Western Nigeria

Fig. 3. Intercropping of a broad-leaf vegetable with short duration narrow-leaf vegetable experiment in Ogun State, South-Western Nigeria.

Fig. 4. Alley cropping of a tree crop with an arable crop in Ogun State, South-Western Nigeria.

These IK facts notwithstanding, it is becoming evident that they must be supplemented with modern technologies which have been demonstrated, in recent times, that they can be made environmentally acceptable in terms of food safety. One of such modern technologies, *agro-chemicals,* is the subject of the present study and report.

3. AGRO-CHEMICALS IN THIRD WORLD AGRICULTURE: A NIGERIAN CASE STUDY OF ADOPTION AND MAGNITUDE PATTERNS

3.1 Overview of Crop Protection Agents

Over the years, farmers in developing countries have been induced, through some incentives, to use chemicals as part of the production inputs. While a good proportion has been so stimulated to use external inputs such as fertilizers, herbicides, insecticides, fungicides, nematicides, etc., the overwhelming proportion continue to use very low quantities of external inputs, while in extreme cases, the use of such inputs is quite minimal. In such cases as do obtain in some developing countries, natural extracts of plant origin are being used with reasonable degree of successes (Radcliffe *et al* 1992). These include the extracts of the neem plant (Fadina and Ogunyemi 2002, Jostweni and Shrivasta 1981); Mango *Mangifera indica*, eucalyptus, *Eucalyptus camaldulensis* (Ogboire) for the control of common plant diseases. What makes their use attractive stems from economic (affordability) considerations on the one hand, and the unpleasant environmental consequences experienced with conventional agrochemicals, on the other hand.

Given that productivity remains low and food deficits remain high, the use of agrochemicals is, understandably, inevitable, particularly with increase in farm size and the intensification of safety guidelines and monitoring capacity for their use. The impacts of the adoption of such modern technologies would need to be assessed, particularly with regard to the adoption by resource-poor farmers.

3.2 Nigerian Major Crop Production and Use of Agro-Chemicals

Main Crop Production

The commonest tree and arable crops in Nigeria on which agro-chemicals are regularly used are cocoa, citrus, rubber, cowpea, maize and millet. However, cocoa is the single most dominant of tree crops, given its widespread occurrence, high volume of production, its weighty contribution to export earning, its income generation for farm producers, and employment generation for processors and associated service providers. Similarly, cowpea is widely produced and consumed in Nigeria which is reputed to be the world's largest producer. In recent times, cowpea production has increased by 4.7% from 1997 to 1998, and by 5.3% from 2000 to 2001 (CBN 2001). Conversely, the production of other staple arables increased by a lower magnitude of 2.8% from 1997 to 1998 and 3.3% from 1999 to 2000.

As stated in Section 1.1 above, the main producer are small-scale, resource-poor farmers, based in rural areas where socio-cultural factors, dominate their thoughts and ways of life (Akinbode *et al* 1984). They act based on their local beliefs and respond to innovations after a long period of observations which convinces them that such innovations are superior to their age-long practices (Etteh 1990). The crucial questions are:

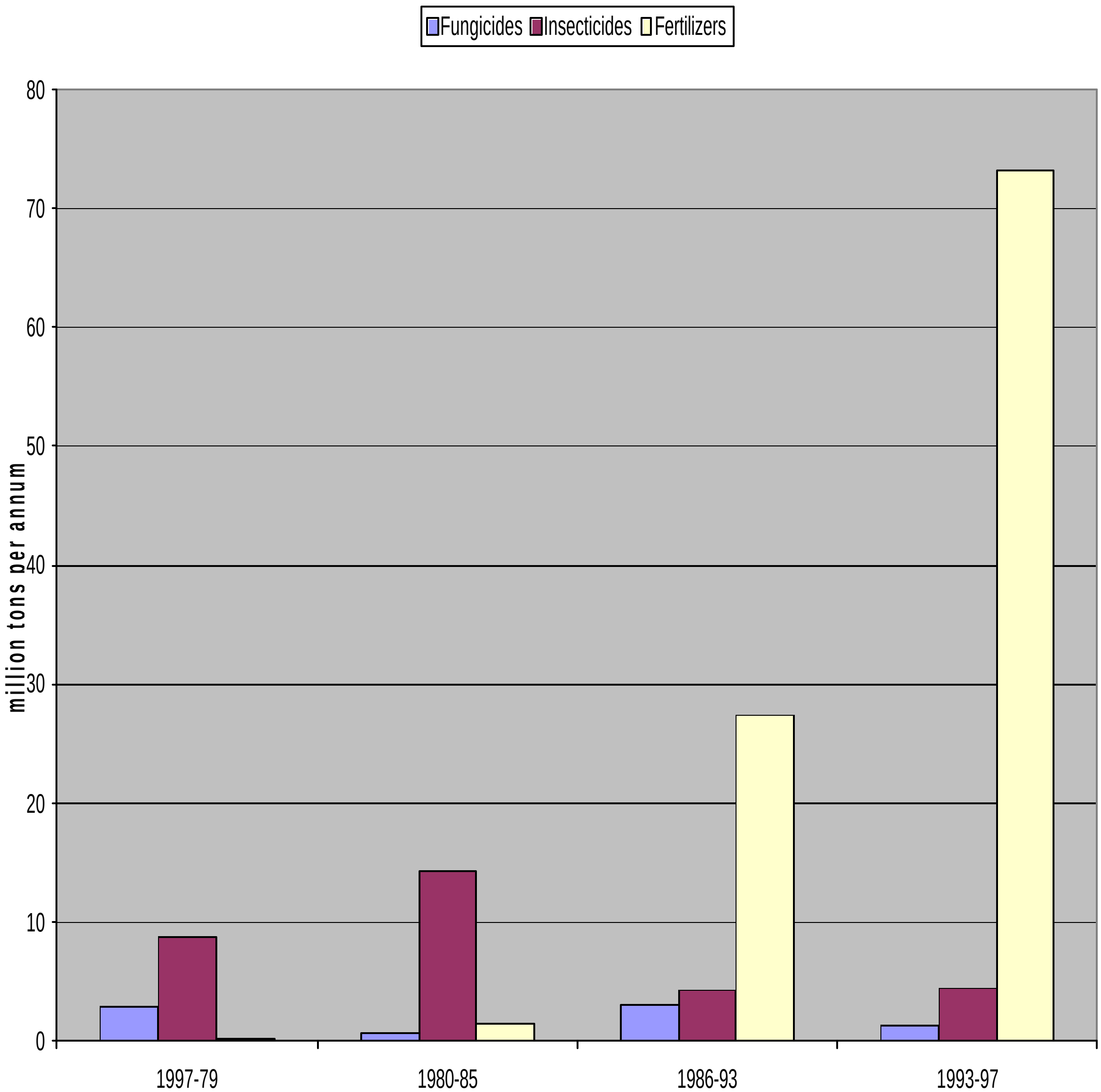
(i) how far has this phenomenon influenced tree and arable crop production, with emphasis on cocoa and cowpea, in Nigeria?

