Strategies for farming systems development in sub-Saharan Africa

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Strategies For Farming Systems Development In sub-Saharan Africa

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IITA, Ibadan

17–20 November 1998

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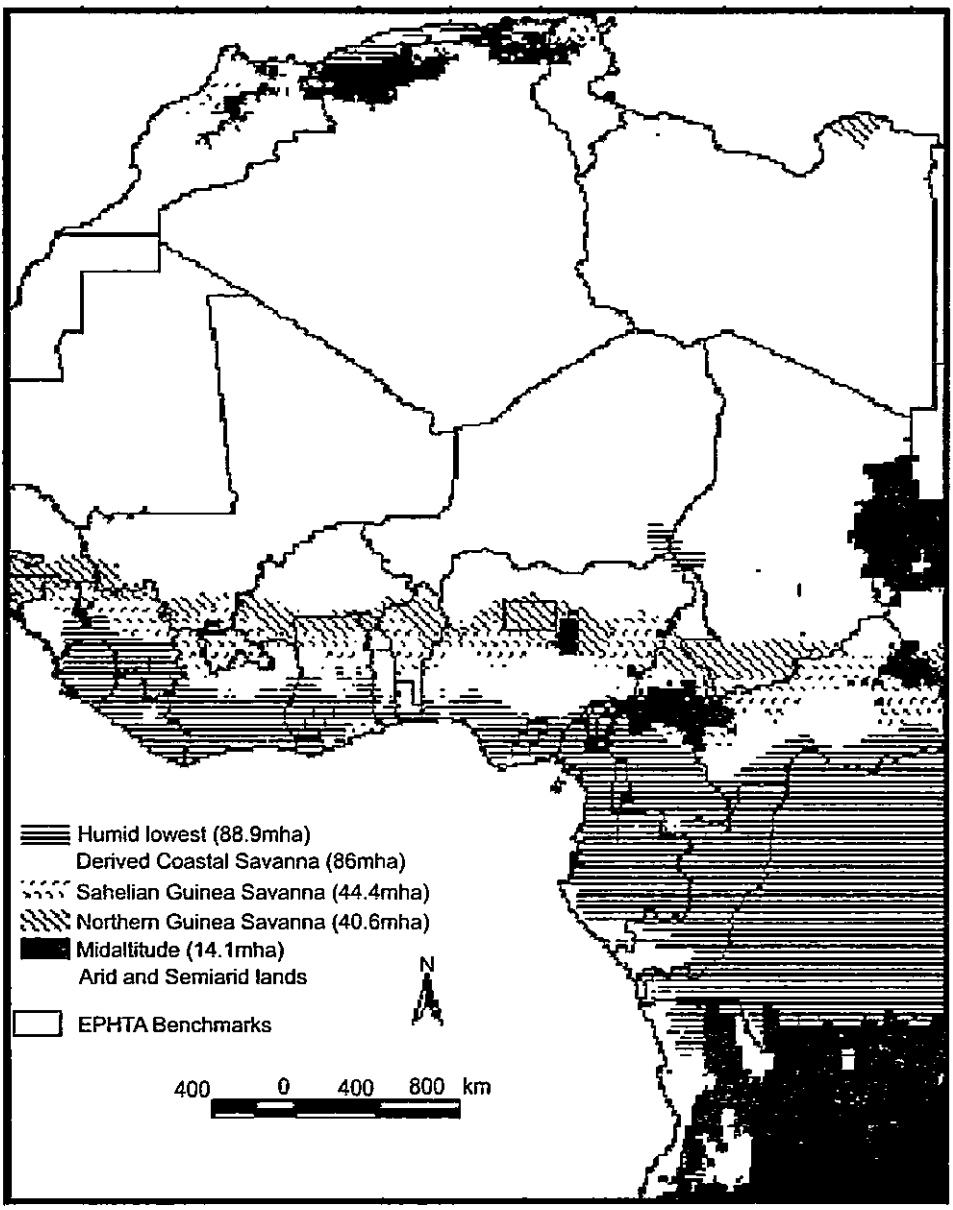

Agroecological zones and benchmark areas of the Ecoregional Program for the Humid and subhumid Tropics of sub-Saharan Africa (EPHTA)

Foreword

The Technical Advisory Committee (TAC), of the Consultative Group on International Agricultural Research (CGIAR), after an in-depth review in 1993, concluded that the problems faced by farmers and their solution are location-specific. That is, the solution for one place probably will not be the solution for another place. Research at specific sites is therefore an essential element in solving the problems of farmers with the aim of making their lives better.

TAC expects that the ecoregional programs will bring new insights to current research activities. Within 5 to 10 years, the programs should lead to significant progress in introducing sustainable production systems to a substantial portion of the ecoregion. Promising new technologies must get down to the farmers' level. The current deregulation of the resource base must be reversed in the near future; otherwise, the ever-increasing needs of expanding populations will not be met.

In 1994, while the ecoregional approach was still new and evolving, TAC asked the International Institute of Tropical Agriculture (IITA) in Nigeria to convene an ecoregional program for the humid and subhumid tropics of sub-Saharan Africa. IITA responded by putting into place a comprehensive mechanism for consulting with potential partners, including an ecoregional program advisory task force and a full-time program coordinator. A series of meetings have taken place since then and the present one is part of that process.

The scientific meeting that was held between 17 and 20 November 1998 is a testimony to the dedication of IITA and collaborating CG centers to the development of sustainable farming systems in sub-Saharan Africa, and to the betterment of the lives of the rural farmers.

The production of these proceeding will help us all, including the FAO, to recognize the areas that have been identified as vital in this initiative.

It will be useful if readers can get back to the EPHTA Program with comments or criticisms that can make the presentations reported here useful to the cause of the project.

Preface

Many development initiatives have been put in place without adequate planning. These always turn to be a failure. The organizers of the EPHTA initiative do not want this project to be like one of these, so a series of consultations have been put in place. The EPHTA project is one that has been conceived and is now being implemented based on good thinking and planning. The present scientific meeting, which has identified and commissioned well tested scientists to prepare and present papers, is a welcome development that can lead research interventions into great success. By characterizing farmers' circumstances and needs, appraising farmers' opportunities, and assessing policy and institutional constraints, it is bound to put on the ground adequate research and development that will result in actually helping the farmers in a way that will improve food production, its marketing and thus the socioeconomy of the farmers.

We are pleased to be given the opportunity to record the presentations and decisions at this meeting. It has given us immense opportunities to be better informed on what the farmers' situations are and what needs to be done for them. I (Dr D.O. Ladipo), thank the Management of IITA and EPHTA for giving me the opportunity to work with Dr Emmanuel Atayi on this assignment. Dr Hassan Adewusi was a most valuable contributor to the production of this document. He was involved in the text preparation and in general graphics. His effort is highly appreciated. Ms Josephine Obinyan is acknowledged for her ready support always. We say thank you also to all the scientists who have contributed papers and discussion efforts at the meeting, and which have been recorded in this proceedings.

Extensive discussions took place after each paper and at the end of the presentation, a review of potential interventions was carried out. These results are not part of this proceeding. They will be available separately from IITA (EPHTA) if you wish to see the details of the discussions.

E.A. Atayi and D.O. Ladipo

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E.A. Atayi and D.O. Ladipo

Acknowledgements

We acknowledge FAO and IITA that provided the funds and logistics for the implementation of the EPHTA scientific meeting and the stimulus for the production of these proceedings. We thank Doyle Baker for his assistance and guidance.

The successful completion of this document has been made possible by various people who were active at the workshop and whose records enhanced the successful capture of the various discussions taken. Our gratitude goes to all those who were at this meeting for their support.

Finally, we thank the Director General of IITA, Dr. Lukas Brader, for his support for EPHTA's various activities and particularly for the success of this scientific meeting. Thank you.

Session I

Resource management and farmer typologies (Benchmark area reports)

Welcome address

E.A. Atayi
EPHTA Coordinator
IITA, PMB 5320
Ibadan, Nigeria

I welcome our dear participants on behalf of the Director General of IITA and Chairperson of the EPHTA Program Management Committee, Dr Lukas Brader. This is the third scientific workshop to be held by EPHTA. The first was the Ecoregional Research Methodology held in Cameroon, 12–16 May 1997 and the second was the Integrated Weed Management Workshop also held in Cameroon, 15–16 September 1997.

This third scientific workshop was jointly organized and funded by FAO and IITA. A Letter of Agreement (LoA) was signed in December 1997 by IITA and FAO to recruit some regional scientists to prepare state-of-the-art papers based on EPHTA outputs and to organize the workshop to present and discuss these papers. It was hoped that this workshop would lead to other workshops. For example, a workshop to harmonize EPHTA research methodologies was being planned for early 1999. I want to apologize for the short notice given to participants for this third scientific workshop and hope you will understand that EPHTA, being a new organization, has to consider various issues of activities and to move out aggressively to generate funding. The present meeting had to come now due to the fact that the editors were trying to meet FAO deadlines. Because of the financial crisis affecting all institutions including IITA, it was decided that to reduce costs of accommodation and food and to minimize payment of per diems, most of EPHTA meeting workshops would be held at IITA Headquarters in Ibadan.

I apologize for any inconvenience this might have caused and wish the participants fruitful deliberations. I will at this juncture present to you an introductory description of the origin of EPHTA and its collaborators.

One-third of all the people in sub-Saharan Africa—some 200 million people—live in the tropics. This forested region of Africa has the potential to be transformed, if not into a "Garden of Eden", at least into a cornucopia of food sufficient to give all of its inhabitants an adequate diet. Across much of sub-Saharan Africa, modest gains in agricultural production have been achieved, but the gains are not keeping with population growth and the migration of people from the rural areas to the cities. Scholars have estimated that even if annual population growth stabilizes at 2.5%, the demand for agricultural products in sub-Saharan Africa in 2025 would be three times greater than it was in 1990.

Problems that limit the growth of food production in sub-Saharan Africa include:

a) Low crop yields and limited adoption of new and improved technologies that have been developed by the research communities;
b) Degradation of the natural environment because of:
   - expansion of cultivated areas
   - shorter fallow periods, which prevent the land from regenerating its fertility
   - lack of appropriate land-conservation practices
   - increased farming pressure on fragile land
   - extension of agriculture into marginal lands not really suited to farming
c) Inadequate marketing structures and unstable national agricultural policies;

d) Inadequate manpower and financial resources for national agricultural research and extension systems (NARES);
e) Inadequate and unsatisfactory rural welfare support, particularly for women and smallholder households.

These concerns can be addressed only with a high level of cooperation and coordination among NARES and the international agricultural research centers (IARCs), among other partners. The worldwide network of 16 IARCs is coordinated through a voluntary group of donor nations, United Nations agencies, and philanthropic organizations called the Consultative Group on International Agricultural Research (CGIAR), with administrative headquarters in the World Bank. In 1993, the Technical Advisory Committee (TAC) of the CGIAR conceived of an ecoregional approach to researching in sub-Saharan Africa, in which the continent was divided into discrete regions, each with a number of ecological characteristics in common. The common problems of each ecoregion were to be addressed by coordinated program.

The CGIAR also recognized that the implementation of the ecoregional approach could best be achieved through a consortium form of organization, because this framework permits open partnership among various institutions in the planning and execution of activities in an ecoregional program.

EPHTA

The Ecoregional Program for the Humid and subHumid Tropics of sub-Saharan Africa (EPHTA) is an ambitious attempt to tackle some of the region's agricultural and resource management problems in a holistic way. The national agricultural research systems of 11 countries participate in the program: Benin, Cameroon, Central African Republic, Côte d'Ivoire, Gabon, Ghana, Guinea, Nigeria, Republic of Congo, Sierra Leone, and Togo. The EPHTA partnership was consolidated in 1996 with the signing of a memorandum of agreement by the original 11 countries.

CGIAR-center members of EPHTA include IITA, WARDA/ADRAO, ILRI, ICRAF, and CIFOR. Other international organizations include the United Nations Food and Agricultural Organization (FAO), France's Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), the International Fertilizer Development Center (IFDC), Togo, Wageningen Agricultural University, The Netherlands, the DLO-Winand Staring Center for Integrated Land, Soil, and Water Research (SC-DLO), and the Institute for Natural Resources in Africa of the UN University.

EPHTA objectives*

The overall objective of EPHTA is to formalize and strengthen close collaboration among national research and extension systems (NARES), international agricultural research centers (IARCs), international and regional research and development organizations, and relevant stakeholders, for implementing holistic ecoregional research and development activities, encompassing benchmark areas, resource management domains, farmer participation in technology development, and innovative technology transfer mechanisms in order to:

1. develop and transfer more productive and sustainable agricultural system for the moist savanna zone

2. develop and protect humid forest zone environments and improve the livelihood of the people in the zone
3. develop the inland valley agroecosystems in an environmentally sound manner

EPHTA aims to increase productivity and food security through the use of sustainable production and postharvest systems, while minimizing natural resource degradation. The ultimate aim is to improve the wellbeing of smallholder and medium-scale farmers, and alleviate their poverty. EPHTA integrates research on specific commodities and agricultural components with research on natural resources, policies, and socioeconomic and institutional issues. The program relies on extensive consultation, drawing upon the opinions and expertise of numerous groups with a stake in the ecoregion's development.

IITA serves as the lead institution for the program, which is executed by three consortia. Two consortia, officially launched in April 1996, are each responsible for a specific zone of the ecoregion: the humid forest and the moist savanna. A third consortium, formed in 1994, handles a special agroecological niche—the inland valleys, mostly along major rivers.

Benchmarks

A limited number of benchmark areas are being developed for the humid forest and the moist savanna, such as the one in southern Cameroon for the forest margins. At a historic meeting in April 1996, EPHTA partners agreed on six benchmark areas and host institutes for the region:

Northern Guinea Savanna
Location: Northwest Nigeria
Host: Institute of Agricultural Research (IAR), Ahmadu Bello University

Southern Guinea Savanna
Location: Northwest of Bouaké, Côte d'Ivoire
Host: Institut des savanes (IDESSA)

Derived/Coastal Savanna
Location: North of Cotonou, Bénin
Host: Institut national des recherches agricoles du Bénin (INRAB)

Forest Margins
Location: Southern Cameroon
Host: Institut de recherche agricole pour le développement (IRAD)

Forest Pockets
Location: Southern Ghana
Host: Council for Scientific and Industrial Research (CSIR)

Degraded Forest
Location: Southern Nigeria
Host: National Root Crops Research Institute (NRCRI)

However, before we go into the workshop proper, it is proper that we take the presentation of the DG (IITA) on the ecoregional approach as this will lead us more clearly into why the EPHTA approach was taken by the CGIAR.

IITA's benchmark approach to natural resources management in West and Central Africa

Lukas Brader
Director General, IITA

Abstract
This paper discusses IITA's experience in the development and implementation of the benchmark approach in the moist savanna and humid forest zones of West and Central Africa. The benchmark approach was developed to facilitate research in heterogenous areas, to increase cooperation between various partners, and to maximize the impact of technology on resource-poor farmers for the achievement of sustainable natural resource management An important feature of this approach is the concentration of research activities in a limited number of benchmark areas. These are areas representing major features of ecoregions. Their selection is based on ecoregion, biophysical and scioeconomic criteria, and opportunities for successful execution of research and extrapolation of results. Such research primarily addresses strategic and transnational issues, although it also leads to local benefits through farmer participatory testing and instititional exchange. Benchmark areas are complemented by pilot sites, which are located outside the bechmark areas but fall within the same ecoregion. They serve to test and adapt technologies that were developed in the benchmark areas and to cover specific environments that are not featured there. Six benchmark areas and six pilot sites are currently operational in the 11 member countries of the Ecoregional Program for the Humid and Subhumid Tropics of sub-Saharan Africa (EPHTA). The bechmark approach was initially centered on problems of natural resource management; so far, activities have expanded to include research on crop improvement and plant health. The paper discusses the implications of the benchmark approach for research prioritization and highlights some challenges drawn from recent experience.

Introduction

Agricultural production in sub-Saharan Africa extends across a wide range of ecozones, resulting in a multitude of biophysical and socioeconomic circumstances and as a consequence, a variety of agricultural production systems. Hence, there is a need to identify and address the specific circumstances and constraints of the individual ecozones and to develop improved technologies matching the prevailing circumstances. To facilitate this, EPHTA was planned and is now being implemented with IITA as the convening center. This is being done in close collaboration with the national agricultural research and extension services (NARES) of West and Central Africa, other international agricultural research centers (IARCs), and agricultural research organizations. EPHTA addresses the research and development needs of the humid and subhumid tropics, encompassing the moist savannas, the humid forests, and the inland valleys within the region.

The benchmark approach is an integral methodological component of EPHTA. The benchmark areas serve as focal points for strategic and diagnostic research and are one of the most important features of EPHTA. Therefore, benchmark development was of the highest priority. The benchmark area approach enables and enhances collaboration across disciplines and between partners, concentrates efforts and resources on well-defined areas,

avoids spatial dispersion and thematic fragmentation of research, and thus enables creation of critical mass. Small pilot sites complement the benchmark areas.

The underlying research paradigm is the understanding of resource-use patterns, which is essential for developing resource management technologies that fit the strategies and needs of farmers. A systems dynamic paradigm is being used as a basis for domain delineation. Resource management domains are areas with similar biophysical and socioeconomic circumstances, which are suitable for specific sustainable land-use systems. They encompass similar dominant patterns of resource use, similar development driving forces, and similar agroecological conditions.

The benchmark approach focuses its research on problems relevant to the entire ecoregion. Effectively targeting agricultural research in such a variable environment is a great challenge to the agricultural research system as a whole (Smith and Weber 1995). Choice and delineation of the benchmark areas are therefore crucial. This paper presents the experience gathered during the first two years of implementation in West and Central Africa.

Benchmark area selection

Substantial effort has gone into developing an approach which (1) ensures partner participation and (2) balances research priorities with farmers' needs in specific agroecosystems. Extensive consultations were held to clarify and agree on concepts and gain the endorsement of all program partners.

Four ecozones in which the benchmark areas were to be located were defined on the basis of length of growing period (LGP) as follows:

- Northern Guinea savanna: 151–180 days
- Southern Guinea savanna: 181–210 days
- Derived/coastal savanna: 211–270 days
- Humid forest: > 270 days

The humid forest zone was further subdivided according to the stage of forest degradation:

- Forest margins, portraying a gradient from large intact forest areas to a forest-farmland mosaic
- Forest pockets, with scattered intact forest patches
- Degraded forest, with no more forest left

There was extensive consultation with many regional stakeholders of EPHTA, including NARES, nongovernmental organizations (NGOs), IARCs, development agencies (such as FAO), and other partners (such as Centre de coopération internationale en recherche agronomique pour le développement or CIRAD). It was decided to develop one benchmark area in each of these zones and subzones (Fig. 1).

The designation of a benchmark area is based on three major criteria (IITA 1996):

- The area is representative of major features of the agroecological zone
- It captures important biophysical and socioeconomic variability and gradients
- It has appropriate circumstances (access, communications systems, physical infrastructure) for successful research and development

The benchmark areas are meant to be focal points for research and are chosen to be large enough (15 000–20 000 km^2) to capture the variation of farmers' circumstances and

farmers' responses to these. They are a spatial representation of resource-use dynamics and are selected so as to contain gradients of resource-use intensity, population intensity, and market access as well as biophysical gradients so as to allow for the extrapolation of research results to the entire ecozone. Their infrastructure should make possible a full range of research and development activities. These activities are decided by a benchmark area steering committee, consisting of representatives of all the stakeholders already mentioned. The composition of the benchmark area steering committee is however flexible to reflect the realities of each benchmark area (Table 1). Joint planning of activities and regular consultations among stakeholders are important prerequisite for successful benchmark approach.

Pilot sites complement benchmark areas. The primary function is to test, evaluate, adapt, and transfer promising sustainable production and postharvest systems. Activities in pilot sites are critical to the delivery of practical results, and are a necessary complement to benchmark area activities. The size of a pilot site is flexible, but they are much smaller than benchmark areas (500–3000 km^2). While there is only one benchmark araea for each ecoregion to avoid duplication and dilution of resources, each country member of the program is free to choose at least one pilot site per agroecological zone. The number of pilot sites is expected to increase over time, as technological options to test/adapt from the benchmark areas become available. Currently five countries in West and Central Africa (Côte d'Ivoire, Gabon, Guinea, Sierra Leone, and Togo) have a total of six operational pilot sites.

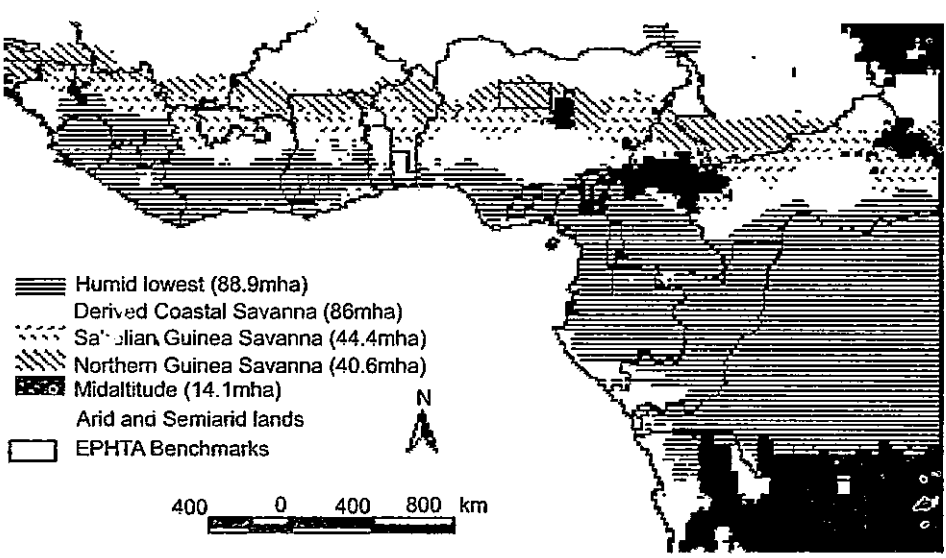

Figure 1. Agroecological zones and benchmark areas in West and Central Africa.

Table 1. Composition of the benchmark area steering committee in three benchmark areas.

	Benchmark area		
	Northern Guinea Savanna	Forest Margin	Degraded Forest
NARS	2	2	1
IARC	1	2	1
CIRAD		1	
University			4
Extension services	2	3	5
NGO	2	1	
Farmers' association		1	
Private seed company	1		
Total	8	10	11

Source: EPHTA (1998a, b, c),
NARS: National Agricultural Research System; IARC: International Agricultural Research Center; CIRAD: Centre de coopération internationale en recherche agronomique pour le développement; NGO: Non-governmental organization

Implementation of the benchmark approach

Strategic characterization

A benchmark area is a heterogenous entity. However, the selection of sites for participatory research must be done thoroughly from well-defined homogenous domains within the benchmark area. Therefore, the first research activity is to conduct strategic characterization studies to determine systems dynamics, delineate domains that reflect the patterns leading to the specific dynamics of the system, select research sites typical of each domain, and choose participating farmers and fields for experimentation. Figure 2 shows the framework for benchmark area development. The procedure for site selection is as follows:

1. An area sampling approach is used to identify potential research villages. The benchmark area is divided into grid cells of 10 minutes by 10 minutes or 343.25 km^2. Villages are chosen in or near the middle of the cell. The area sampling approach is preferred to other sampling methods as it is thought to capture better the spatial variability of the biophysical and socioeconomic factors within the benchmark area.
2. A village group interview is then conducted at each potential site to collect data using a structured questionnaire. The questionnaire is developed from hypothesis on the causes of resource-use pressure and systems response, so that the systems dynamics are incorporated in the process of domain definition and site selection.
3. A multivariate analysis is performed to classify the surveyed villages into homogenous areas referred to as resource domains. A resource domain is made up of a group of farming communities that are located in similar biophysical environments and experience similar development patterns; thus they face similar problems and require similar technological interventions.
4. One (or more) typical village of each resource domain is then selected. The selected villages become the research sites for the benchmark area and the entire ecoregion that area represents.

An area of this strategic characterization can be given from the forest margins benchmark

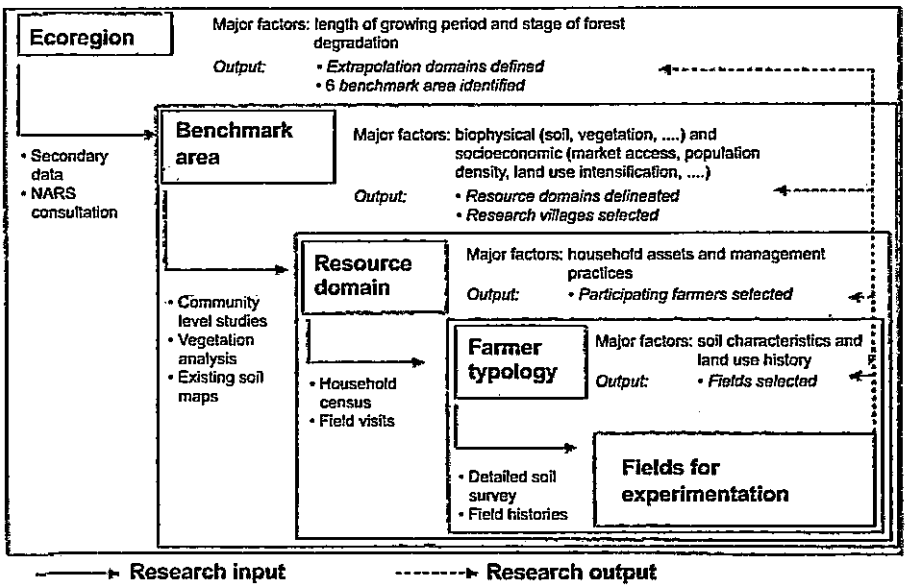

Figure 2. Framework for benchmark area development.

area. The area sampling approach resulted in 45 potential research sites. These were further grouped into three blocks, namely Yaoundé, Mbalmayo, and Ebolowa. A multivariate analysis on the data from village group interviews resulted in the selection of six research villages, two in each block. The results from the multivariate analysis show a spatial gradient in socioeconomic factors from the medium-populated Yaoundé block close to Yaounde in the north of the benchmark area towards the remote, low populated Ebolowa block with poor infrastructure in the south (Table 2). For example, the length of fallow and intensity of hunting activities increase from the Yaoundé to the Ebolowa block, while off-farm revenue decreases. The spatial gradient is emphasized by the vegetative cover that changes from the predominant degraded secondary forest type in the north towards an evegreen primary forerst type in the south. This spatial gradient is typical of a region with poor infrastructure and where only one major center (Yaoundé) is located within the boundaries of the benchmark area. Yaoundé is the major force driving the intensification in the use of natural resources, resulting in a decreasing pressure on the resource base as one moves away from the city. The features of the forest margins benchmark area were also found elsewhere in the Congo basin (Manyong et al 1996).

In the northern Guinea savanna, 65 potential research villages were identified during the first planning meeting of the benchmark area committee. The stakeholders delineated a large area of 25 000km^2 for the benchmark area, so as to include the required variability on both biophysical and socioeconomic factors. However, only 65 villages were retained for the village group interviews since some of the grid cells fall in a game reserve where there are no villages. The multivariate analysis resulted in the definition of four resource domains, namely a low resource-use domain referred to as domain 1, a low to medium resource-use domain (domain 2), a medium to high resource-use domain (domain 3), and

Table 2. Characteristics of the research villages in the forest margins benchmark area.

	Yaoundé x block	Mbalmayo block	Ebolowa block
Average fallow length (years)	3.9	5.4	7.5
Land selling/buying (% of villages)	67	27	7
Villages on tarred roads (%)	20	13	13
Mean market distances (km)	17	20	21
Transport costs to market (FCFA)	292	503	493
Hunting revenue (% of villages)	0	27	53
Off-farm labor revenue (% of villages)	33	13	7
Max. rural pop. density (15 villages) (persons/km^2)	88	41	15
Min. rural pop. Density (15 villages) (persons/km^2)	14	10	2

Source: Gockowski and Baker (1996)

a high resource-use domain (domain 4). Three villages per domain were suggested for on-farm participatory research and other detailed characterization.

The results from the analysis in the northern Guinea savanna benchmark area show that a gradient does not always follow a spatial distribution, as was hypothesized and demonstrated for the forest margins. The characteristics of the defined resource domains in the northern Guinea savanna benchmark area indicate a gradient in most of the parameters from domain 1 to domain 4 (Table 3). However, the spread of villages that belong to a domain across the benchmark area shows no spatial gradient (Fig. 3). The area has a medium to high population density (60–200) persons/km^2), good road infrastructure, and includes or is surrounded by many centers. Therefore, the impact of one major center to induce a spatial gradient in the socioeconomic factors (as was the case for the forest margins) is weakened because the effects from many centers neutralize each other. These results suggest that the variability and the gradient in biophysical and socioeconomic factors within the northern Guinea savanna benchmark area are driven by village characteristics (such as the size of the village, road infrastructure, and social infrastructure) and not by proximity to one major center (Manyong et al. 1997).

Another important step in the benchmark approach, once the research villages have been chosen, is characterization of the variation in livelihood strategies and factor endowments at the level of the household. This information allows research to better target technological interventions and also allows for the stratification of the farmer community participating in on-farm trials according to their set of household circumstances and identified livelihood strategies. In the forest margins benchmark area, a multivariate analysis of census data from the 528 households comprising the six research villages identified two principal livelihood strategies. The first is applied by households with abundant land that devote proportionately more time to natural resource-based activities (hunting, fishing, and gathering of forest resources) while generating agricultural revenues from cocoa plantations. These land-abundant households would be more amenable to the development of land-using and labor-saving technologies. The second strategy associates relatively labor-abundant households with a commercial strategy based on food crop sales, the cultivation of a greater number of annual crop fields, and greater differentiation of field types (Gockowski and Baker 1996). By scoring households of the six research villages along each of these two livelihood dimensions and cross-tabulating, four broad household groups can be identified with relevance to technology development:

Table 3. Characteristics of the resource domains in the northern Guinea savanna benchmark area.

	Resource domain			
	1 (n = 9)	2 (n = 32)	3 (n = 15)	4 (n = 9)
Village size (no. of households)	62	292	737	750
Population density (persons/km²)	88	97	127	159
Distance to paved road (km)	15	7	6	5
Public services (0–1)	0.04	0.11	0.21	0.34
Fallow (years)	2.88	1.34	0.60	0.00
Cereals (0–10)	8	7.64	8.04	8.29
Grain legumes (0–10)	0.66	1.08	0.97	1.18
VEGETC (0–10)	1.75	1.68	3.11	3.66
LVSTK (0–10)	4	3.84	3.66	2.88
DEPSF (0–10)	0	0.34	1.06	0.22
Fuel wood dependency (010)	0.66	2.78	3.93	6.44

Source: Manyong et al. (1997)
n: number of research villages; VEGETC: index of vegetables (new enterprises) as a main source of cash; LVSKC: index of livestock (traditional enterprise) as a main source of cash; DEPSF: index of dependency on staple food.

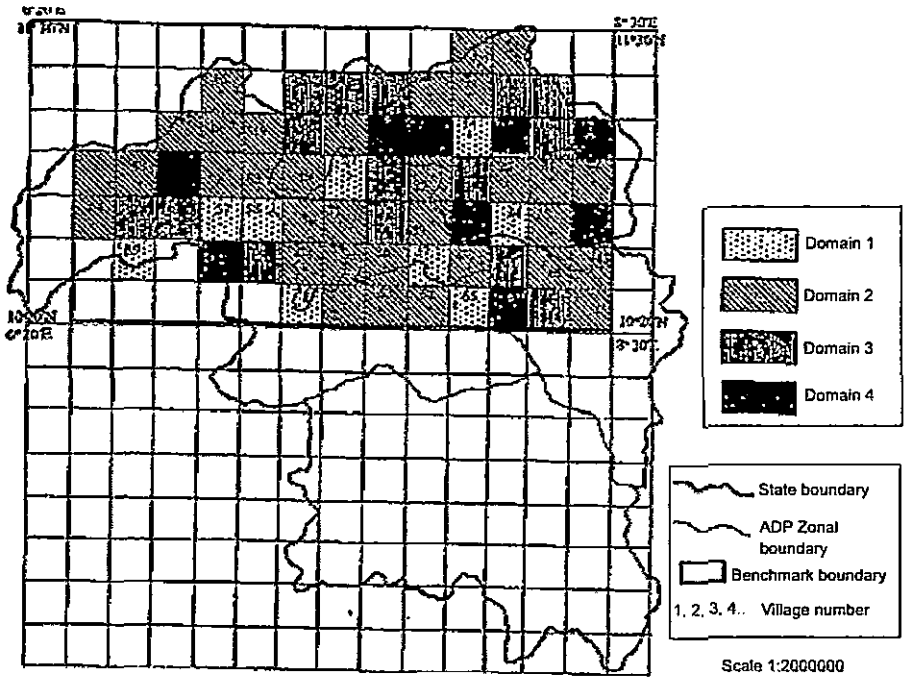

Figure 3. Resource domains in the northern Guinea savanna benchmark area, Nigeria (Manyong et al. 1997).

- land-scarce, labor-scarce households with little commercialization of their agricultural products.
- labor-scarce, land-abundant households, tending to pursue a cocoa commercialization strategy while undertaking a range of natural resource-based activities.
- land-scarce, labor-abundant households, relying on commercial food crop production for revenue generation.
- land- and labor-abundant households, undertaking both commercial food production and cocoa production revenue strategies.

The last strategic characterization in the implementation of the benchmark approach is the choice of fields for experimentation. Detailed soil surveys and field histories are the major criteria for the selection of the fields. An example of the result from this activity is shown in Figure 4, which shows the distribution of on-farm trials on the major soil units of one research village in the derived savanna benchmark area.

Subject studies

Characterization studies are almost completed in the six benchmark areas. Field studies, both on processes and participatory technology testing with farmers, have been initiated on some well-identified transnational issues of natural resource management. Major themes include research on short fallow systems, integrated weed management, crop–livestock integration, multistrata systems, soil fertility management, and home gardens. However, the scope of research has expanded beyond natural resource management. Other activities include participatory breeding activities (for example, of soybean) and integrated pest management (such as the use of trap crops to control *Striga hermonthica* on maize).

Both male and female farmers are actively involved in problem identification and technology testing and evaluation. For example, about 200 farmers from the derived savanna benchmark area and about 95 farmers from the northern Guinea savanna area are participating in various agronomic and crop–livestock trials. A directory of 188 community-based organizations and farmers' federations has been established for the forest margins benchmark area.