(ii) what has been the trend among Nigerian farmers who rely on IK with minimum inevitable use of external inputs *vis-à-vis* those who use fairly large quantities of external inputs (fertilizers, fungicides, insecticides and herbicides), in terms of crop productivity and living standard of the people?

Consumption of Agro-Chemicals

Fig. 5 shows the trend in the importation of agro-chemicals into Nigeria between 1974 and 1997.

Fig. 5. Annual average values of agro-chemical importation by Nigeria



Source: Okuneye et al. 2002: Environmental impact of trade liberalization in the Nigerian export crop sector. A final Country Report, presented to UNEP, Geneva, 2001.

It is obvious that, by the standards of the industrialized nations, the use of agro-chemicals, particularly as farm production inputs, is extremely low, as also asserted by UNEP (1992). Fertilizers predominate, followed by insecticides and fungicides. The low level of use is made even clearer, especially for insecticides, since the quantities shown include those for non-agricultural uses including insect control for public health purposes.

Given the low rate of use of these agro-chemical inputs by small-scale farmers, it was of interest to assess the environmental issues surrounding the production of the dominant crops with and without the inputs and to relate them to indigenous technical knowledge in the prevalent farming systems and practices.

The main objectives of the study, funded by UNEP, were:

(i) To describe the agricultural practices in some selected major crop producing areas of South-Western Nigeria, and their influence on agricultural production and the environment;

(ii) To discuss the emergent changes in the leadership structure in the rural areas and how this directly and indirectly influences the knowledge of the environment in relation to their agricultural production practices;

(iii) To assess the trend in environmental management as a result of the IK of the farmers; and

(iv) To suggest the modalities for using modern technologies to improve on indigenous knowledge without introducing conflicts that might negate strategic crop production in Nigeria as a typical developing country sustained by resource-poor farming.

4. METHODOLOGY

The study in the period 2000-2004 covered the South-Western zone, about 10% of Nigeria's land area of 923,921 km^2 (spreading from latitude O^o 20' to 14^o 10' North of the Equator; and from longitude 2^o 15' to 14^o 15' East.

The population, by 1991 census projection, is 125 million, with the rural population accounting for 65%. Varieties of tree crops, arable crops, livestock, wildlife and fisheries are produced mainly by small-scale farmers that represent about 75% of the farmers, and who are responsible for about 90% of crop output.

The study sites were located in Ogun State (one of Nigeria's 36 States and the Federal Capital Territory), and were selected in consultation with the Ogun State Agricultural Development Project (ADP) as the State Agency responsible for Extension Services. Of the four agro-ecological zones of the State, two areas were chosen: the first, a high cocoa and cowpea producing area; and the second, a marginal production area.

The study adopted the Rapid Rural Appraisal Method using questionnaires in a household survey format, using 100 farmers in each of the two locations. This was complemented with Focus Group Discussions with respondents involving recorded interaction with respondents under a semi-formal arrangement. The community leadership and some community based organizations representatives were also interviewed as Key Informants (Fig. 6), as detailed in Ayinde (2004). This was done because of the strong cultural values attached to traditional leadership through knowledge by oral history (Akinbode *et al* 1984) and the need to adopt new modus of extension services for upliftment of the quality of life in rural areas (Adedipe 1983). The Questionnaire used is attached hereto as an Appendix.