An example of a successful introduction of a new technology through collaborative research with farmer involvement is the use of leguminous cover crops in short fallow systems to control weeds and restore soil fertility in the derived savanna benchmark area. Participatory technology testing with farmers was initiated with various technological options (alley cropping, mulch, green manure cover crops) to restore soil fertility in an area with high population and severe soil degradation in the Mono Province of the Benin Republic. The farmers soon noticed the ability of one leguminous cover crop, the velvet bean (*Mucuna pruriens* var *utilis*), to smother the noxious weed *Imperata cylindrica*. Smothering this weed resulted in the saving of labor to tend the maize–cassava–groundnut mixed cropping from an average of four times weeding to about two times weeding for a cropping season that lasts 3 months. Additional advantages are the accumulation of up to 160 kg N/ha (Sanginga et al. 1996); erosion control; the maintenance or improvement of the soil physical, chemical and biological properties; and an increase in maize yield from about 1.3 to 3 t/ha (Vissoh et al. 1998). The analysis of the economic returns of systems with and without *Mucuna* indicated a benefit : cost ratio of only 0.62 for the farmers' system without *Mucuna*. Others showed 1.24 for the new system with *Mucuna* fallow but without a market for *Mucuna* seed, and 3.56 for the new system with both *Mucuna* fallow and a

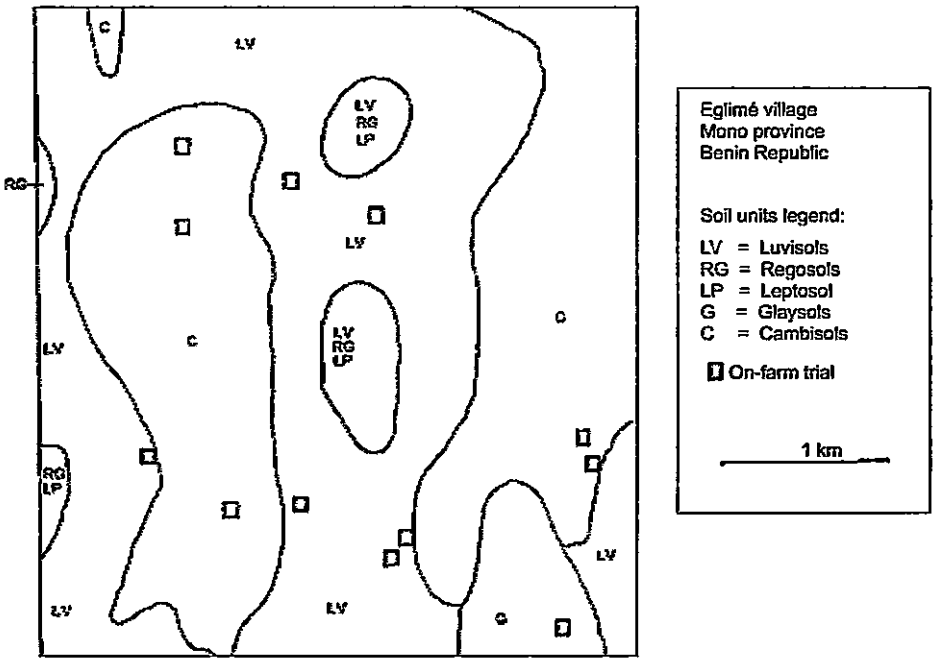

Figure 4. Distribution of on-farm trials on major soil units, Eglimé research village, in the derived savanna benchmark area, Bénin Republic.

market for *Mucuna* seed. NGOs and official extension services have taken the technology and widely disseminated it. The number of *Mucuna* users rose from about 20 farmers in 1988 to 10 000 in 1996 (Table 4). Adoption of the new technology throughout Mono Province would result in annual savings of about US$1.85 million (Vissoh et al. 1998).

Another success story is the adoption and rapid expansion of soybean in Kaya village in resource domain 2 of the northern Guinea savanna benchmark area. A study of the cropping systems in 1997 revealed that soybean occupied 25.2% of the farmland; in contrast the percentage was only 1.3 in Danayamaka village in resource domain 2 in the same benchmark area (Manyong et al. in preparation).

Table 4. Estimated number of farmers using *Mucuna* in Bénin Republic.

Year	Number of farmers
1988	20
1989	100
1991	500
1993	3000
1996	10 000

Source: Vissoh et al. (1998).

The difference reflects the different development patterns of the two villages. Farmers in Kaya village are market-oriented and quickly adopted the new, high-yielding soybean varieties, which have low pod shattering and improved pest resistance. Danayamaka village has poor infrastructure that does not allow marketing to develop. Sorghum, the traditional crop in the Guinea savannas, dominates the cropping systems. The diversification in land use in Kaya village has resulted in high-yielding crops that have a comparative advantage in the climatic conditions, while the traditional, low-yielding crops grown in the savannas have declined (Table 5).

Research prioritization

The benchmark approach facilitates research in a small, manageable, and strategically chosen area. The database generated allows for research priorities to be set within the ecoregion. Investment in developing the ecoregional and benchmark database is crucial for successful research prioritization. Addressing natural resource management, crop improvement, and plant health problems using a dynamic approach along gradients in resource-use intensification (through the definition of resource domains) helps to predict development trends as agroecosystems evolve over time. This allows the research systems to anticipate rather than to correct the incidence and severity of constraints in general and other natural resource management problems in particular.

Many benefits are derived from this innovative approach in the definition of research and development strategies. This approach forces partners in West and Central Africa to shift research planning from institute mandates to ecoregional priorities. For example, stakeholders in the forest margins benchmark area gave high priority to research on multistrata and short fallow systems. In the northern Guinea benchmark area, the stakeholders chose research on crop–livestock integration and cereal–legume crop rotation as their focus. This approach also promotes farmer participatory research. As the database increases, it is expected that the ability of the stakeholders to deliver public goods will be accelerated.

Challenges

The approach is still too new for meaningful assessment of its impact to be made. Although some positive results have been achieved so far (definition of resource domains; selection of research sites; participating farmers; and fields to conduct experiments; participatory breeding activities; integrated pest control), recent work in the benchmark areas has highlighted some challenges to ecoregion-based development. For instance, the coherence, research planning, and data integration between stakeholders from various institutions need to be improved. Increasing the number of meetings among the stakeholders and conducting joint research activities are ways to improve efficiency in the partnership. While both the benchmark areas and pilot sites are well characterized, the issues of delineation of the extrapolation domains within each larger ecoregion still need to be addressed. A geographic information systems expert and the availability of geo-referenced secondary data are necessary to successfully fill this gap. Issues such as those related to policy and integrated pest management cut across benchmark and ecoregional boundaries, and they must be addressed inside and outside the benchmark area to fully achieve development results.

Table 5. Changes in the land-use systems in Kaya village, northern Guinea savanna benchmarks area (% of farmland).

Crop	1990 (n = 65)	1997 (n = 132)	Change (1990–1997)
Maize	50.7	43.3	–7.40
Sorghum	33	12.5	–20.50
Rice	5.9	7.8	+ 1.9
Soybean	2	25.2	+ 23.2
Groundnut	0.6	2.3	+ 1.7
Cowpea	1.1	1.9	+ 0.8
Others	6.7	7	+ 0.3
Total	100	100	0

Source: Manyong et al. (in preparation).
n: number of farmers.

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Introduction to the workshop

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The paper delivered by the Director General of IITA, Dr Lukas Brader, gives a clear account of why EPHTA was established and also it says in clear terms the approach being taken to ensure viable results in this initiative. I will now give you more details on the present workshop, particularly on how we will approach this meeting on the long run.

EPHTA background

Benchmark area teams have been conducting a baseline resource management survey, based on a standardized questionnaire administered through village-level interviews. The main purpose of the baseline resource management survey is to identify domains based on system dynamics. The domains are used for targeting and will eventually be a basis for extrapolating results to pilot sites.

During the course of presentations, you will listen to the presentations by experts. The presentations will be state-of-the-art papers. After this, we will have the scientific planning workshop. The purpose of this workshop is to formulate strategies for supporting farming systems development.

The specific objectives will be:

1. Characterize farmer circumstances and needs: resource use patterns, dynamics and domains, farmer typologies and strategies
2. Appraise farmer opportunities: profitability of sustainable production systems, market-oriented enterprises
3. Assess policy and institutional constraints: impact of structural adjustment on policy and support services, innovative support through NGOs, private sector, farmer organizations
4. Clarify intervention strategies and priorities: development of themes and issues, immediate action to help farmers

To achieve the above objectives, we will have the following arrangements on our daily activities.

Workshop sequence

Session 1	Benchmark area reports
Workshop 1	Resource management and farmer typologies
Session 2	State-of-the-art papers (farmer opportunities)
Workshop 2	Farmer opportunities
Session 3	State-of-the-art papers (policies and institutions)
Workshop 3	Institutional and policy issues
Workshop 4	Priorities for target domains

Daily sequence (Days 1–3)

Paper presentation session
Discussant synthesis and remarks
Topical workshop

Topical workshops (Days 1–4)
Introduction of issues and questions
Division into small discussion groups
Plenary reports and discussion

With all these, I believe we will be able to achieve a lot of success at this scientific meeting. Thank you.

Cameroon forest margins benchmark

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The report concentrated on the field activities implemented by the benchmark area (BA). The main activities involved surveys to characterize the land-use systems and the post-harvest systems. The results obtained are summarized below.

Land-use systems

Three land-use systems can be recognized in the humid forest region of Cameroon:

(a) ***Coffee/food crops/cocoa system.*** Practiced in the Southwest Province and Moungo division of the Littoral Province; in the low lying area characterized by high rainfall (over 3000 mm per annum); soils are highly fertile nitrosols; principal cash crop is coffee, followed by cocoa; food crops include cocoyam, cassava, and plantains.

(b) ***Household farms of plantation workers.*** Widely practiced in infertile xanthinc ferralsols in the high rainfall zone of the Littoral and parts of the Southwest Provinces; land pressure is high, and land rental and sharecropping are common; cassava is the principal food crop grown, alongside with some leafy vegetables.

(c) ***Cocoa/food crops/coffee system.*** Found throughout the southern plateau and extends throughout the humid lowlands of Cameroon, including the East, Center, South and parts of the Littoral Provinces; soils are mostly orthic ferralsols; short cycle crops such as groundnuts and maize are intercropped with cassava, plantain and cocoyam: cocoa is the main cash crop. Three subsystems can be identified in this system:

- (i) Food crop production subsystem: Newly opened forest land is planted with *Cucumis melo*; six months after harvest, cassava, groundnut, cocoyam, maize, and plantain then follow.
- (ii) Cocoa production subsystem: Cocoa is cultivated on newly cleared land or after food crops have been harvested; carried out by men; cocoa planting gives long-term land-use rights to farmers and their descendants, and sometimes limits farm expansion by more able villages.
- (iii) Home garden/small livestock subsystem: This system, managed around homesteads, includes fruit trees (such as citrus and mango), vegetables, and small livestock and poultry.

Cropping systems in the humid forest region

The main cropping systems so far identified in the forest zone are:

- groundnut-based maize fields in which cassava and sweetpotato are the important crops;
- maize field in which groundnuts and leafy vegetable are intercropped;
- home gardens made up mainly of horticultural crops (green leafy vegetables and others);
- plantain/banana fields;
- *egusi*-based farms;

- cocoa plantations, usually monoculture but sometimes intercropped with plantains;
- coffee plantations (of the *robusta* type—coffee *canephora* var. *robusta*), mostly in the littoral;
- oil and raffia palm fields;
- rubber plantation fields.

Fallow periods in the benchmark area of southern Cameroon

Fallow lengths of more than 10 years were found to occur mostly in the Ebolowa and Mbalmayo blocks. It is in these blocks that you still find most of forestlands.

Crops varieties and farmers' traditional cultural practices

In many fields, mostly local varieties are grown. The situation has changed somewhat for maize and cassava because farmers now grow improved planting material of these crops. Fields close to urban centers grow commercialized imported seeds of vegetables such as tomato, cabbage, and spinach. The challenge is now for specific varieties adapted to humid forest region conditions to be developed by the research.

Farmers still prefer to use traditional cultural practices such as planting on the flat (because they claim the soil is much too hard for deep cultivation), and zig-zag planting. Farmers' practice mixed cropping, involving as many as eight crops. Very few farmers use fertilizers or chemicals on food crops.

Four administrative divisions in the benchmark were surveyed to monitor total land area devoted to food and cash crops. It was found that a larger area is devoted to food crops in the Lekie and Mefou divisions than in the other division, reflecting the proximity of these divisions to Yaoundé, the largest city in the benchmark area.

Remote sensing estimates of land use and land cover in the three blocks of the benchmark area show that the most primary forests are found in the Ebolowa block; there are hardly any primary forests left in the Yaoundé block where logging activities started a long time ago and where there is the greatest land-use intensification. Cocoa cultivation is more dominant in Ebolowa and Mbalmayo, and accounts for more than 10% of the total area; chemicals and fertilizers are used only on cash crops (cocoa and coffee), and in some home gardens.

Farm sizes of peasant farmers

The size of individual peasant farm varies from 900 m^2 (for home gardens) to 5000 m^2 (for coffee or cocoa plantations). Farm size was correlated with family size. A family with more children had larger farms and more fragmented farms per season than one with a small number of children. Farmers having other sources of income, such as a monthly paid job, can afford to hire labor and therefore increase their field size.

A new category of farmers has arisen in recent years comprising retired ministers and directors and young university graduates, unable to find employment in government; they grow plantations of the rapid paying food crops such as cassava, maize, and plantains. These "enlightened farmers" usually have larger farms than the conventional subsistence growers and most of the time they practice monocropping. The main constraint to increased production is lack of planting material.

Land tenure

All farmland in Cameroon, although said to officially belong to the government, is actually owned by individuals or families. Only farmers owning these lands (or those to whom such land has been given or rented out) can carry out any form of exploitation. Even the exploitation of raffia palms for palm wine production can only be done with the consent of the owner of such land.

Non-farm activities in the benchmark area

In some areas, peasants have engaged in other income-generating activities apart from agriculture. These include handicrafts, the making of cane furniture, carving of mortars and pestles, tapping and sale of wine from oil and raffia palms, and the sale of non-timber products, hunting and inland fishing.

Postharvest systems

Summary of the results is as follows:

Production. The diagnosis has revealed that the farmers of the region cultivate a wide range of food and cash crops. The major food crops include cassava, groundnut, maize, plantains, yam, and cocoyam. In addition to crops, most farmers rear domestic animals, mainly on free range. The farming system is based mainly on multiple cropping.

Harvesting. Crop harvesting is carried out mostly using simple tools such as hoes, machetes, and sticks. The harvesting technique is directly related to the cultural practices of the region. Techniques such as mechanization must be carefully evaluated because they are related to improvements in cultural practices such as monoculture and uniform planting.

Storage. Current storage structures and practices were found to be limiting. They are responsible for high losses that are reported to range from 10 to 60%. There are improved public domain storage technologies developed by both the Institute of Agricultural Research for Development (IRAD) and its collaborating international research institutions which have, however, not yet been brought to the attention of farmers of the region. Priority should be given to the dissemination of this information through training and demonstration units.

Both fundamental and adaptive research should also be carried out on those storage problems against which there are no technologies. Environmentally friendly control techniques for storage of diseases and pests should be developed to resolve the most important storage problems in the area. Studies on controlling losses due to physiological factors must be done in collaboration with breeding programs.

Processing. There exist traditional techniques for transforming most of the food crops into various products. These techniques are, however, limiting in terms of capacity and efficiency. Improved and more efficient technologies exist but have not yet been brought to the attention of most farmers of the region. It is recommended that these technologies be introduced to the end users through training and demonstration units.

Utilization. The survey revealed that most of the crops and animal products are used as human food. The diversification of crop uses through the development of new products is necessary. This can serve as a further incentive to increased production and productivity.

Marketing. Problems of storage and processing are linked to those of marketing. If products

are not handled, stored, or processed, subsequent marketing will be difficult. As the farmers reported, marketing of food products should be better organized. Transport facilities are either inappropriate or lacking. The poor infrastructure and poor marketing facilities all contribute to the poor marketing of food products in the region. Research and development issues that need to be addressed include cataloging markets, determination of volumes of each crop available for marketing, prices, market information system, common initiative group formation and dynamics, record keeping, and finances.

Recommended themes for action/research based on the above

- dissemination of available improved postharvest technologies (storage, processing, marketing, and socioeconomic issues) through training and demonstration units
- applied and adaptive research on storage, processing, and marketing issues for which technologies are not yet available (all important crop and animal resources)
- appropriate grain storage structures adapted to the humid forest region
- environmentally friendly techniques for controlling grain storage pests and diseases
- appropriate root and tuber storage structures
- techniques to control physiological spoilage of roots and tubers during storage in collaboration with breeders
- promising traditional food processes for both crop and animal products
- appropriate packaging systems for various products
- affordable labor-saving devices (manual and motorized) for food handling, processing, and packaging
- new products to include animal feeds and industrial products
- analytical data on raw materials and products for the purpose of characterization
- marketing studies to include in-depth inventory of resources, product volumes, prices, consumer tastes and preferences, market channels, market information
- socioeconomic studies on all issues mentioned above

Discussions

Question: What main types of farmer have been identified in the Cameroon BA?

Answer: Cash crop farmers, food crop farmers, mixed cash crop/livestock farmers, and mixed food crop/cash crop farmers.

Question: What particular resources have been identified as being most limiting to the farmers?

Answer: The following have been identified:

- lack of improved planting materials for cassava, maize, and other crops
- declining soil fertility, improved fallow management being used to remedy the situation
- inability to afford resources for intensified agriculture

Question: As a follow-up to the above question, what opportunities have been lost to farmers because of these resource limitations?

Answer: Increased production to meet the needs of processing industries. To ameliorate the situation, government has taken some measures. Loans are obtained from the government through the National Employment Fund (NEF) for agriculture. Funds are given by NEF for training/retraining of youths in agriculture.

Question: What has been the progress made on the BA baseline survey in Cameroon? Has there been further progress from earlier reports?
Answer: The data have been used in Cameroon BA for identification of constraints to be addressed by agricultural research within the framework of EPHTA.
Question: With a relatively young population but an ageing farming population, what are the incentives to attract more young and able-bodied people into the agricultural sector?
Answer: NEF loans to unemployed young university graduates and retired civil servants.

Degraded forests benchmark

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The report contained three components:

1. Baseline survey of southeast Nigeria agroecological zone
2. Resource management survey of the Degraded Forest Benchmark Area (BA)
3. EPHTA activities implemented to date by the BA

Highlights of baseline survey results

The southeast Nigeria agroecological zone lies roughly between longitude 5°34' and 9°24' E and latitude 4°15' and 7°20'N. It occupies a total area of 78 612 km² and is characterized by the following:

- Based on the 1991 census figures, the total population of the zone is 18 821 872;
- Important geographical features include plains and lowlands in the west, coastal landscape in the upper central parts of the zone, and the Eastern Highlands, near the border with Cameroon. Many rivers, including the Niger, Cross, Imo, and Anambra/Manu drain the zone.
- Five climatic regions are distinguishable from the zone:

(i) Zone I (equatorial forest zone): The driest month has at least 60 mm rainfall; average annual rainfall is always greater than annual potential evapotranspiration.

(ii) Zone II: Only one or two months with less than 60 mm rainfall, maximum temperature being 35°C.

(iii) Zone III: Three dry months with less than 60 mm rainfall, the total annual rainfall being 1875–2500 mm; rainfall shows more seasonal rhythm and is modified by local environmental factors.

(iv) Zone IV: Four months in which rainfall is less than 60 mm and the driest month has less than 29 mm; total annual rainfall ranges from 1600 mm to over 2000 mm.

(v) Zone V: Four dry months with monthly rainfall less than 49 mm; annual rainfall ranges from 1500 to 1830 mm.

Note: Based on the above, a good part of the zone lies outside the humid forest zone characterized by length of growing season with more number of days of less than 2700 mm rainfall.

- The dominant vegetation of this zone consists of both fresh water and salt water swamps to the west, coastal grasses at the coasts of the Atlantic Ocean, and lowland rainforest occupying most of the zone, while to the far north is the rainforest–savanna transition zone.
- The soils fertility map of the zone shows areas with low, medium, and high N, P, or K. Major crops grown in the zone are yam, cassava, maize, rice, cocoyam, plantain, and to a less extent, sweetpotato.
- Major crop combinations indicate that the dominant crop mixture in the zone (88%) is yam/maize/cassava/vegetables intercrop. The major vegetables are *egusi* melon, telfairia, okra, and *amaranthus*. Some cassava/groundnut intercrops with or without maize are popular in some parts of the zone.

- Using the baseline survey information, the following three blocks of the degraded forest BA were delineated: Abakaliki, Umuahia, and Port-Harcourt blocks.

Preliminary results of the resources management survey

Based on the information from the baseline survey, a resource management survey of the BA was conducted between 3 and 11 September 1997 in 45 villages that constitute the BA villages. The data from this work have not been fully analyzed, but the following have been indicated:

(i) Most of the BA is flat land or plateau. Only the Umuahia Block (20%) has sloping hillside lands.

(ii) The number of households in a village increases from Block I (Abakaliki) to Block III (Port-Harcourt). The highest number of households in a village (5210) was observed in Port-Harcourt block.

(iii) Most of the village dwellers (98%) use firewood as a major source of fuel. Electricity is not available to 64% of the people of the BA which has virtually no pipe-borne water.

Some EPHTA activities carried out so far

- Six BA villages (two per block) have been selected, based on the available data;
- Thirty contact farmers (five farmers per village) have been selected; each farmer was given four varieties of improved cassava and three varieties of yam hybrids.
- Conducting on-station work on short fallow stabilization. About 15 varieties of cover crops, using *chromolaena* spp. as a check, are being evaluated for potentials for regenerating soil fertility and suppressing weeds.
- Multiplying some more improved cassava and yam (2 ha) for distribution to contact farmers in 1999.

Constraints

(i) The resource management surveys conducted in 1997 as well as the household resource management survey have not been analyzed. The NARS lack the expertise for detailed data analysis.

(ii) Lack of vehicles, office infrastructure, and operation funds hinder effective operation.

Discussions

Question

(a) Is there evidence of cassava replacing yam as intensification pressure increases?

(b) If yes, what is being done to prevent the loss of valuable genetic resources in farmers' varieties?

(c) What is the extent of fertilizer use?

(d) What about crop–livestock integration?

Answer

(a) Yes, cassava has gradually replaced and taken the position of yam in terms of area grown. The reason, of course, is declining soil fertility. Most varieties of yams perform best under high soil fertility and, in fact, some varieties have been lost (extinct) because they could not be produced in poor soils.

(b) What is being done falls within our short fallow/soil fertility regeneration studies. If we can regenerate soil fertility to a reasonable level, the trend may be reversed.

(c) Fertilizer use was very low in the late 1970s due to poor extension and farmers' belief that fertilizers reduce the quality of root crops. But by the mid-1980s to this day, fertilizer use rose to a point that every farmer needs fertilizer but it is no longer affordable by the resource-poor farmers.

(d) Crop–livestock integration exists among farmers but is definitely not developed consciously. This is an important area for research and development.

(e) Horticultural production systems have not really been fully studied but there is a promise that this activity could greatly improve farmers' well-being, if developed.

Question

(a) As a follow-up to question 1 on fertilizer use, how widespread is the use of fertilizer in your area?

(b) Do farmers use fertilizers to counteract reduction of fallow period in yam production?

Answer

(a) Already answered.

(b) Farmers use fertilizer a lot, but not necessarily to counteract reduction of fallow period. The fact is that at present, fertilizers are too expensive for farmers.

Question

There is something not correct about the village characterization in the Abakaliki BA; rice is the dominant crop in the area followed by yam. This is not reflected in the preliminary characterization presented. Why?

Answer

You are correct, all the data from our characterization survey have not been analyzed. What I showed was secondary data for Enugu State and believe that if I had data for Ebonyi State, rice would have been shown as the most important crop.

Question

Maize is the third most important crop in your area. Recognizing the fact that you are located in a root crop institute, how do you cater for the needs of farmers that grow maize?

Answer

We in the southeast zone are in the Zonal Research Institute, which houses a Zonal Farming Systems Headquarters. The Farming Systems Team has the mandate to research into all the farming systems of people in southeast Nigeria. So what we do is go for improved technologies wherever they are, bring them home, tailor them, and adapt them to the needs and capabilities of our farmers.

Question

Your report did not include activities on the wetlands of the Abakaliki block of the degraded forest zone. Farmers make use of the wetlands, particularly for rice cultivation. What are your plans for the wetlands?

Answer

Yes, reports given did not indicate the wetland activities. I used available information from our BA baseline report.

Forest pockets benchmark

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Summary of baseline information for benchmark area of Ghana

(i) ***Study villages/towns***

The benchmark area (BA) was divided into three blocks:

- Kumasi (15 villages)
- Obuasi (17 villages)
- Asankragua (15 villages)

(ii) ***Institutional, socioeconomic, and biophysical constraints to agricultural production***

The constraints identified included:

- Gradual shift towards a forest/savanna transition zone.
- Road networks outside the major town are inadequate.
  Marketing and extension facilities are lacking for food crops, but available for cocoa, the main cash crop.
- Traders travel to the production villages to purchase farm produce at very low prices.
- No active agricultural credit program in operation, especially in Obuasi and Asankragua blocks.
- Poor soils and erratic rainfall.

(iii) ***Land tenure system***

- About 50% of farmers reported that they did not have sufficient land for agricultural production.
- Most land owned through inheritance.
- Sharecropping.
- Women and land ownership: apart from their husband's land, some women have rights to other land to grow crops for their own need. Women who did not have access to other lands are mostly spouses of settler farmers.

(iv) ***Land-use changes***

- Declining importance of traditional forest crops such as cocoa, plantain, and cocoyam. Cassava, maize, oil palm, and cowpea are replacing these.
- Farmers have forecast that if the present trend continues, crops such as plantain and cocoyam will be out of the system in the next decade or so, especially in Asankragua block.

  Major food crops grown and consumed: cassava, maize, cocoyam, plantain, and yam.

  Major tree crops grown: cocoa, citrus, oil palm, avocado, and kola.

  Mixed cropping patterns: the patterns for the mixed cropping are as follows:

- Cocoa + cassava + maize + plantain + cocoyam + yam + pepper + garden egg + okra
- Oil palm + cassava + maize + plantain + cocoyam + yam + pepper + garden egg + okra

- Citrus + maize/cowpea
- Maize + cassava + plantain + cocoyam + yam + pepper + garden egg + okra

The food crops in the cocoa, citrus, and oil palm plantations are only predominant during the first two to three years after establishment. They are phased out when the plantations start bearing fruits (i.e., between three and four years after establishment).

Sole cropping: Crops that sometimes grow as sole crops include maize, rice, pepper, tomato, garden egg, and okra.

(v) **Livestock**

Generally, goats, sheep, and poultry are the major animals reared in the BA.

Obuasi and Asankrangua blocks: livestock and poultry production is on a small scale, mostly on a free-range system.

Kumasi block: livestock rearing is expanding and poultry production is on a large scale.

(vi) **Soil fertility maintenance**

Soil fertility is maintained through the use of fallow.

Where pressure on land is highest, the use of live mulch, especially *Mucuna*, is becoming increasingly popular.

The use of fertilizers is limiting due to the high cost.

(vii) **Postharvest and utilization**

For long periods of storage and high selling price in the lean period, harvested palm fruits are generally processed into palm oil and palm kernel oil in all the three blocks. Dry "Kokonte" chips are processed from cassava tubers. Pepper is dried and stored in jute or fertilizer bags. Rice and maize are stored in traditional cribs and occasionally smoked to control insects.

(viii) **Marketing channels and policies**

Generally, traditional cash crop produce such as cocoa and kola are sold directly to companies engaged in their procurement for export.

Food crop produce are sold through the following channels:

- Farmer–consumer at the village
- Farmer–middleman at village–consumer at urban markets
- Farmer–middleman at village–retailer at urban market–consumer at urban market
- Farmer–middleman from urban center–consumer at urban center
- Farmer–middleman from urban center–retailer at urban market–consumer at urban center

It was concluded with hope that the above results would guide the development of sustainable systems for the forest pockets of the subregion.

Discussions

Question

What is the current status of resource management survey in your BA?

Answer The survey has been conducted in all the three blocks with 15 villages each. The data are yet to be entered into the computer for analysis. The problem is researchers' time to do the data entering and analysis.

Question

You completed the baseline survey in May. What is retarding the analysis of the data? And what assistance do you think IITA can give?

Answer

Researchers involved in the study have a problem finding the time. If we could get personnel to assist in the data entry, the analysis and report writing would not be a problem. IITA could help us with a technician for such duties and also in providing secretarial assistance to the Coordinator.

Question

Farmers sell their produce at give-away prices, primarily because of inadequacy of access roads to the farms. Are these roads continuously inaccessible or are they seasonally inaccessible, i.e., are they accessible during the dry season? To help farmers get better prices, should you not be addressing the issue of postharvest handling and storage?

Answer

Roads are inaccessible after the rainy season when the produce is ready for sale. The program would address postharvest and storage issues. The problem is that majority of our consumers make use of more of the fresh produce than the processed ones.

Question

How do commercialization strategies vary across the gradient of population densities?

Answer

Cocoa is the main commercial crop for all the blocks, but because of deforestation, the change is towards food crops such as cassava, plantain, and cocoyam, especially in the Kumasi and Obuasi blocks.

Question

How do blocks differ in terms of resource management? Are there different strategies that might be targeted to blocks?

Answer

The main difference among the blocks is the population density and the nature of agricultural intensification, as well as the crop grown. The strategies should address the constraints that would be specified in the main report, which would be written when the data have been appropriately analyzed.

Northern Guinea savanna benchmark area

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Results of baseline survey of northern Guinea savanna benchmark area of Nigeria

Most of the report was on the results of the baseline survey, summarized below.

Access to agricultural land. Access to agricultural land is mainly by inheritance. Land is held in trust for the community by the community head, although individual families exercise considerable control over their farmlands.

Unmarried females have access to land, but are expected to surrender such land to their fathers when they get married. The process of inheritance means that farmlands are increasingly fragmented into uneconomic sizes among future family members; the average farm size hardly exceeds 2 ha.

Roads. The NGS BA is well linked with accessible roads that facilitate transport of goods and services in and out of the farm areas.

Water bodies. General water bodies including Rivers Kaduna, Galma, Challawa, Tubo, Danmari, Getameya, Koriga, and Manriga exist in the NGS-BA. The riverbanks and watersheds are foci for inland valley/Fadama agricultural activities. These rivers provide the irrigated agricultural production and fish farming opportunities in the area.

Low adoption of packages which include chemicals as components

Factors that adversely influence adoption of improved on-farm packages in the NGS include:

- ***Land fragmentation.*** Land fragmentation would be blamed for the low adoption rates for improved on-farm packages. Farmers now focus their scarce inputs on those crops that demonstrate the highest potential consistent with declared goals of farm production.
- ***Increasing use and cost of agrochemicals and fertilizers.*** Crops such as cowpea require considerable protection against pests and diseases with applications of synthetic pesticides. These chemicals are imported and costly. The increasing cost of these agrochemicals discourages adoption of the improved on-farm packages for such crops.
- ***Socioeconomics.*** There have been vigorous extension activities to promote improved on-farm technologies by various organizations including the World Bank-assisted Agricultural Development Project (ADP). These efforts are widely believed to account for the widespread adoption of maize and maize-related technologies in the NGS-BA.
- ***Climate.*** Within the NGS-BA, short drought spells occur commonly in the rainfed-cropping season, and adversely constrain adoption of improved on-farm technologies. For example, long season or late-maturing, high yielding crop varieties (e.g., maize) may not be adopted in the NGS-BA. Rainfed cropping season in the NGS-BA is between June and September. Drought spells occurring within this period would cause moisture stress and hamper optimum yield of crops.

- ***Soils.*** Soils in the NGS-BA have low organic carbon and total nitrogen, and have poor moisture retention capacity and shallow rooting depths. Crop production in the area, therefore, requires the use of organic matter. This is adversely influencing maize production, to the advantage of sorghum; increasing land area is presently being put to sorghum cultivation.

Hired labor is now a major component of total labor requirement. Agricultural labor in the NGS-BA comes from both family and hired sources. In the late 1970s and until the mid-1980s, the share of hired labor in the total labor input was low and fairly stable at 20–25%. Presently, hired labor is a major component of the total labor requirement.

Farm credits. The NGS-BA is uniquely fortunate to host the headquarters of the Nigeria Agricultural and Cooperative Bank (NACB) and several branch offices. Several other commercial banks having agricultural credit facilities operate within the BA.

However, availability of credits at the smallholder level is still dismally low, mostly lacking in many locations, but is becoming increasingly necessary because:

- the liberalization of fertilizer pricing needs to be supported by institutional cash credit.
- animal-powered implements which are currently being promoted for on-farm labor saving may suffer slow adoption in the absence of a strong cash credit backup.
- lack of cash credits of institutional form can limit labor hiring among farmers who rely on hired labor for on-farm work.

Marketing structure. Periodic and daily markets are found in the NGS-BA. The daily markets, mostly located in the urban areas, are well linked by good intrastate roads. Intrastate and/or interstate roads link the periodic markets, mostly in the rural areas.

The intrastate roads, which link the periodic markets, vary markedly in their motorability. The feeder roads between the village and markets have lateritic surfaces; together with sporadic fuel availability, high costs, and vehicle maintenance, cost of transportation is largely out of reach of many farm families.

Produce processing is still largely by manual operation, and limits the volume of threshable grains to an average of two or three 100 kg bags of maize per day. The cost of a powered maize sheller (N45 000.00), for example, is beyond the reach of most smallholder farmers in the BA.

Discussion

The following questions and comments raised during the discussions as well as the answers provided by Prof. Ogungbile are presented below.

Question

How was the resource management survey data analyzed?

Answer

Multivariate principal component analysis.

Question

Cotton farming in francophone West Africa has opened up opportunities for the intensification of food crop farming. Was cotton production used as a stratifying factor to see if it was associated with intensification of the food crop system, i.e., is there a typology of cotton-based farming systems?

Answer

No. Cotton is not a very important crop in the BA (NGS). However, this and other criteria can be used to stratify producers or domains if the need arose.

Question

Why is hired labor increasing? What are the implications of increasing hired labor to the farming systems, especially if intrahousehold changes; choice of crops, extra-agricultural activities?

Answer

Because cash crop farmers have money to pay for hired labor. There is a higher availability of casual labor because of school dropouts.

Question

What is the present role of trees in your BA?

Answer

Very little impor

Question

How do you ex[illegible] ssue of land fragmentation?

Answer

Fragmentation results from the practice of inheritance as the major method of land acquisition. A deceased man's land property is shared among his sons. It means a son's farm size would be smaller than that of his father, if the latter has two or more sons. This is repeated over several generations.

Question

Why did you not mention the role of *Fadama* in your report?

Answer

Although I did not indicate the importance of *Fadama*, there is the National *Fadama* Development Program being executed by the Agricultural Development Project Authority in Kaduna State. Farmers engage in dry season farming in the BA.

Benin coastal/derived savanna benchmarks

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The report was written and presented in French and there was not enough time to effect translation and synopsis in English. Consequently, the report is presented with little alteration. Basically, the report below describes the characteristics of the four different agroecological zones of the coastal/derived savanna.