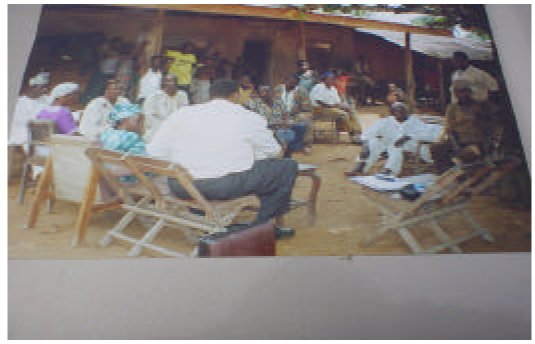


Fig. 6. Focus Group Discussions and Key Informant Interview Sessions in a typical farm homestead.

5. RESULTS AND DISCUSSION

5.1 Agricultural Practices and the Environment.

Farmers in the study area have evolved over a long period to identify the type of agricultural practices germane to their farming objectives. Suffice it to say that most of these farmers have low level of formal education (Table 1) and are resource-poor. These two factors may have accounted for the type of farming practices adopted by them in order to primarily meet the farm family requirements and to dispose of the surplus through various marketing techniques. The latter is becoming of equal importance with increase in farm holdings, use of improved seeds and some modest application of agro-chemicals, particularly fertilizers.

Table 1 indicates that mixed cropping is the most widely practised agricultural system by the farmers. The crop combination with respect to cocoa production shows farmers' IK on the need for young cocoa seedlings to have enough shade prior to their full establishment. These cover crops are still left to produce crops which serve as supplementary revenue to the cocoa farmers. In the case of cowpea, farmers are aware of the importance of pesticide use for optimum performance; however, the adoption of mixed cropping in cowpea production was seen more from their own perspectives that it will limit the spread of pest build-up on their cowpea farms.

Eighty-eight percent (88%) of the farmers practised mixed cropping with diverse number of crop combinations. It was found that mixed cropping led to 26% rise in total crop output and 32% rise in profit for the cowpea farmers. There were economies in labour and pesticide use as well as minimization of crop loss as compared with sole cropping

The issue of burning and crop rotation were investigated. About 55% of the farmers stated that they burnt their cleared trees and shrubs before planting. By this, they saved 27% labour costs needed for land preparation and used 43% less fertilizer and insecticides than those who did not. These practices were mostly common with the small-scale farmers that formed 88% of the sample. These corroborated the findings that cultural practices like crop rotation and mixed cropping are veritable cultural ways of controlling pest build-up in arable crop production (Kitch *et al.* 1997).

The land management practices adopted by the farmers interviewed were informed more by the expected gains rather than by financial incapacitation to subscribe to large-scale land cultivation since they also engaged in labour contribution in cooperative activities. This necessitates the adoption of minimum tillage with slight variations in its applicability. Some farmers only removed the shrubs and left the trees scattered on the farm to serve as windbreaks and to thereby prevent lodging of crops planted on the farm.

The pest management practices adopted were found to be environment-friendly and can be classified into two:

(i) Use of conventional pesticides below the minimum recommendation

A lot of variation also abounds in the quantity of pesticide applied and the number of application periods. For instance, in cowpea production, the recommended number of times of application is 5; but the average rate of application was 2 times by the farmers interviewed. Farmers adduced two reasons, namely, not being able to afford the cost and that the supplementary crops would serve as traps for some of the crop pests in question. The latter should be seen as an approach in their perception to reduce the problem of pesticide toxicity on the farmers and the environment in general, in addition to the pest control safeguards (Altieri 1991, Altieri and Anderson 1986, Periera 1991, Sinha 1994 and Sinha 1998).

(ii) Use of non-conventional pesticides

Use of local pesticides was a common practice among 42% of the farmers. Neem (*Azadirachta indica*) extracts were commonly used to spray crops especially cowpea in place of the conventional insecticide while chilli pepper (*Capsicum annum.*) was also used to preserve harvested cowpea in the store. In the case of cocoa, life plant (*Jatropha gossipifolia*) and tobacco (*Nicotiana tabacum*) plants were used to prevent insect build-up on the cocoa plantation. These observations point to the need for complementarities of modern technology with IK for crop production, Ogunyemi and Fadina (2000) and for crop disease protection (Fadina and Ogunyemi 2000) and crop pest control (Altieri 1991).

Table 1: Agricultural practices in some parts of Southwest Nigeria

ATTRIBUTE	COCOA FARMERS	COWPEA FARMERS
Level of formal education	Low level	Low level
Production methods	Mixed cropping	Sole cropping Mixed cropping
Crop combination	Cocoa/Banana/Cocoyam Cocoa/Sweet Orange	Cowpea/Cassava Cowpea/Maize
Land management practices	Minimum tillage Use of rudimentary farm tools	Minimum tillage Use of rudimentary farm tools
Pest management practices	Conventional method Indigenous knowledge	Conventional methods Indigenous knowledge
Environmental Management Practices	Burying pod husks	Using leaves and seed sheaths as manure

Source: Field Survey Data, 2002

5.2 Leadership Structure in the Rural Areas and its Influence on the Knowledge of the Environment and Agricultural Production.