Discussion

Question: How important will techniques developed for the "depression de l'ama" be for areas outside the benchmark?

Answer: The "depression de la lama" represents almost 10% of the total area of the benchmark. This will be taken into account in the benchmark study if it appears that it is important in the ecoregion.

Synthesis and remarks

Root crops dominated crops grown in the Humid Forest Zone, especially cassava. Fallow identified as main system of replenishing soil fertility, although the effectiveness is being affected by land pressure.

- Little/limited use of fertilizers due to high costs or non-availability.
- Land tenure is by inheritance, resulting in land fragmentation with increase in number of children and generations.
- Small-scale farmers have problems with credit access.
- Presentations gave little or no attention to the issue of transportation.
- Also not mentioned were:
  complementary use of inputs
  rate of adoption of technologies
- Some crops (e.g., yam) are being abandoned because of decreasing soil fertility.
- Problem of soil erosion not highlighted in all presentations as should have been done, given its importance.
- Changing nature of farm labor from mostly family labor to predominantly hired labor.
- Problem of inadequacy of good road network to ensure evacuation of farm produce.

What can be done to address these issues?

- Provide agronomic solutions as appropriate (mentioned by presenters).
- Give adequate attention to credit access to farmers.
- More attention to soil degradation caused by livestock.
- More attention should be given to fisheries/exploitation of water resources.
- Involve extension systems in identification of constraints and priority setting.

Session 2

Farmer's opportunities

Economics of maintaining and enhancing natural resources base through the adoption of stabilized short fallow systems

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Abstract

Declining soil fertility was identified as a major problem of agriculture in the humid and subhumid ecozones of sub-Saharan Africa. The traditional as well as Ruthenberg approaches to the fallow concept identified variuos types of fallow systems. Among them, the use of green manure cover crops and the fodder bank-based systems compared favorably with the natural long fallow systems. Other systems in decreasing order of importance included agroforestry, farmyard, grain legume and chemical fertilizer-based systems. High economic returns are expected at both regional and farmer levels after three years in the use of *Mucuna* fallow system with first year profit possibility if seeds could be sold. It also controls speargrass, reduces weeding, and improves soil fertility. This technology has been adopted by about 52% of sampled farmers in Mono Province, Republic of Bénin. The profitability and sustainability of the fodder bank-based systems as a more appropriate long-term option for improving animal nutrition and soil fertility were also demonstrated. The profitability of the systems across West Africa was highlighted. Benefits and constraints for the adoption of other systems were enumerated.

Problem statement

One of the major problems facing agriculture in humid and subhumid zones of sub-Saharan Africa is the declining fertility of its already low activity clay soils which continue to be subject to slash-and-burn systems (Conway 1997). It is estimated that between 360 million and 550 million hectares of land under shifting cultivation systems are supporting about 250 million people (FAO 1992, Conway 1997). Although productivity performance of slash-and-burn systems is low, it was possible to sustain productivity levels ecologically as long as the fallow phase was sufficiently long compared to the cropping phase (Conway 1997). But rapid population growth and the resulting pressure on land have shortened fallow lengths below levels necessary for sustainable production. Shortened fallow produces low vegetative cover, thus less organic matter, supply of soil nutrients, and increased weed infestation. Use of inorganic fertilizers could compensate for the low supply of soil nutrients. However, inputs of inorganic fertilizers averaged only about 10 kg per year in sub-Saharan Africa in 1994/1995, little more than 10% of the average for all developing countries (Vlek 1990). These problems are contributing to the low and declining agricultural productivity, and worsening poverty, food insecurity, and resource degradation.

To sustain agricultural production in an increasing population environment would require the development and adoption of stabilized short fallow systems that are both productive and protective of the resource base (Smith 1973).

Classification of fallow systems

If fallow is only defined in relation to the number of years or length of period when a piece of land is not carrying any edible or cash crop, the Ruthenberg index can be used to determine the land-use intensity and classify fallow systems into three major groups (Ruthenberg 1980).

Shifting cultivation system was common among farmers and this was aimed mainly at soil fertility restoration. This has been associated with a low level of economic development and low population density. This system is therefore a reflection of a specific stage of agricultural development and would be seen as one of the major constraints to the increase of agricultural development. The system is typical of areas where the years of fallow are at least twice the years when a piece of land is cultivated to edible or cash crops. In that case, the Ruthenberg index is assumed to be equal to or less than 33%.

Unlike the shifting cultivation systems, bush fallow systems are characterized by long fallow periods, which are not long enough to establish the climax vegetation. These represent the early stage of the intensification phase described by Manyong et al. (1996). The years of fallow are as long as the years of cultivation, in which case the Ruthenberg index would be between 33 and 66%.

Continuous cropping systems are found in areas where land is put into cultivation for a number of years greater than the years of fallow. This system corresponds to a late stage of intensification in the use of land (Manyong et al. 1996). The corresponding Ruthenberg index is assumed to be equal to or greater than 66%.

This traditional approach of classifying fallow systems is based solely on the duration of a cropping cycle (i.e., years of cultivation and years of fallow). It does not take into consideration the functions a fallow is expected to perform on the natural resource base. The following benefits to agricultural production are expected from a piece of land left to lie naturally fallow for a long period:

- Build-up of surface soil organic matter
- Recycling of soil nutrients
- Improvement of soil fertility; N_2-fixing and fallow species
- Better habitat for soil fauna
- Weed suppression
- Suppression of soil-borne pests and diseases
- Provision of feed for livestock
- Provision of firewood and other economic benefits to humans

Any system that fulfils part or all of the above functions would result in the stabilization of or improvement in agricultural production. Therefore, a stabilized short fallow system is one that satisfies these requirements. A lot of research effort has been invested in the development of more productive and sustainable short fallow systems that can accomplish most of the benefits expected of natural fallow system in a comparatively shorter time. Examples of such practices include the following forms of short fallow systems in West Africa:

- Chemical fertilizer-based systems (e.g., cotton-based systems)
- Farmyard manure-based systems (e.g., compound fields)
- Green-manure cover crop-based systems (e.g., *Mucuna* planted fallow)
- Fodder bank-based systems (especially for livestock in the Guinea savannas of West Africa).

- Agroforestry-based systems (e.g., alley cropping).
- Grain legume-based systems (e.g., groundnut-based systems in Senegal).

Assuming the fallow fulfils all the functions, Table 1 shows how each of the identified short fallow systems compare with the natural long fallow system. Green manure cover crops and fodder bank-based systems are close to natural fallow, followed in a decreasing order of importance by agroforestry, farmyard manure, grain legume, and chemical fertilizer-based systems. None of the short fallow systems is as good as an ideal, natural long fallow system.

Table 1. Matrix functions/short fallow systems.

Function	Fallow	Chemical	GMCC	Fodder	Agro-forestry	Grain legume
SOM	+++	-	++	++	++	+
Nutrient recycling	+++	+	++	++	++	++
Soil fertility	+++	+++	++	++	++	++
Soil fauna	+++	-	+++	+++	++	+
Weed control	+++	+	+++	+++	+	+
Pests control	+++	+	+++	++	+	+
Feed	+++	-	++	+++	++	++
Fuelwood	+++	-	+	+	+++	-

+Positive contribution
-No contribution

Types of stabilized short fallow systems

Chemical fertilizer-based systems

Research to shorten the length of fallow period focused on chemical fertilizers, which become more available. Numerous fertilizer trials have been conducted to determine the type and rates of fertilizers required for different crops, crop varieties, soils, locations, and climates. (Balasubramanian et al. 1978.). This has resulted in recommendations for maize and other crops in some West African countries as shown in Table 2. In order to conserve foreign exchange and reduce heavy bills arising from the importation of fertilizers, some countries (Nigeria and Bénin) have extended their research into examining local raw materials such as phosphate rocks as sources of cheaper phosphorus. Nigeria has ventured into the manufacturing of fertilizers by establishing many factories to produce urea, single superphosphate, and blend compound fertilizers (Carsky et al. 1997).

Farmers' response to increased intensity on cultivated land is by applying inorganic fertilizer. Fertilizer use has increased drastically over time. In spite of the recommendations, only very few farmers apply the recommended rates and the actual use of fertilizers by farmers in West Africa is very low (Norman et al 1982). Nigerian farmers use more fertilizer than most other countries in West Africa as a result of the subsidy on fertilizers for many years. Over 70% of fertilizer used in Nigeria is applied in the savanna zones of the country.

Table 2. Fertilizer recommendations for maize in several countries of West Africa.

	Recommendation (kg/ha)		
Country	N	P_2O_5	K_2O
Bénin	60	40	0
Cameroon	100	30	30
Mali	84	15	15
Nigeria (semiarid)	60	60	60

Fertilizer is the most widely adopted improved purchased input. From the low adoption rate recorded by Norman in the 1970s, Smith et al. (1994) reported that approximately all farmers in Kaduna and Katsina States and about two-thirds of the farmers in Bauchi and Sokoto States were already using fertilizers by the mid-1980s. Manyong et al. (1996) reported similar results in a survey of the northern Guinea savanna Benchmark Area of Nigeria. They, however, added that only about two-thirds of the farmers applied the recommended rates. Farmers select crops for which they apply fertilizer. Maize, sorghum, cotton, and vegetables get the highest priority. Fertilizers are considered to be a more efficient way of increasing yield than any other means. Many farmers regard it as a waste of time and effort growing maize without fertilizer. Increased use of fertilizers has resulted in the reduction of the fallow period in the area (Table 3).

Fertilizer availability has changed the status of maize from being a backyard crop in the 1970s, to a major profitable cash crop in 1980s. The use of fertilizers is highly profitable in the market-oriented regions. In spite of the recommendations and subsidies on fertilizers, the actual use of fertilizer by farmers in West Africa is very low (Carsky and Iwuafor 1997). Manyong et al. (1998) reported that less than two-thirds of the farmers applied the recommended dose of inorganic fertilizers because of scarcity and high cost of the input in the northern Guinea Savanna Benchmark Area. High-level application of fertilizer has been associated with the problem of soil acidification which limits the amount of nitrogen that can be applied by the farmers (Jones 1976). These problems associated with the use of inorganic fertilizers suggest that we cannot wholly rely on inorganic fertilizers for agricultural intensification.

Table 3. Change in fallow periods: Northern Guinea savanna, Nigeria, group interviews, 1989.

		States			
	All villages	Northern Kaduna	Southern Katsina	Bauchi	Southeast Sokoto
1989 percentage of villages	27	10	5	9	3
No fallow	59	50	100	56	33
Fallow declining	26	50	0	22	0
No change	11	0	0	11	67
Mid-1970s percentage of villages	4	0	0	11	0
No fallow	30	40	20	33	0

Source: Smith et al. 1994.

Farmyard manure-based systems

Farmers have long recognized the importance of animal manure and compost in the maintenance of soil fertility, especially in the drier savanna where animal rearing is practiced side by side with crop production. Farmers build up manure in the compounds from the dropping of animals mixed with crop residues. Cattle produce more manure than other animals, although farmers have claimed that manure produced by small ruminants takes a shorter time to process and is of better quality. Manure is transported to fields in baskets, on animal drawn carts, and on donkeys. *Fulani* pastoralists are sometimes invited to camp their animals in a particular field for a fee in exchange for animal droppings. In a survey of nine villages in the Sudan savanna zone of Nigeria, it was found that an average household produces about 2000 kg of manure and it is applied at the rate of about 550 kg/ha. The removal of subsidies on fertilizers in Nigeria has made farmers pay more attention to the processing and utilization of farmyard manure. The quantity of manure produced by farmers in any given year is rarely adequate. The amount available is therefore rotated in the fields with each field receiving manure every other two or three years. Carsky et al. (1997) attributed the relative fertile soils described by Norman et al. (1982) in the "ring" cultivation system of northern Nigeria and in the compound fields reported by Rungo-Metzegar (1988) in Ghana and Prudencio (1993) in Burkina Faso to the deposit of household wastes and animal manure in the land area around villages. Jones and Wilde (1975) as a result of the use of animal manure have reported significant yield increases. Not only does animal manure supply nutrients, its use has been found to allow a build-up of soil organic matter and helps to neutralize the acidifying effect of chemical fertilizers (Jones and Wilde 1975).

The large quantity of manure required to be effective and the high demand for labor input involved in transporting the manure have limited the area of land that can receive manure. More land would be required to grow livestock feeds if livestock population were to increase to supply more manure. Given the shortage of supply of manure, it appears that animal manure will continue to be used to complement inorganic fertilizers.

Green manure cover crop-based systems

Cover crops such as *Stylosanthes guianensis, Pueraria phaseoloides, Mucuna pruriens, Centrosema pubescens, Lablab purpureus* (white and black), *Aeschynomene histrix* have been used to minimize soil degradation in many Western and Central African countries.

Mucuna is one of the most tested cover crops at the on-station and on-farm levels. Varieties tested found suitable, and subsequently disseminated in Benin Republic and elsewhere are *M. pruriens utilis* and *M. cochinchinensis.*

Mucuna is adapted to a broad range of rainfall, but grows better in areas with a bimodal rainfall regime in most western and central African countries. It thrives in semiarid zones with less biomass and it is possible that some varieties may not complete their productive cycle, thereby making seed multiplication difficult (Tarawali et al. 1998). *Mucuna* residues can be burnt, left as mulch, or incorporated into the soil. Because incorporation into the soil requires substantial labor input for seed preparation, direct seeding into mulch may be preferred since there has been no evidence to prove yield differences in adopting either of the two methods. Osei-Bonsu and Buckles (1993) observed effective weed control with direct seeding method. No weeding was required up to six weeks after planting.

Adoption of the *Mucuna* fallow system was reported to have been enhanced by *Mucuna*'s

ability to control speargrass in the bimodal rainfall zone of Benin. Versteeg and Koudokpon (1990) reported a drastic reduction of *Imperata* on farmers' fields by *Mucuna* and a sharp decline in the shoots of speargrass was observed by Dovonou (1994). Akobundu and Pokun (1984), and Akobundu and Udensi (1995) found *Mucuna* to be more efficient than any other method of controlling *Imperata* in a research-managed trial.

Two effective management methods have been developed for intergrating *Mucuna* into the cropping system in Bénin. They are (1) the *Mucuna* pure stands or the *Mucuna* improved fallow and (2) *Mucuna* in relay with maize.

Sole *Mucuna* cover crop fallow is recommended to improve degraded soil and to reduce severe infestations of speargrass and other weeds, which are capable of causing farmers to abandon the field to fallow.

The maize-*Mucuna* relay strategy was designed for fields with layer weed infestation and rehabilitation. *Mucuna* is also known to leave thick mulch free of weeds, making the land preparation for subsequent maize crop relatively easy. It is therefore suitable for minimum tillage practices. Because *Mucuna* is a climbing plant, planting it early can reduce maize yields.

Yield increases have been reported for crops that follow an improved *Mucuna* fallow. According to Versteeg and Koudokpon (1990), an increase of about 500 kg/ha was observed for a local maize variety and 800 kg/ha for an improved variety following one year of fallow with *Mucuna*. In Ghana, maize yield of about 3–4 t/ha was obtained on fields, which previously had *Mucuna* without nitrogen application. *Mucuna* fallow, either as an intercrop or as sole crop, is capable of supplying an equivalent of about 100 kg N/ha to the following maize crop. Sanginga also observed similar results in the bimodal-rainfall zone in southwestern Nigeria. Codjia (1996) reported about 98% higher yields of maize after a *Mucuna* short fallow without chemical application.

According to Manyong et al. (1998) high economic returns are expected at both farmer and regional levels three years after *Mucuna* is adopted. Furthermore, they argued that the *Mucuna* fallow system could prove to be profitable even in the very first year of introduction if only the seeds could be sold. Indicating the profitability of the *Mucuna* system, a benefit cost ratio of 1.24 was obtained from an economic analysis over the 8-year period using the *Mucuna* fallow system and 0.6 without *Mucuna*. The ratio increased up to 3.56 if it were possible to sell *Mucuna* seeds (Table 4).

Table 4. Average future cost and returns over 8 years of systems with and without *Mucuna* fallow in Mono Province, Bénin.

	With *Mucuna*		
	Scenario 1[a]	Scenario 2[b]	Without *Mucuna*
Gross returns (USD/ha)	354	836	11
Variable cost (USD/ha)	9	9	4
Labor	276	276	172
Net revenue (USD/ha)	69	620	–66
Benefit-cost ratio	1.24	3.56	0.62
MRR(%)	124	629	–

Source: Manyong et al. (in preparation).
Note: MRR = Marginal rate of return; USD = United States Dollar.
(a) Only maize seeds are sold.
(b) Both maize and *Mucuna* seeds are sold.

The results of an adoption study conducted by Manyong et al. (1996) in Mono Province of Bénin Republic indicate a high rate of adoption of the improved *Mucuna* short fallow system. *Mucuna* technology had been used by about 52% of the sampled farmers (Manyong et al. 1996). The main reasons for adoption were to control speargrass (*Imperata cylindrica)* and to improve soil fertility. Other determinants of adoption were presence of young palm trees, secure land tenure, access to extension information, and the opportunity cost of adopting *Mucuna* technology. Adoption of *Mucuna* as the improved fallow in Bénin is in contrast to experiences in Nigeria and Côte d'Ivoire where earlier efforts to introduce *Mucuna* fallow failed.

All seeds produced cannot be harvested and the uncollected seeds that germinate before maize is grown the following season may constitute an early weeding problem. Other constraints to adoption include land scarcity, land tenure, non-edible products of *Mucuna,* fire outbreak, complementarity with other crops, and the possibility of disease incidence. Popularizing the consumption of *Mucuna* grain would definitely increase the market for *Mucuna* seed and adoption of the cover crop consumption as hay.