There has been increased presence of educated, well-informed people as rulers and as members of decision-making organs in the rural areas in the recent past. This has rubbed on the knowledge and perception of the rural people regarding the environment and the importance of environmental management. With this trend, there has been a crossing between local knowledge and the modern ideas brought about by the increasing number of retired educated people in the rural areas. One effect this has created is the decline in the-use of *Gammalin 20*, a fungicide, to harvest fish in rivers and lakes. This has also brought about increased use of improved inputs such as fertilizers. The leadership structure change was more visible in those rural areas which share common boundaries with the urban areas and other areas where there is a presence of industrial development, which is the peri-urban areas.

5.3 Trends in Environmental Management Consequent on Indigenous Knowledge of the Farmers.

In environmental economics, two forces are at play; the economic and the environmental issues. The former aims at maximization of productivity with the exploitation of the resource base in the minimum time, while the other aims at ensuring the cautious exploitation of the resource base for long-term generational development (Adedipe 2001).

According to estimates, the utilization rate of pesticide is only about 30%; the remaining 70% of pesticides is retained in the soil or drained with the rainwater into rivers and lakes (UNEP 2002). By implication, the retained pesticide in the soil will accumulate over the years and may be translocated by arable crops which may be cultivated on the contaminated land. Consumption of such contaminated crops may have negative health effects. The spate of pesticide use in Nigeria will increase if IK adoption is allowed to decline. It has been estimated that Nigeria consumes about 1.3 million tonnes of pesticides per annum (FMARD, 2000), and that farmers improperly apply hazardous pesticides in combination with other chemicals. The risk from pesticide exposure to farmers' health may increase with applications because of fatal toxicity of chemical pesticides (Dung and Dung, 1999).

As highlighted earlier, pesticide use among the farmers interviewed is very low and this is because most of the farmers do not have the financial wherewithal to procure these chemicals when needed. The need to reduce the possibility of crop loss to pest necessitates the use of conventional pesticides and supplementation with protective types. Other studies, for example Apantaku (2000), indicate that indigenous farming practices is an age-long practice among the Nigerian farmers who are still largely conservative in their approach to crop production and management. Nevertheless, extension agents have had to learn some of these indigenous practices for onward transmission to other clientele for adoption. There are other technologies that are jealously guarded by the local farmers. One of this is the indigenous technology used for the prevention of weaver birds (*Quela spp.*) attack on rice and prevention of infestation of black ants on the farms.

5.4 Symbiosis of Indigenous Knowledge and Modern Technologies in Sustainable Development

While IK has made tremendous contribution to crop production by resource-poor farmers; and given the recent experiences of due recognition by agricultural scientists world-wide

(Chambers *et al* 1989, Warren 1991), there is the need to further strengthen the socialization of modern technologies into farming systems and practices of subsistence crop production (Ogunyemi 2000).

During the course of the present study, Adedipe (2001) emphasized the need to recognize the simultaneous operation of two forces, the *economic* and the *environmental.* The one aims at production systems for maximum profit, using modern technologies, while the latter is protective of the environment with due regard to sustainability. The strict protection of the environment is, therefore, double-edged: first, it is the environment that provides the basic inputs (edaphic and atmospheric); second, the same components also, if modified by natural disasters, but in this case by contamination resulting from anthropogenic (farming) activities that involve modern technologies, can impact the environment and the agricultural output. The present study could not show significantly assertive environmental impact, but revealed that trade liberalization policies *potentially have economic and social impacts to the tune of N171.6 billion (US $ 1.60 billion)per annum*; that is, the projected pragmatic impact. This is, perhaps, an underestimation since trade liberalization normally brings with it stressful competition involving extensive use of inputs, the levels of which may be so high as to negatively impact the environment. The cost of mitigative policy measures was estimated to be N22.87 billion (US $ 202 m), indicating the need for instituting a pre-emptive and/or proactive policy support options for decision-making.

This is why there is the need for a ***balance of properties*** approach, which requires that, for now, Nigeria (as a typical developing country) should balance its economic and social development needs with some tolerable level of negative impact on the environment, given that Nigeria, as a developing economy, must first survive to be able to accommodate stringent environment-consciousness in the future, thereby guaranteeing truly sustainable development that would inevitably involve modern technologies, their threats to the environment notwithstanding (Adedipe 2001).

5.5 Linking Local Knowledge with Global Science: A Conceptual Model for Agricultural Development in Developing Countries

Basically, the Millennium Ecosystem Assessment (MA) is aimed at the management of ecosystems through the adoption of viable policy options for decision-making towards the improvement and sustenance of human well-being. Having advocated the *balance of properties* approach as summarized above, and having due regard to the benefits of indigenous knowledge (IK), and having basically posited that IK cannot on its own meet current and future demands of crop production, the question is: how can the benefits of modern technology gainfully and sustainably rub on IK to achieve the ultimate goal of the MA? It is here being proposed that there is need for a *systematic hybridization* strategy, the process of which is briefly presented in Fig. 7.