Factors influencing adoption of cover crops

Using the adoption study of *Mucuna* in Bénin as a case study, the following factors may be speculated to affect the adoption of cover crop technology elsewhere:

- Technology is unlikely to be adopted where fertilizer and herbicides are readily available at lower prices.
- Farmers operating on fertile soils are not likely to adopt the technology.
- Infestation of noxious and parasitic weeds is likely to be an incentive to adopt; so also the need for dry season livestock feed in the dry savanna.
- Adoption in the drier zones is lower because planting sole crop *Mucuna* would result in losing an entire season of growing food or cash crop. Close contact is needed among researchers, farmers, and extensionists.

Fodder bank-based systems

The fodder bank concept was developed by ILCA/ILRI and targeted at livestock farmers in the subhumid zone of West Africa in order to provide concentrated legume feed to be preserved for the dry season grazing (Ajileye et al. 1994). *Stylosanthes* is the legume species usually associated with fodder banks. *Stylosanthes* is usually planted as a sole crop to supplement natural grass or improved legume association. Some of the major attributes of *Stylosanthes* include tolerance to diseases, adaptation to infertile soils, drought resistance, ability to fix nitrogen and high seed yield (Tarawali et al. 1998) Although it was designed for pastoralists, *Stylosanthes* was reported to have been successfully integrated into crop rotation as an intercrop and relay crop to the benefit of crop farmers. Ikwuegbu and Ofodile (1992) estimated an N fertilizer replacement value of about 45 kg/ha after two to four years fodder bank composed of *Stylosanthes* or *S. hamata* in the Guinea savanna zone of Nigeria.

The fodder bank concept was introduced to the subhumid zone of Nigeria during the 1980s and it was extended and diffused by the National Livestock Development Project (NLPD) in the Federal Department of Agriculture. *Stylosanthes* fodder banks have also been extended to agropastoralists and smallholder farmers in Côte d'Ivoire, Cameroon, and Mali by different development projects.

Economic evaluation

A number of studies had shown that adoption of the fodder bank concept could be profitable and sustainable as well as being a more appropriate long-term option for improving animal nutrition and soil fertility. Bationo et al. (1988) reported that cattle with access to forage legumes in the dry season produced more milk, lost less weight, and had shorter calving intervals, and better rate of calf survival. An average weight gain of 140 g/d for heifers grazed on improved fodder pasture while those grazed on unimproved pasture lost an average of 58 g/d.

The positive impact of fodder banks on crop production has also been demonstrated. Higher crop yields on the fields that previously carried pastures were due to legumes' improvement of soil properties. It has also been shown that *Stylosanthes* can maintain crude protein needed during the dry season. Von Kaufmann and Mohamed Saleem (1989) showed that crude protein produced from fodder banks was cheaper than that from cotton seed cake which is an alternative form of dry season supplementation (Table 5). Also, using a model to appraise the economic returns of fodder banks over a period of 10 years, Von Kaufmann and Mohamed Saleem showed that fodder banks can be a profitable enterprise in the long run in Nigeria as shown in Table 6.

In Côte d'Ivoire, farmers were able to earn average revenue of CFA 1.5 million per annum after three years of installation of fodder banks in the eco-farms project. The major part of this income came from milk sales, followed by proceeds from beef and crops (Table 7). The potential profitability of dairy production in peri-urban areas of Nigeria using fodder banks (Table 8) and the opportunity cost of using land for home grown fodder rather than cultivating a highly favored sorghum crop was much lower than the accrued benefits from yields produced by cows supplemented with forage hays.

Table 5. Cost of obtaining crude protein from a 4-ha fodder bank compared to cotton seed cake in subhumid Nigeria.

Fodder bank (4-ha)	16,000
DM produced (kg)	8,000
DM available (kg)	720
CP content (kg)[a]	5,944
Capital cost (N)	
Cotton seed cake CP	720
Required DM at 30% (kg)	2,400
Capital cost (N)	0
Recurrent cost[b]	2.27

Source. Von Kaufmann and Mohamed Saleem (1989).
Note: CP = Crude protein, DM = Dry matter; Nigeria Naira (₦) (in 1989 ₦7.3 = $1 US Dollar; in 1989 N75.2 = USD).
(a) Assumes 9% crude protein available in dry matter.
(b) Calculated as N680t[(1)] of cotton seed cake at 30% CP.

Table 6. Economic returns on fodder banks in subhumid Nigeria over 10 years 1989.

	Net present value (N)[a]	Internal rate of return (%)	Without fodder bank (N)	With fodder bank (N)	10th year incremental revenue
1HP	1414	22.5	49.907	90833	4950
1HP+reduced force sales	7538	34.1	43907	90833	7138
1HP+increased crop yields	9395	36.3	49907	90833	8544

Source: Von Kaufmann and Mohamed Saleem (1989).
Note: 1HP = Improved hard productivity.
Nigeria naira (in 1989 =N73 = 1US Dollar in 1998 N75.2 = 1US Dollar) calculated at 20% discount rate.

Adoption of fodder bank technology

Experiences differ from country to country with regards to the dissemination and adoption of the fodder bank concept. In Nigeria, most pastoralists who have invested in fodder banks agreed that they are useful as supplementary feed sources during the dry season and that animals grazing fodder banks performed better than those without access did. Benefits derived include less "forced sales" of underfed stock, cows grazing fodder banks have better conception rates and milk production, and better survival of calves. Fencing increased the security of land tenure and farmers save some cost in hiring labor for herding. Crop farmers also take advantage of the nitrogen build-up in the fodder banks through rotational cropping (Ajileye et al. 1994).

In Nigeria, between 1980 and 1986, only 25 banks were established. However, with the credit scheme introduced by NLPD with a World Bank assistance loan, the adoption rate increased to over 400 fodder banks in 1990 (Ajileye et al. 1994). Adoption rate has dropped since 1991. Biological and socioeconomic constraints include inadequate seed supply, expensive cost of fencing, land scarcity, and land tenure problems, lack of capital, inappropriate ecological adaptation, ineffective on-farm and extension programs to promote the technology, and shortage of labor.

Table 7. Contribution of various products and enterprises to the total income of six ECO-farms (1994/95).

	Farm income (10^6 x 0F) (%)		
	Milk	Beef	Crops
F_1	1.6(71.9)	0.32(14.3)	0.31(13.8)
F_3	1.15(72)	0.29(18.4)	0.15(9.4)
F_4	1.33(70.6)	0.45(23.8)	0.10(5.6)
F_6	1.08(66.7)	0.43(26.5)	0.11(6.8)
F_7	0.84(70.7)	0.22(18.2)	0.13(11.1)
F_8	0.48(57.5)	0.18(22.3	0.17(20.2)
Avg	(68.2)	(20.6)	(11.1)

Source: Adapted from ECO-farm project (1985).
Note: Avg = Average; 0F = CFA-Franc; (in 1998, 610.85x0F = US $1).

Table 8. Indications of profitability of using grown fodder for dairy production 1993–94.

	Extra kg milk		Extra kg milk yield per kg feed		Value of milk N	Margin over feed off-take per kg feed
System	a	b	a	b	(a)	(b)
Semi-intensive (smallholder)			Experiments 1 & 2			
Forage legume hay	0.332	0.830	4.98	12.45	2.54	10.01
Experiment 3 Zero-grazed system (on station)						
Green tree foliage	0.340	1.840	5.10	27.00	-	7.95

Agroforestry-based systems

Alley farming was developed at IITA as a soil management practice and as an alternative to fallow system in the 1980s. It is a concept in which field crops are grown between rows "hedgerows" of trees or shrubs, for the maintenance of soil fertility, or part of the hedgerows biomass is fed to animals as fodder.

There are three stages:

i. Establishment stage characterized as the first period of tree planting and growth when outlays of resources are made, but there is no return.
ii. Productive stage is a period during which hedgerow species provide useful products or services. It is also characterized by resource requirements.
iii. Maintenance stage is the intervening period between establishment and productive stages, resource outlays are minimal, and benefits would not have begun to arrive.
iv. Species used in alley farming are:
   Leucaena leucocephala
   Gliricidia sepium are the commonest species in Nigeria
   Chromolaena odorata introduced lately
   Senna siamea
   Leucaena diversifola in Bénin Republic
   Flemingia nacrophylla

Senna spectabilis, Senna Siamea, Albizia lebbeck, and *Cajanus cajan* in Togo in addition to the above species.

Benefits of alley farming

Many studies have shown that alley farming improves soil fertility. Studies at Ibadan, Nigeria showed a linear response between maize grain yield and levels of *Leucaena leucocephala* or *Gliricidia sepium* mulch fields with alley cropping having slower loss of soil nutrients and organic matter but levels of K and P declined faster. In the absence of fertilizer, alley farming can reduce, but not eliminate the need for fallow. Similarly, it has been shown that *Chromolaena odorata* foliar application on the surface, significantly increased total N, organic carbon, available P, and exchangeable cation content in the soil.

Gradual restoration of soil fertility with the inclusion of *Senna siamea, Leucaena diversifolia, Leucaena leucocephala, Flemingia macrophylla, Senna spectabilis* occurred in the *terre de barre* soils of Bénin Republic.

In a similar vein, alley cropping increased maize yield, with or addition of between 91.0 to 176.2 kg/ha N, 4.15 to 12.33 kg/ha P, and 26.84 to 57.0 kg/ha K to the soil annually, in Togo Republic.

In livestock production, the prunings are used as animal feed supplements. The overall quality of feed is improved by a contribution of protein from leguminous trees, provided that there is a regular pruning.

Trials in Ibadan, Nigeria, showed that *Gliricidia* is moderately palatable to sheep. Inclusion of legume forage with *Panicum maximum* ration improved nutritive value, raised animal productivity, and increased survival rates of the offspring from birth to weaning from 40 to 50 to 95% (Ikwegbu and Ofodile 1992). In dairy cattle, in early lactation period, the response of milk production to supplementation of a *P. purpureum* ration with *Leucaena* ration is high especially in the dry season. In mid-lactation, the response is muted. A study in Nigeria showed that using 348 kg of foliage from *Leucaena* and *Gliricidia* as mulch on maize increased grain yield to between 22 and 28 kg and as alley cropping fodder increased the number of goats (herd productivity) from 7.8 to 11.3 and kids from 11.3 to 12.3.

Rate and level of adoption

The potential for the adoption of alley farming cannot be judged by research results in spite of the impressive results obtained at the research farms. In Nigeria, studies by IITA showed that 11 farmers established 14 alley farms in Zakibiam (Benue State) between 1980 and 1985 and only three farmers were still participating in the final year fertilizer trials in 1988. In 1989, after the research ended, only one farm was cropped. Most of the alley farms planted in 1989 in Ayepe (Oyo State) were abandoned in 1990. Similarly, 139 farmers in southeastern Nigeria had 175 plots in 1991, but fewer were available (109 farmers and 119 plots) by 1991. Individual farmers generally do not adopt alley farming easily, concluded ILRI, and a community approach accompanied by extension efforts is most promising.

Constraints to adoption

Adoption rate is poor, due to the following constraints:

Agronomic: Hedgerow biomass and grain yields on-farm are far below those reported for on-station farms. These have been attributed to poor soil and drought. Accidental uprooting during weeding, herbicide and termite damage, wrong timing, and method of planting are also problematic.

Socioeconomic: Land tenure problems, labor changes when pruning and weeding operations may overlap, orientation of program to individuals, and no extension involvement.

The conclusion was that high potential for adoption cannot be identified on the basis of research data.

Grain legume-based systems

The use of legumes in a rotation can reduce the length of fallow period and permit continuous cropping through the supply of atmospherically fixed nitrogen, often utilized by the relay cereal crop component from the soil. In the savanna zone of West and Central Africa, sorghum, maize, and millet are the main cereal crops and the principal legume crops are groundnut, cowpea, and soybean. The crops are usually grown in mixture with other crops. Where farmers adopt some form of crop rotation, the sequence is often not systematized.

The yield-increasing effects of crop rotations especially where legumes are involved have been attributed to a number of factors including the improvement of soil fertility, enhancement of balanced nutrient removal from the soil (Singh 1974), and improvement of soil physical properties. Other benefits of crop rotation include soil conservation, organic matter restoration, and pests and disease control (Spurgeon and Grisson 1965).

The value of crop rotation is measured by its effect on land productivity and its economic returns. Jones (1974) showed that yields of maize grain after groundnut were significantly higher than maize yields following sorghum or cotton. Lombin and Abdullahi (1981) reported that where cotton, sorghum, and groundnut were grown in rotation, the best sequence appeared to be cotton followed by sorghum followed by groundnut.

Improved rotation of grain legumes is more likely to be adopted by the farmers than non-grain legumes. Apart from their use as protein supplement food, legumes such as cowpea, groundnut, and soybean are the major cash crops. Smith et al. (1994) observed that cereal crop rotation with legumes increased in half of the villages surveyed because of the profitability of legume crops. The northern Guinea savanna benchmark area has emphasized the need for increased grain legume rotation with cereal crops. The result of the first year of a 4-year maize/legume and sorghum/legume rotation trial initiated in the benchmark area indicated that the highest profit was obtained from maize/groundnut followed by maize/cowpea and sole cowpea enterprises. Sorghum/soybean mixture gave the highest cost benefit ratio, followed by sole cowpea (Ogungbile et al. 1998). Rodriguez (1986) showed how cowpea in a 4-year maize-cowpea rotation benefitted subsequent maize planted in Burkina Faso. Maize grain also benefitted from intercroppped cowpea.

Although farmers preferred grain legumes to non-grain legumes, the potential contribution may be low because of the export of nutrients in the grain. In addition, the haulms of grain legumes are usually harvested for animal feed.

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Benefits of grain legume–cereal rotation

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Abstract
Cereals are the most important food crops in the savanna zones. Maize has a higher yield potential than sorghum in the absence of two major constraints—low N supply and *Striga hermonthica* parasitism. Both of these constraints can be alleviated to some extent by grain legume rotation. Therefore, the benefits of grain legumes to cereal production will be examined in some detail. The N benefit is expressed as the N fertilizer replacement value, the amount of N fertilizer that can be replaced by legume rotation. It depends on many factors related to the cropping pattern and the agroecological zone. The *Striga hermonthica* benefit derives from the ability of some cultivars of soybean and cowpea to stimulate germination of *S. hermonthica* seeds without supporting the parasite's growth, resulting in reduction in the seedbank. The number of emerged *S. hermonthica* plants and the *Striga* damage score are both decreased and the maize yield is increased. These cropping system benefits, along with the fact that grain legumes serve to improve protein intake of people, justify research efforts to maximize benefits of grain legumes to cereals.

Importance of and constraints to savanna cereal production

Cereals (especially maize and sorghum) are highly suitable crops for the savanna zone of West Africa. Yield potential of maize is high in the subhumid zone compared to wetter and drier environments (Kassam et al. 1975) because of adequate moisture, relatively low disease pressure, high solar radiation, and low night temperatures. Constraints to production of both crops are similar, although more severe generally for maize than sorghum (Weber et al. 1995).

A cost of high maize productivity is its high nutrient requirement compared to other crops of similar growth duration. Maize grain generally contains 2% N so grain harvest exports 2 kg per 100 kg of grain yield. Total exports are 2.6 kg N, 100 kg of grain produced if above-ground residues are removed (Cretenet et al. 1994). Sanchez (1976) in a review of literature found similar levels of nitrogen removal by maize. Table 1 includes grain and stover contents of major nutrients for grain yields of 1, 4, and 7 t/ha. It gives an idea how quickly soil N can be depleted by maize, especially when maize yields are high and stover is exported. Of course, yields on farmers' fields are low, but even at these low yields, soil nutrients are being mined beyond the power of the soil to replenish them. Van der Pol (1991) estimated that average annual depletion of soil N by maize in southern Mali was approximately 25 kg N/ha. Contrary to this, phosphorus inputs and outputs were estimated to be more or less in balance (Van der Pol 1991), thereby justifying an emphasis on nitrogen supply for maize. The benefit that African farmers forego by applying inadequate amounts of N to cereals is enormous.

Striga hermonthica parasitism is the most serious and visible cause of yield loss in cereals (especially sorghum and maize) in the West African savanna (Sallé and Raynal-Roques 1989) after inadequate N supply. Damage from *Striga* spp. to all crops in sub-Saharan Africa has been estimated to be US$7 billion. In the Nigerian northern Guinea savanna, Oikeh et al. (1996) estimated yield loss ranging from 0 to 46% and averaging 10% for 66

Table 1. Nutrient removal by maize (Sanchez 1976).

Part	Yield (t/ha)	Nutrient (kg/ha) N	P	K
Grain	1.0	25	6	15
Stover	1.5	15	3	18
TOTAL	2.5	40	9	33
Grain	4.0	63	12	30
Stover	4.0	37	6	38
TOTAL	8.0	100	18	68
Grain	7.0	128	20	37
Stover	7.0	72	14	93
TOTAL	14.0	200	34	130

fields. Sauerborn (1991) estimated that yield loss from all *Striga* spp is 24% in six West African studies from which data were available.

Cultivation of grain legumes in rotation with cereals may help to improve N nutrition and reduce *Striga hermonthica* parasitism. Each of these benefits will be studied below. Also, the role of legumes in human diets should not be ignored. Cereals lack amino acids methionine and cysteine. Legumes have those but lack lysine. Therefore, cereal–legume diets have complete protein, very necessary in the absence of meat.