The scheme recognizes the identification of Ecosystems Services, Drivers and Policy Options for Decision-Making (A), for the goal of promoting and sustaining human well-being (Z). As part of the essential ingredients, IK (characterized by strong socio-cultural belief with a strong community orientation), on the one hand, provides a short-term measure for crop output in third world agriculture. The formal scientific base of modern technologies (characterized by socio-cultural neutrality and strong universal orientation) represents the tool that will produce adequate food; but it must do so with strong recognition of the benefits of IK in terms of the thought process, and the social values, in order to produce a hybrid, *indigeno-scientific-knowledge* (ISK), a short-term transitional phase.

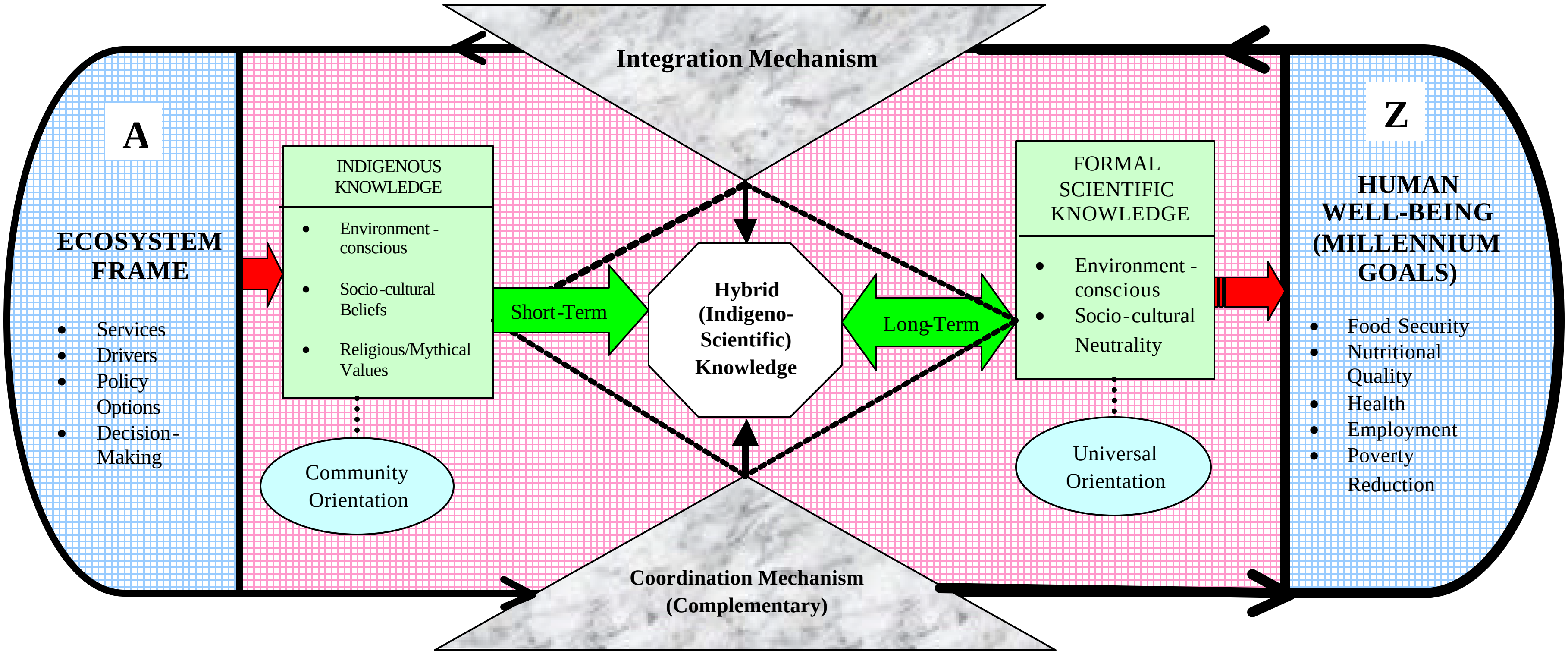


Fig. 7 Epistemological Inputs and Linkages Towards Sustainable Agricultural Research and Development Capabilities

Adedipe, 2004

There are 2 alternative mechanisms of the hybridization. The one is the *integration mechanism* which would be too rapid, given the overall state of pervasive illiteracy, low resource base, and slow research/extension delivery of the developing nations. The other is the *coordination mechanism* which carries with it close interactions and collaboration between IK and modern technology actors, in terms of constructive engagements based on mutual understanding and the sharing of the benefits of new products (intellectual property rights). This must also be accompanied by national, regional and global equities in trade through a gap bridging process. For long-term success, the *coordination* rather than the *integration* of IK with modern technologies appears to be a more realistic and enduring choice. Otherwise, and as observed by Chambers *et al* (1989), the present failure evident in the conventional generation and transfer of technology would remain with humankind for quite a long time.

By this suggested approach, **human well-being**, along the lines of the Millennium Goals, can be guaranteed and sustained for a stable and secure world inbued with food security, desirable nutritional quality, healthy living, gainful employment and poverty-reduction. We must be reminded that as of 1989, resource-poor farming affected 1.4 billion people of Asia, Latin America and Sub-Saharan Africa (Chambers *et al* 1989).

We may well be dealing with 2 billion as of today! The seeming regional pains are, indeed, global pain. We believe that it is to prevent, or at least considerably minimize, such a situation, that the epistemological considerations were, commendably, included in the MA.

6. CONCLUSION

The Benefits of Indigenous Knowledge to Subsistence Agriculture

As in many parts of Africa, Nigerian farmers are noted for their IK and the utility of this in their farming businesses. This system has reduced the negative impact agriculture would naturally have on the environment. It has also been found that farmers were able to maximize their total gross margin by using fewer amounts of pesticides in cowpea production in Nigeria consequent on the adoption of mixed cropping techniques in their cowpea production systems (Ayinde 2004). Furthermore, the use of neem extracts has been found to contribute significantly to the income of farmers (Jostwani and Shrivasta 1981). This gives a justification for its use by cowpea farmers in Nigeria.

The study concludes that small-scale, resource-poor farmers have good reasons for sticking to their local knowledge and farming practices attendant thereto, and that modern technologies can only be successful and sustainable if the interplay of local knowledge of cultural, social and ecological systems are taken into consideration. In so stating, it is suggested that, given the pervasive scenario of rapid population growth (2-3% per annum) and the attendant domestic food demand deficits, there is the emergent need to balance the sustaining IK of the production system with modern technology, through a systematic hybridization strategy.

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A P P E N D I X

QUESTIONNAIRE

ENVIRONMENTAL IMPACTS OF TRADE LIBERQALIZATION AND POLICIES FOR THE SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES: A COUNTRY STUDY ON EXPORT CROP PROMOTION IN NIGERIA

QUESTIONNAIRE FOR INDIVIDUAL FARMERS

A. IDENTIFICATION

Type of crop grown (a) Cocoa (b) Rubber (c) Oil Palm

Name ………………… LGA ……………. Town ……………… State …………….

Farmer ID Number ….……………………….

B. BACKGROUND INFORMATION.

1. Sex …………… 2. Age ………….. 3………………….

4. Membership of Cooperative Society? Before 1985 yes/no, 1986-1992 yes/no, 1993 -1999 yes/no, 2000 yes/no.

5. Membership of other Social/Political Organization?
Before 1985 yes/no, 1986-1992 yes/no, 1993-1999 yes/no, 2000 yes/no.

6. Primary occupation? Before 1985…………….. 1986-1992…………….
1993-1999……………… 2000…………………..

7. Secondary occupation? Before 1985…………… 1986-1992…………….
1993-1999…………….. 2000…………………..

8. Educational level? Before 1986……………... 1986-1992……………
1993-1999………………. 2000………………….

9. Any formal training in Cocoa/Rubber/oil palm production?
Before 1985 yes/no, 1986 yes/no, 1993-1999 yes/no, 2000 yes/no.

10. (a) No of dependent male children……………………..
(b) No of dependent female children…………………..
(c) No dependent Wives………………………………
(d) No of other dependants…………………………….
(e) No of independent Wives………………………….

11. How long have you been resident here? .... Years

12. Number of extension contact per year?
1985…………… 1993…………….. 1999………………. 2000………………

13. When did you start working in the Cocoa/Rubber/Oil palms production sector?
……………………………………………………

14. When did you acquire the first Cocoa/Rubber/Oil palm farm……………………..

15. How did you acquire your farm?..

16. What was the size then?
Hectare…………………………………… No of trees…………………………….

17. How many more cocoa/rubber/oil palm farms have you acquired since the first?
Number…………………..

a. Size (ha)………………………. Year…………………
b. Size (ha)……………………… Year…………………
c. Size (ha)……………………… Year…………………

18. What are the major obstacles to Cocoa/Rubber/Oil palm production?
Before 1986……………………………………………………………………………………..
After 1986………………………………………………………………………………………
Now (Since 1999)………………………………………………………………………………

19. Cocoa marketing?
Briefly state how you have been marketing your produce

(a) Before 1986?..
(b) After 1986?...
(c) Now (since 1999)?..

20. Indicate your sources of land acquisition:
a………………………………………………… (ha), Year
b………………………………………………… (ha), Year
c……………………………………………….. (ha), Year
d……………………………………………….. .(ha), Year

C. INFORMATION ON COCOA/RUBBER/OIL PALM PRODUCTION

		YEAR		
	COCOA	*1985*	*1993*	*1999/2000*
1	Age of cocoa tree (years)			
2	Output (tons)			
3	Product Price (N)			
4	Fertilizer use (kg) by type			
	a. Urea			
	b. Phosphate			
	c.			
5	Fertilizer price (N/kg) by type			
	a. Urea			
	b. Phosphate			
	c.			
6	Fertilizer price (N/kg) by type			
	a. Urea			
	b. Phosphate			
	c.			
7	Frequency of fertilizer application (No of kgs/ha per year)			
	a. Urea			
	b. Phosphate			
	c.			
8	Pesticide use (litres) by type			
	a.			
	b.			
	c.			
9	Pesticides price (N/Litres) by type			
	a.			
	b.			
	c.			