Potential benefits of grain legumes to cereals

Nitrogen supply

Grain legumes fix nitrogen (N) from the atmosphere and leave a portion for the succeeding non-legume crop (Table 2). Figure 1 depicts the flows of N that occur in a legume crop. Flows that are limited to the soil system (such as leaching of nitrate and atmospheric deposition) are not shown. It shows that, with respect to the legume crop:

INPUT = Uptake of SOIL-N + BNF-N

OUTPUT = Export of GRAIN-N + Sloughing of ROOT-N (+ Export of STOVER-N).

With respect to the soil:

INPUT = Return of STOVER-N + Sloughing of ROOT-N

OUTPUT = Uptake of SOIL-N

Table 2. Estimates of N fertilizer replacement value for the savanna zone from trials and extrapolated from expert knowledge.

Rainfall and cropping pattern	Cowpea early	late	Soybean early	late
Monomodal (single crop)	15	20	5–10	10–15
Monomodal (double crop, legume first)	40	—	10	15
Bimodal (legume second)	20	25	15	20
Bimodal (legume first)	40	50	20	25

Sources:
Carsky et al. (1997); Carsky et al. (1999); Carsky et al. (2001); Carsky et al. (2002); Ogoke et al. (2001); Singh et al. (2002).
Note: See text and Figure 2 for concept of N fertilizer replacement value.

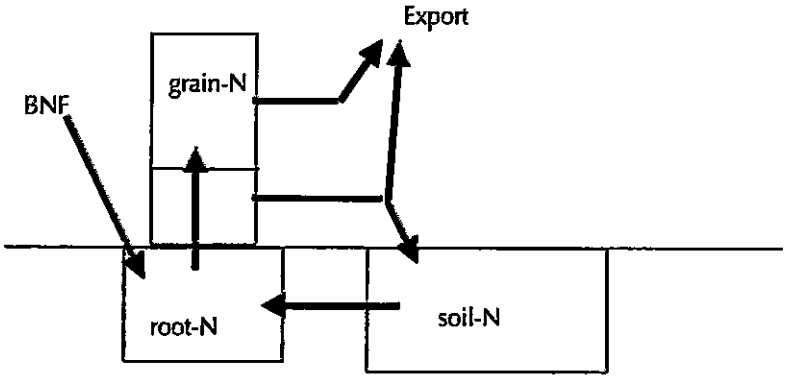

Figure 1. Major fluxes of Nitrogen in the soil–legume system.

Of major importance is the amount of N fixed by the legume and the amount exported. For example, if the legume fixes 100 kg N/ha and takes up 50 kg N/ha from the soil, but exports 125 kg N/ha in the grain, then the legume depletes the soil N pool by 25 kg N/ha. In this example, P_{fix} (the fraction of legume N derived from BNF) is 67% (100/150) and the N harvest index (NHI, the fraction of legume N contained in the grain) is 83% (125/150). A useful indicator of the effect of a legume on soil N is:

If P_{fix} > NHI, then soil N accrual occurs

If P_{fix} < NHI, then soil N depletion o ccurs.

The benefit of legume rotation is often expressed as the N fertilizer equivalent value (NFRV). NFRV is estimated by comparison of legume–cereal with cereal–cereal (or fallow–cereal) and an N response curve as in Fig. 2. An important assumption of the response curve method is that N is the only limiting factor. If there is an additional benefit from legume rotation, then the NFRV will be over-estimated. Therefore, if possible, all N levels should be included for both systems. If yields converge at high N levels (as in Figure 2), then it is likely that N supply is the only benefit of legume rotation. The scenario in Figure 2 suggests that a NFRV of approximately 20 kg/ha is achieved through legume rotation. If an economic analysis is attempted, then the benefit can be easily calculated as the NFRV multiplied by the cost of fertilizer. The cost of legume rotation system should include the additional cost of growing the legume (which may be less than the cereal control) and the opportunity cost of growing the legume.

A management issues that influence the N benefit of grain legumes, especially cowpea is the management of its residues. We have seen above the importance of residue management and the expected negative effect of exporting legume residues. Cowpea residues are, however, important sources of nutrients for ruminants. Feeding of cowpea residues to livestock may result in less N benefit to a subsequent cereal crop, but greater benefit to the farm household. This needs to be studied with a view toward estimating the benefit to the soil and household economy, especially with the return of livestock manure.

Insecticide treatment of cowpea usually increases grain yields and may decrease the residue N available to the subsequent cereal crop. It may therefore change drastically the N budget in a cowpea rotation system. The N benefit to subsequent cereal was greater when insect attack resulted in poor grain yield in a study conducted in northern Nigeria (Table 3).

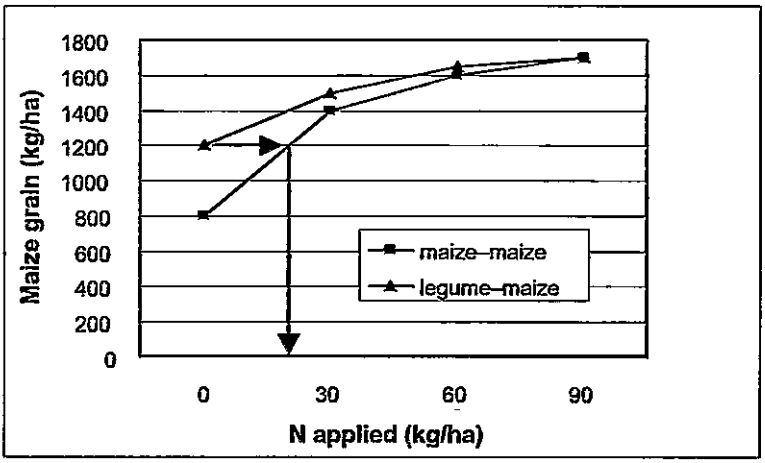

Figure 2. Schematic diagram showing N fertilizer replacement value of legume rotation that is estimated at approximately 20 kg N/ha.

Table 3. Comparison of effect of cowpea rotation on subsequent maize yield in two trials in which cowpea was managed differently.

	Kaduna	Bauchi
Dual-purpose cowpea cultivar	local	IT89KD-288
Insecticide treatment	yes	no
Cowpea grain yield	moderate	trace
N content (kg/ha) of cowpea hay	21	58
Maize yield increase (%) over fallow	22	76

Striga hermonthica parasitism

The possibility of using soybean as a trap crop for *S. hermonthica* has been mentioned by several authors (Andrews 1947; Parkinson et al. 1987; Doggett 1988; Sallé and Raynal-Roques 1989). Soybean is a relatively new crop in West Africa, whose production has expanded rapidly in some areas (Smith et al. 1993). Therefore, its potential contributions to cereal-based cropping systems should be fully exploited. Recently, a laboratory screening procedure was developed which permits identification of efficacious trap crops in vitro (Berner et al. 1996). The method was used to screen 55 soybean cultivars and many cultivars did not stimulate substantially more germination than a distilled water control. However, several cultivars, including TGx 1740-7F—highly adapted to the dry savanna zone—stimulated germination of more than 50% of *S. hermonthica* seed (Berner et al. 1996). Soybean rotation has resulted in 10 to 50% reduction in *Striga parasitism* in trials in the savannas at Bauchi (northern Guinea savanna of Nigeria), Badeggi (southern Guinea savanna of Nigeria), and Bohicon (derived savanna of Bénin). This reduction was associated with an increase in maize yield of about 600 kg/ha at Bauchi (partly due to soil N supply and partly due to *Striga hermonthica* reduction). Cowpea might also be used as a trap crop but has been less well studied than soybean.

Conclusion

Grain legume cereal rotation systems provide several opportunities for synergy between system components. Grain legumes may benefit the subsequent cereals by improving N supply and by reducing *Striga hermonthica* parasitism. Several management issues influence the benefits of grain legumes to cereals and therefore warrant research.

Targeting improved grain legume cereal rotation systems should match the benefits from the legumes to the constraints for cereal production. N supply is a constraint to cereal production throughout the savanna zone and *Striga hermonthica* is a problem in the dry savanna zone. Increased use of grain legumes can improve the cropping systems with very little risk to farmers.

Advocating increased use of grain legumes may have limits. Smil (1997) reviewed the global situation and found that the market for legumes may be limited. World consumption of pulses has progressively declined since 1950, even in Africa. If markets are saturated, then increasing legume use will not be acceptable.

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Economics of diversified food production on wetlands

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Abstract
This paper takes a look at wetlands as a production system in agriculture. It reviews the circumstances leading to the unending food crisis in sub-Saharan Africa (SSA) and the potentials of the estimated total of 200 x 10ha of wetlands in the ecoregion in alleviating the food shortage problem through diversification of food production. Apart from rice and sugarcane, other food crops, such as cassava, maize, cowpea, yam, sorghum, soybean, cocoyam, and plantain, can be cropped under various combinations profitably. The paper identifies different crop combinations for the different wetlands. Cost and returns analyses indicate that all the combinations are profitable in various degrees. In the forest zone, rate of returns to investment (RORI) is in the order: cassava/plantain (110%) > cassava/maize (90%) > yam/plantain (60%) > maize/cocoyam (54%) > yam/maize (50%) > sole rice 40%. Benefit Cost Ratio (BCR) is in a similar order. In the derived savanna zone RORI is in the order cassava/maize; cassava/sorghum (70%) > onion/sorghum; onion/millet; onion/maize; maize/cowpea; sweetpotato (50%) > sole rice (30%) BCR is in similar order. In the semiarid zone RORI is in the order sugarcane (90%) > maize/melon; sorghum/melon; maize/cowpea > sorghum/cowpea (50%) > sole rice (30%). BCR is in the same order. Estimated RORI for various vegetables shows that okra (163%) > *amaranthus* (154%) > *celosia* (147%) > *corchorus* (19%). BCR is the same order. Farmers' exposure to risk, working in wetlands, is a major limitation to productivity of this important agroecosystem. This can be surmounted through linkage of activities between agricultural workers on the one hand and health and social workers on the other. Other areas requiring further research are pasture productivity on wetlands, agroforestry, studies on gender issues, and ergonomics of wetlands agriculture.

Introduction

Sub-Saharan Africa (SSA) is going through a seemingly unending food crisis. For some two decades now, the issues have been those of food shortages resulting from drought; desert encroachment; increasing human population, faulty and unsustainable agricultural practices, leading to degradation of production systems. According to Okigbo (1989) there is widespread concern about sustainability in agricultural production and development programs. Hardly a day passes without an article, conference, seminar, radio or television program, or publication on agricultural research and development devoted to one or more aspects of sustainability in agriculture and development. Accounts from Nigeria, for instance, indicate that agricultural productivity and total annual food and fiber production are pitiably poor and much below expectation (Ikpi 1994). While population has been growing steadily at 2.83%, food production is a mere 1.5%, and from an all-time high of 98% food sufficiency ratio at independence, the country is down to a paltry 45% local food production (Central Bank of Nigeria 1992; FAO (1992) and the Central Bank of Nigeria (1992) separately and independently shows that as at 1992, the Nigerian had less than

350 kg of grain equivalent of food available to him for the year if he could afford it. Six years afterwards, this situation rather than improving tends to be worsening. Accounts from other countries in SSA are not any better. For example, while population growth rate in Bénin Republic has been put at 3.1%, agricultural growth rate has rarely exceeded 1% as in Ghana, Niger Republic, and several others (World Bank 1994). Various forms of panacea have been proffered over the years. Among these is the mechanism for sustainability and partnership in agriculture of the Ecoregional Program for the Humid and Subhumid Tropics of Sub-Saharan Africa (EPHTA) with priorities among others, to characterize humid forest production systems and agroecological subzones and development of sustainable land-use systems and technologies. Among these production systems are the vast wetlands of the tropics which potentials have been generally suboptimally tapped. In this paper, economic analyses of the potentials of wetlands are based on experiences from Bénin Republic and Nigeria. The two countries have a lot of similarities in geology, climate, vegetation, agricultural practices, culture, and tradition. Most of the parameters used in the analyses are, however, based on the Nigerian situation.

Coverage and characterization of wetlands in Africa

Juo and Lowe (1986) assert that tropical sub-Saharan Africa has a total of 200 x 10ha. of wetlands that exist in the form of small inland valleys, river flood plains, inland basins, and coastal wetlands. They identified the potentials of wetlands for the cultivation of rice and other food crops in solving the food crisis that has resulted from the erratic rainfall in the last twenty years coupled with the badly degraded soils that have reduced yields of food crops in the uplands. Wetlands are formed when natural or man-made barriers impede the flow of water resulting in flood plains, peatlands, marshes, swamps, mangroves, lakes, reservoirs, ponds and canals (Kio and Ola-Adams 1986). This is illustrated by Raunet (1985). The wetlands of tropical sub-Saharan Africa with a growing period of 150 days also include deltas, estuaries, and tidal flats, inland basins comprising extensive drainage depressions, river flood plains, consisting of recent alluvial deposits bordering rivers, and inland valleys, the flat-floored, relatively shallow valleys that are widespread in the undulating landscape (*dambos, fadamas, bas-fonds*, inland valley swamps) (FAO 1978). They are lands in which the wet conditions influence the possibilities for land use. The excessive wetness may be caused by flooding or by high ground water tables and ponding (Andriesse 1986). There is also the predominance of coarse soil in the sedimentary formations and granitic rocks. Acid and potentially acid sulfate soils are widespread in the coastal wetlands. In the dry zones salinity and alkalinity are extensive. The only common characteristic of wetlands, particularly the small inland valleys is their great heterogeneity, both within the valleys and among them.

Wetland soils may be mineral or organic. Some wetland areas, especially the seasonally dry ones, have mineral soils, with or without a thin peat cover. Other wetland areas, particularly the perennially wet ones, have deep peat soils in their centers, grading through shallow peat into a band of seasonally dry mineral wetland soils adjacent to dry land (Brinkman and Blokhuis 1986). As yet, there is little or no empirical evidence supporting nonutilization of the vast area of wetlands in sub-Saharan Africa, yet, according to Moormann and Juo (1986) most of the wetlands are underutilized. Many of the large wetlands such as the deltas and floodplains in the humid, forested regions have never been cultivated, and the small wetlands, such as the inland valleys (or *fadamas*) in the

subhumid regions, often have been used only for upland crops such as yam, sweetpotato, and vegetables that are grown either during the dry season or on large mounds or raised beds during the rainy season.

In Nigeria, there exist large expanses of wetlands. These wetlands, though scattered and in pockets, would cover over 24 009 km² (Kio and Ola-Adams 1986). According to Onofeghara (1986), Nigerian wetlands, which either throughout or for most parts of the year contain moisture at a level far in excess of that tolerated by most plants, include among others:

- the mangrove swamps, (NigerDelta area)
- the lake Chad Basin
- the Kainji Lake Basin
- the ground water of upland savanna sites
- the interdome depressions typified by the Hadeija-Nguru (Baturiya) wetlands)
- the valley bottoms of rivers
- the flood plains (typified by Ogun, Osun, Katsina-Ala, Gongola, Imo, and Cross River flood plains, the flood plains of the Niger and Benue troughs and their tributaries are included in this category
- the heavily wet areas of some of our rainforest
- the most extensive of the wetland areas of Nigeria in the Niger-Delta area which covers over 9000km² within the eight coastal states of Lagos, Ondo, Edo, Delta, Rivers, Bayelsa, Akwa Ibom, and Cross River.

According to Umoh (1995) the Niger-Delta wetlands are among the world's largest. Table 1 shows the distribution and extent of Nigerian wetlands.

Table 1. Distribution and extent of Nigerian wetlands.

Coastal saline wetlands (mangrove swamps)		Freshwater wetlands (flood plains)	
Name	Extent (ha)	Name	Extent (ha)
Niger Delta	617 000	Niger River	1 177 000
Cross River estuary	95 000	Benue River	242 000
Imo River and Qua Ibo River	36 000	Cross River	250 000
Estuaries (Others)	110 000	Imo River	26 000
		Lake Chad	55 000
		Ogun/Oshun Rivers	380 000
Total	858 000		2 130 000

Source: (Adapted from Nigerian Environmental Study/Action Team (NEST 1991).

In Bénin Republic, the area of wetlands has been put at 200 000 ha. This represents 17.8% of the total land area for the whole country. They are found across the country and along the flood plains of all the major rivers in the country.

The need for diversified food production on wetlands

Nigeria's current population is approximately 89 million. By 2010 it is projected to reach 152.5 million. The population of Bénin Republic was 4.8 million as at the last census. It is currently put at 5 million people and it continues to rise. The implications of this need

little emphasis. FORMECU (1996) observes that there had been a significant increase in the area of agriculture (mainly in dryland) in Nigeria within a period of 18 years (Table 2). The same is not true of wetland agriculture. The facts are that there is a shrinking land–man ratio upland. Assigbe and Mama (1993) also observed that in the Republic of Bénin, it is becoming clear more and more that the development of inland valleys is a must as fertile soils in the uplands are being depleted in the country. The consequence of this is continuous cropping. When land is cropped over and over, migration from degraded soils to more fertile soils becomes inevitable (Popoola 1990). According to Olayide (1982), the variables of migration which have economic implications are the capital costs of development with each migration, trekking requirements, "carrier" systems, and physical capital requirements. This form of migration is termed obligatory movement, which is determined basically by constraints of soil. This movement can be objectively costed. They include:

(a) to have access to soils with adequate supplies of plant nutrients, which could otherwise be attained at large costs, by applying chemical capital such as fertilizers,
(b) to have access to soils in acceptable physical conditions, with little or no damage by erosion and to limit flooding and silt deposition on lower ground. These effects can be corrected or offset only at very substantial costs.