10	Frequency of pesticide application (No. of litres/ha per year) by type			
	a.			
	b.			
	c.			
11	Herbicide use (litres) by type			
	a.			
	b.			
	c.			
12.	Herbicide price (N/litres) by type			
	a.			
	b.			
	c.			
13	Herbicide-frequency of use by type			
	a.			
	b.			
	c.			
14.	Organic farming? (yes or no)			
15.	Type of organic farming (name)			
	a.			
	b.			
	c.			
16.	Value of organic fertilizer (N)			
17.	Labour use (man days)			
	a. Planning			
	(i)			
	(ii)			
	(iii)			
	b. Weeding			
	(i) manual			
	c. Fertilizer Application			
	d. Organic manure application			
	e. Pesticide Application			
	f. Harvesting/tapping			
	g. Post-harvest operation			
	(i) pod breaking			
	(ii) fermentation			
	(iii) drying			
	(iv) bagging			
	(v) transportation			
	(vi) storage			
18	Other cash expenses			
	a. Bags			
	b. Tools			
	c.			
	d.			
19	Cropping pattern on cocoa field			
	a.			
	b.			
	c.			
20	Types of insect attack			
	a.			
	b.			
	c.			

21	Type of disease attack			
	a.			
	b.			
	c.			
22	Method of pesticides application			
	a.			
	b.			
	c.			
23	Method of fertilizer application			
	a.			
	b.			
	c.			

		YEAR		
	RUBBER	*1985*	*1993*	*1999/2000*
1	Rubber farm size (hectares)			
2	Age of rubber tree (years)			
3	Output (tons)			
4	Product Price (N)			
5	Fertilizer use (kg) by type			
	a. Urea			
	b. Phosphate			
	c.			
6	Fertilizer price (N/kg) by type			
	a. Urea			
	b. Phosphate			
	c.			
7	Frequency of fertilizer application (No. of kgs/ha per year)			
	a. Urea			
	b. Phosphate			
	c.			
8	Pesticide use (litres) by type			
	a.			
	b.			
	c.			
9	Pesticides price (N/Litres) by type			
	a.			
	b.			
	c.			
10	Frequency of pesticide application (No. of litres/ha per year) by type			
	a.			
	b.			
	c.			
11	Herbicide use (litres) by type			
	a.			
	b.			
	c.			
12.	Herbicide price (N/litres) by type			
	a.			
	b.			
	c.			

13	Herbicide-frequency of use by type			
	a.			
	b.			
	c.			
14.	Organic farming? (yes or no)			
15.	Type of organic farming (name)			
	a.			
	b.			
	c.			
16.	Value of organic fertilizer (N)			
17.	Labour use (man days)			
	a. Planning			
	(i)			
	(ii)			
	(iii)			
	b. Weeding			
	(i) manual			
	c. Fertilizer Application			
	d. Organic manure application			
	e. Pesticide Application			
	f. Harvesting/tapping			
	g. Post-harvest operation			
	(i) pod breaking			
	(ii) fermentation			
	(iii) drying			
	(iv) bagging			
	(v) transportation			
	(vi) storage			
18	Other cash expenses			
	a. Bags			
	b. Tools			
	c.			
	d.			
19	Cropping pattern on cocoa field			
	a.			
	b.			
	c.			
20	Types of insect attack			
	a.			
	b.			
	c.			
21	Type of disease attack			
	a.			
	b.			
	c.			
22	Method of pesticides application			
	a.			
	b.			
	c.			
23	Method of fertilizer application			
	a.			
	b.			
	c.			

	OIL PALM	YEAR 1985	1993	1999/2000
1	Oil palm farm size (hectares)			
2	Age of oil palm tree (years)			
3	Output (tons)			
4	Product Price (N)			
5	Fertilizer use (kg) by type			
	a. Urea			
	b. Phosphate			
	c.			
6	Fertilizer price (N/kg) by type			
	a. Urea			
	b. Phosphate			
	c.			
7	Frequency of fertilizer application (No. of kgs/ha per year)			
	a. Urea			
	b. Phosphate			
	c.			
8	Pesticide use (litres) by type			
	a.			
	b.			
	c.			
9	Pesticides price (N/Litres) by type			
	a.			
	b.			
	c.			
10	Frequency of pesticide application (No. of litres/ha per year) by type			
	a.			
	b.			
	c.			
11	Herbicide use (litres) by type			
	a.			
	b.			
	c.			
12.	Herbicide price (N/litres) by type			
	a.			
	b.			
	c.			
13	Herbicide-frequency of use by type			
	a.			
	b.			
	c.			
14.	Organic farming? (yes or no)			
15.	Type of organic farming (name)			
	a.			
	b.			
	c.			
16.	Value of organic fertilizer (N)			
17.	Labour use (man days)			
	a. Planning			
	(i)			
	(ii)			
	(iii)			
	b. Weeding			
	(i) manual			
	c. Fertilizer Application			

	d. Organic manure application			
	e. Pesticide Application			
	f. Harvesting/tapping			
	g. Post-harvest operation			
	(i) pod breaking			
	(ii) fermentation			
	(iii) drying			
	(iv) bagging			
	(v) transportation			
	(vi) storage			
18	Other cash expenses			
	a. Bags			
	b. Tools			
	c.			
	d.			
19	Cropping pattern on cocoa field			
	a.			
	b.			
	c.			
20	Types of insect attack			
	a.			
	b.			
	c.			
21	Type of disease attack			
	a.			
	b.			
	c.			
22	Method of pesticides application			
	a.			
	b.			
	c.			
23	Method of fertilizer application			
	a.			
	b.			
	c.			

D. INFORMATION ON OTHER CROPS

		YEAR		
		1985	*1993*	*1999/2000*
1	Farm size for other crops			
	a.			
	b.			
	c.			
	d.			
2	Sources of land owned			
	a. Rented			
	b. Inherited			
	c.			
3.	Output of other crops			
	a.			
	b.			
	c.			
	d.			
4	Price/unit of other crops (₦)			
	a.			
	b.			
	c.			
	d.			

5	Fertilizer use for other crop fields a. Maize/Yam b. Cassava/maize c. d.			
6.	Fertilizer price (₦/kg) a. b. c.			
7	Frequency of use of fertilizer on other crops a. b. c.			
8	Pesticide use for other crops a. Maize/Yam b. Cassava/Maize c. Yam d. Vegetable e.			
9	Prince of pesticide use for other crops a. b. C			
10	Frequency of pesticide use for other crops (No. of litres/ha per year)			
	a.			
	b.			
	c.			
11	Herbicides use for other crops			
	a.			
	b.			
	c.			
12.	Price/unit of herbicides use for other crops			
	a.			
	b.			
	c.			
13.	Frequency of use of herbicide for other crops			
	a.			
	b.			
	c.			
14.	Types of insecticide attach for other crops			
	a.			
	b.			
	c.			
15	Types of disease attack for other crops			
	a.			
	b.			
	c.			
16	Methods of pesticide application for other crops			
	a.			
	b.			
	c.			
17	Methods of fertilizer application for other crops			
	a.			
	b.			
	c.			

E. COCOA/RUBBER/OIL PALM MARKETING

		Year		
	Cocoa	1985	1993	1999/2000
1	Market Channel			
2	Ease of marketing through the channel			
3	Proportion of produce unsold in store for month after harvest			
4	Proportion in store for 8 months after harvest			

		Year		
	Rubber	1985	1993	1999/2000
1	Market Channel			
2	Ease of marketing through the channel			
3	Proportion of produce unsold in store for month after harvest			
4	Proportion in store for 8 months after harvest			

		Year		
	Oil palm	**1985**	**1993**	**1999/2000**
1	Market Channel			
2	Ease of marketing through the channel			
3	Proportion of produce unsold in store for month after harvest			
4	Proportion in store for 8 months after harvest			

F. HEALTH

1. Do you wear any protective clothing when spraying?
   a. 1985 Yes ( ) No ( )
   b. 1993 Yes ( ) No ( )
   c. 1999 Yes ( ) No ( )
   d. 2000 Yes ( ) No ( )

2. If Yes, kindly describe the type of clothing

   1985: ………………………………………………..
   1993: ………………………………………………..
   1999: ………………………………………………..
   2000 …………………………………………………

3. If you don't use any protective clothing, why?

   1985: ………………………………………………..
   1993: ………………………………………………..
   1999: ………………………………………………..
   2000: ………………………………………………..

4. How do you dispose the empty container of chemicals used on the farm?

   1985: ………………………………………………..
   1993: ………………………………………………..
   1999: ………………………………………………..
   2000: ……………………………………………….

5. Do you use these containers later for domestic purposes (e.g. drinking, cooking, fetching water, storing palm oil, etc.)?

Year	***Purpose***	***Any observation***
1985		
1993		
1999		
2000		

Are you aware that those chemicals are harmful to human beings? Yes/No ………………………

Any other comments ……………………………………………………………………………..

7. What water borne diseases are common in the area?

Before 1985	1993	1999	2000
a.	a.	a.	a.
b.	b.	b.	b.
c.	c.	c.	c.

8. Which one have you personally experienced in your family?

Before 1985	1993	1999	2000
a.	a.	a.	a.
b.	b.	b.	b.
c.	c.	c.	c.

9. Which one have had increased rate of occurrence since 1986 in this area?

(a) ……………………. (b) ………………………….. (c) ………………………………

10. Which air borne disease is common in your area?

(a) …………………… (b) ………………………… (c) ………………… (d) ………………….

11. Which one have you experienced in your household?

Before 1985	1993	1999	2000
a.	a.	a.	a.
b.	b.	b.	b.
c.	c.	c.	c.

12. Which ones have in increased in frequency since 1986 in this area?

(a) …………………….. (b) ……………………. (c) ………………… (d) ………………….

13. How do you treat such diseases?

	Methods of Treatment	**Cost of Treatment**
Air-borne	1.	
	2.	
	3.	
	4.	
Water-borne	1.	
	2.	
	3.	
	4.	