Arising from the pressures on agricultural lands are food shortages. Symptoms of food crisis in sub-Saharan Africa emerged in the late 1960s. These were clearly evident from the increasing food supply shortfalls and rising food prices. The 1970s witnessed a rapid deterioration in the region's food production situation. As from 1973, the decline in farming activities became more pronounced. Not only were there widening food supply-demand gaps, there were also rising food import bills. Projections by the World Bank (1988) showed that between 1980 and 1990, 17% of the entire population experienced food insecurity annually. This corroborates findings by Ekpo (1984a, b, and 1986). Land for agricultural production, however, is inelastic, yet the annual population growth is put at 2.3–3.2% for most developing countries. To meet the growing demand for food and fiber, two options were proposed by Agboola (1989); extension of area under cultivation and intensive cultivation using improved technology.

Table 2. Land use and vegetation changes: 1976 and 1993/95.

Land use category	1976		1993/95		
	% of country	km²	% of country	km²	Change
Intensive (crop) agriculture	35.5	322794	40.2	365491	42697
Extensive (grazing) agriculture	18.3	166326	20.6	187236	20910
Sudan savanna	12.5	113880	9.0	81694	-32186
Guinea savanna	16.6	151293	9.0	81386	-69907
Floodplain agriculture*	1.0	9451	2.3	20918	11467
Gully erosion	0.0	122	2.0	18517	18395
Shrub swamp*	1.9	16899	1.0	9248	–7651
Freshwater swamp*	2.0	18316	1.8	16499	–1817
Undisturbed forest	2.9	15951	1.3	12114	–13837
Sahel savanna	1.4	12549	1.3	11983	–566
Discontinuous grassland	0.7	6137	1.2	11248	5111
Mangrove forest*	1.1	9994	1.1	9977	–17
Agriculture/denuded	0.4	3518	1.0	9206	5688
Continuous grassland	0.1	1034	0.9	7989	6955
Natural water	0.7	6951	0.9	7851	1260
Montane forest	0.7	6762	0.7	6759	–3
Urban (major + minor)	0.2	2083	0.6	5444	3361
Riparian forest	0.8	7402	0.6	5254	–2418
Sand dunes	0.1	812	0.5	4829	4017
Montane grassland	0.2	1739	0.3	3112	1373
Reservoir	0.2	1327	0.3	2888	1561
Rock outcrop	0.2	1424	0.3	2632	1208
Tree crop plantation	0.1	830	0.2	1641	811
Forest plantation	0.1	997	0.2	1573	576
Teak plantation	0.1	628	0.1	1156	528
Irrigation project*	0.0	147	0.1	988	841
Grass mash	0.5	4882	0.1	871	-4011
Saltmarsh/tidal flat	0	4	0.1	545	541
Agricultural project	0	16	0.1	485	469
Alluvial*	0.1	487	0.0	269	–218
Livestock project	0.0	52	0.0	139	87
Mining	na	na	0.0	62	62
Canal	0.0	2	0.0	29	27

*Indicates items related to wetlands cultivation.
Source: Assessment of land and vegetation changes in Nigeria between 1976/1978 and 1993/95 (FORMECU Abuja 1996).

In view of the resource-poverty of most smallholder farmers in the tropics, the second options appear unattainable, at least for now. The first option, though fraught with some drawbacks, appears more attractive. This appears a justification for optimal use of hitherto unused lands, especially the expansive wetlands in the sub-Saharan region.

Crop combinations in wetlands

Rice is virtually synonymous with wetland agriculture. However, empirical evidence shows that several other field crops solely or in combination can profitably thrive in this agroecosystem. In Nigeria, such possible combinations based on zones include:

1. ***Kainji Lake basin flood plains***

   Rice, cassava, sorghum, maize, sweetpotato, cowpea, onions, and beans.
   Possible combinations:
   - i. rice (sole during wet season)
   - ii. cassava/maize
   - iii. cassava/sorghum
   - iv. maize/cowpea
   - v. sorghum/cowpea
   - vi. sweetpotato/maize
   - vii. onions/sorghum–alley farming
     onions/millet "
     onions/maize "
     onions/vegetables "
   - viii. beans (sole)

2. ***Hadejia–Nguru wetlands***

   Rice, melon, sorghum, maize, cowpea, sugarcane, and beans
   Possible combinations:
   - i. rice (sole during wet season)
   - ii. sugarcane (sole)
   - iii. melon/sorghum
   - iv. maize/cowpea
   - v. melon/maize
   - vi. sorghum/cowpea
   - vii. fodder (sole)
   - viii. beans (sole)

3. ***Sokoto–Rima flood plains***

   Rice, sugarcane, cowpea, sorghum, maize, fish, and beans
   Possible combinations:
   - i. rice (sole)
   - ii. sugarcane (sole)
   - iii. fodder (sole)
   - iv. melon/sorghum
   - v. melon/maize
   - vi. maize/cowpea
   - vii. sorghum/cowpea
   - viii. bean (sole)

4. ***Benue flood plains***

Rice, cassava, cocoyam, yam, sweetpotato, soybean, cowpea, plantain, and beans.

Possible combinations:

i. rice (sole)
ii. soybean/yam/plantain (scattered in farmland)
iii. yams/maize/plantain (scattered in farmland)
iv. sweetpotato/soybean
v. soybean/cocoyam/plantain (scattered in farmland)
vi. plantain (sole)
vii. beans

5. ***Niger–Delta wetlands***

Crops grown: rice, yams, cocoyams, plantains, cassava, maize, and beans

Possible combinations:

i. rice (sole)
ii. yam/maize/plantain (scattered in farmland)
iii. cassava/maize/plantain (scattered in farmland)
iv. plantain (sole)
v. beans

6. ***Fadama***

Maize, rice, tomatoes, yam, okro, *amaranthus, cochorus, celosia,* pepper, and beans.

Possible combinations:

i. rice (sole) (wet season)
ii. maize/yam
iii. *Amaranthus/Cochorus/Celosia*/lettuce
iv. okro/pepper/tomatoes
v. beans (sole)

It should be noted that more and varied combinations abound, hence these lists are not exhaustive.

Measures of profitability in wetland agriculture

Profitability is a major incentive to investment in any enterprise thus, the objective of any rational entrepreneur is to operate profitability. The entrepreneur is usually free to vary the levels of both cost and output, and his ultimate aim is the maximization of profit rather than the solution of constrained-maximum and minimum problems (Henderson and Quandt 1980). Paradoxically, the average peasant/subsistence farmer in most developing countries considers as top priority, the survival of his household in terms of food security. This explains why he does not cost most of his inputs, particularly household labor. Few or no records of his enterprise are kept.

A major limitation in the assessment of profitability in wetland agriculture is the fact that most scientific investigations into profitability, resource allocation, and enterprise combination behavior have been based generally on dryland farming. Such efforts include Osuji 1978; Olayemi 1980; Adesimi 1980; Aromolaran 1992. Another limitation is that

farming on wetlands is not often continuous. Irregular intervals exist in the farming cycle, giving rise to disjointed yield data and price regimes. For these reasons, such measures as Net Present Value (NPV) or determination of Internal Rate of Returns (IRR) are not easily accomplished. Most previous attempts have also been on single enterprise approach which Djogbenou (1981) views as an unrealistic framework for farm business analysis. Again, according to Umoh (1995) the enterprise costs and returns for a single crop do not give a good indication of the income position of the whole farm with various crops. It does not highlight the trade-off situations or enterprise combination problems faced by the farmer. Additionally, the wetland farmer should be interested in how to allocate his resources to different enterprises rather than single enterprise, more so as Izac et al. (1990) opine that cultivation of inland valleys is integrated in upland farming activities.

This paper views diversified food production on wetlands as the multiple use of the resource base, i.e., conscious and deliberate cultivation of more than one crop on one piece of land. According to Popoola (1984), whether the combination is staggered or simultaneous in time or space, the goal is to optimize the use per unit of land, while at the same time paying special attention to, and applying the principle of sustained yield.

Costs and returns analysis

Returns here are viewed as the product of output(s) and average price per unit of output. In other words, the attainable total revenue from the production process. Costs of production are classified into variable costs which is a function of the output level, and the fixed costs, usually the cost of capital inputs which is incurred whether production takes place or not. Profit, therefore, is the positive difference between the estimated total revenue and the total cost of production.

This is mathematically represented as:

$$TR = P_Q Q$$
$$TC = TVC + TFC$$
$$TVC = P_1X_1 + P_2X_2 + \dots P_nX_n$$
$$TFC = K$$
$$\pi = TR - TC$$
$$\pi = P_Q Q - P_1X_1 + P_2X_2 C K$$
$$\pi > 0$$

Rate of returns on investment (RORI) is given as

$$\frac{\pi}{TC} \times \frac{100}{1}$$

Benefit-cost ratio (BCR) $= \frac{TR}{TC}$

where TR = Total revenue
P_Q = Unit price of output
P_1 = Unit price of variable input
X_1 = $1 = 1, 2$
Q = Total output of the crop(s)
TC = Total cost
TVC = Total variable cost
TFC = Total fixed cost
α = Profit which must be > 0

The following assumptions underline the ensuing analysis:

1. Average farmgate prices for the products are used.
2. Average output levels for the crops are used.
3. An average of one hectare of land is used for each enterprise.
4. A rent of N1000 (US$10) is assumed per hectare of farmland.
5. All transactions are at the farmgate.
6. A production cycle is assumed for each crop, i.e., from planting to harvesting.
7. The exchange rate (N to US$) = N100.00 to US$1.
8. The exchange rate (N to CFA) = eq =N= 1.00 to approx. CFA 6.00.
9. Straight line method is assumed for depreciation of fixed cost items, thus, fixed cost is assumed to be approximately equal to depreciation charges on the implement plus land rent.

The identified operations in wetland agriculture % contribution to cost of operation

(i)	Land clearing (varies by agroecology)	28.3%
(ii)	Packing and burning	5.7
(iii)	Tillage	28.3
(iv)	Sowing/planting	3.8
(v)	Weeding (1st and 2nd)	15.1
(vi)	Fertilizer application (if applicable)	11.3
(vii)	Harvesting	7.6
(viii)	Others	varied

Arising from these, the major inputs identified are:

(i) Land
(ii) Labor
(iii) Agrochemicals (fertilizers)
(iv) Propagules (various)
(v) Implements

On the basis of the above, the inputs are classified as follows:

Fixed cost items		**Variable cost items**
Implements		Labor
(i)	Cutlass/matchet	Propagules
(ii)	Hoes	Fertilizers
(iii)	Sickle	
(iv)	Bucket/watering can	
(v)	Basket	
(vi)	Rent on land	

The analysis are based on three major agroecological zones:

(i)	Forest zone	-	75% tubers; 25 grains in combination
(ii)	Derived savanna zone	-	50% tubers; 50% grains in combination
(iii)	Semiarid zone	-	25% tubers; 75% grains

Costs and returns are thus prorated accordingly.

The yield data used in the computations were obtained from various sources. They include Cross River State Fourth National Development Plan Report 1975–1980; Diehl 1979; Popoola 1990; Izac et al. 1990, Swennen 1990; and Akinbola and Kutu (in press). They are summarized in Tables 3 and 4.

Table 3. Estimated yields (ha) for different food crops on wetlands.

Food crops	Yields (tonnes)
Yam	14.7
Maize	2
Plantain	15
Cassava	19
Cocoyam	3
Rice	19
Sorghum	2
Sweetpotato	19
Cowpea	0.5
Onions	20
Melon	0.5
Sugarcane	20

Source: Various, as listed above.

Table 4. Estimated yields (ha) of vegetables in an inland valley in Ibadan, Nigeria.

Crop	Yield t/ha	X Yield t/ha*
Amaranthus	10.1–26.8	18.45
Celosia	6.2–23.7	14.95
Corchorus	5.0–12.0	8.5
Okra	2.5–8.5	5.5

Source: Akinbola and Kuku (in press).
Differences in yield are due to soil types.
* Mean yield calculated by author.

Costs and returns

Costs and returns are presented for the different crop combinations for three different zones (Tables 5, 6, and 7). Those for vegetables are presented separately in Table 8. In the forest zone, the crop combination with the highest RORI is cassava/plantain (RORI = 110%; BCR = 2.1). The crop combination with the least RORI is sole rice (RORI = 40% BCR = 1.4). Returns to investment are, however, positive for all the crop combinations. These are indicators of profitability. In the derived savanna zone, the best combinations are cassava/maize and cassava/sorghum (both have RORI = 70% and BCR 1.7). Again, sole rice records the least RORI of 30% and BCR of 1.3. As in the forest zone, all combinations have positive returns to investment. In the semiarid zone, the best enterprise is sugarcane with RORI = 90% and BCR = 1.9. Again, rice has the least RORI = 30% and BCR = 1.3.

Okra is the most profitable vegetable enterprise in wetlands in Nigeria with RORI of 163% and BCR of 2.63 while *corchorus* brings the least returns to investment (RORI = 19% and BCR = 1.19). None of the vegetable enterprises, however, yielded negative returns.

Table 5. Estimated costs and returns in diversified food production on wetlands.

	(Forest zone)				
Crop mix	TR	TC	π	BCR	RORI
Yam/plantain	190,200	119,502	70698	1.6	60%
Cassava/plantain	111,000	52,542	58,458	2.1	110%
Yam/maize	159,000	104,398.25	54,601.75	1.5	50%
Cassava/maize	93,000	48,598.25	44,400.75	1.9	90%
Maize/cocoyam	106,469.48	69,073.25	37,396.23	1.54	54%
Rice (sole)	72,000	50,922	21,078	1.4	40%

Source: Field survey (Popoola 1998).

Table 6. Estimated costs and returns in diversified food production on wetlands.

	(Derived savanna zone)				
Crop mix	TR	TC	π	BCR	RORI
Cassava/maize	76,000	44,279.5	31,720.5	1.7	70
Cassava/sorghum	76,000	44,279.5	31,720.5	1.7	70
Onions/sorghum	59,821	39,821	20,000	1.5	50
Onions/millet	59,821	39,821	20,000	1.5	50
Onions/maize	59,821	39,821	20,000	1.5	50
Maize/cowpea	52,000	35,642	16,358	1.5	50
Sorghum/cowpea	52,000	35,642	16,358	1.5	50
Rice (sole)	64,000	48,000	16,000	1.3	30
Sweet/potato/maize	59,821	39,821	15,000	1.5	50

Source: Field survey (Popoola 1998).

Table 7. Estimated costs and returns in diversified food production on wetlands (semiarid zone).

Crop mix	TR	TC	π	BCR	RORI (%)
Sugarcane	200,000	69,500	130,500	1.9	90
Maize/melon	56,500	34,642	22,858	1.5	50
Sorghum/melon	52,000	34,642	17,358	1.5	50
Maize/cowpea	52,000	34,642	17,358	1.5	50
Sorghum/cowpea	52,000	34,642	17,358	1.5	50
Rice (sole)	60,700	46,200	14,500	1.3	30

Source: Field survey (Popoola 1998).

Table 8. Estimated costs and returns in various vegetable enterprises in an inland valley in Ibadan.

Vegetables	TR	TC	π	BCR	RORI (%)
Amaranthus spp.	230,625	70,695	139,930	2.54	154%
Celosia spp.	224,250	90,695	133,555	2.47	147%
Corchorus spp.	85,000	71,250	13,750	1.19	19%
Okra	247,500	93,995	153,505	2.63	163%

Source: Field survey (Popoola 1998).

Problems and prospects of diversified food production on wetlands

Diversified food production (which is synonymous with polyculture) is not a new practice in the traditional farming systems in sub-Saharan Africa. The biological, environmental, and socioeconomic merits of this system are many, but are generally taken for granted. Recent thinking, however, indicates that serious attention must be paid to this ecologically sound form of agriculture. For now, it is the most sustainable means of producing food for the teeming populations of the subregion. From all indications, monocropping, which borrows heavily from temperate agriculture, is not sustainable, given the resource-poverty level of our peasant farmers. Again, with the diminishing land : man ratio, the need to extend food production into hitherto suboptimally utilized areas such as the wetlands of the subregion becomes an ecological and economic imperative. However, there are still some issues, which need to be addressed:

- The issue of excess water in soil remains a problem in wetland agriculture. Since different crops require different levels of soil water, the issue of compatibility of crops to be combined becomes important. Drainage systems, which will reduce soil water to optimum levels for various crops, need be exploited and perfected.
- As of now, not much success has been recorded in research work to establish the relationship between percolation rates and growth of different crops. Research should be intensified to determine performances of different crops in relation to the magnitude of percolation in different crop fields.
- The problem of water-borne diseases prevalent in wetlands has persisted. In view of the social and economic losses arising from disease-induced loss of valuable mandays, preventive and curative measures of control need to be intensified. This calls for linkage between agricultural workers on the one hand and health and social workers on the other.
- In spite of the interest shown so far by government in the area of fadama development, there is still need for substantial national interest as against private uncoordinated involvement.
- Research should be intensified in the ergonomics of wetland agriculture. At present, there are serious information gaps on labor/energy requirements for farm operations in wetlands.
- The Unified Agricultural Extension System (UAES) still has a major role to play as a liaison agency between research and the end users of research results.

The prospects of diversified food production on wetlands are high. The enterprise is viable and profitable. However, to optimize benefits on a national and ecoregional scale more efforts are required. These include intensification of research on various agroforestry

models on wetlands with a view to increasing wood output, particularly for domestic energy in the semiarid areas of sub-Saharan Africa. APCU (1996) reports that a farmer in Doro Baga, a village in the Lake Chad Basin area of Borno State, has been earning several thousands of Naira annually from a woodlot of less than 0.4 ha. Similarly, farmers in river valley areas of Dalijam, Kebbi State of Nigeria, have been earning good money from woodlots of *Eucalyptus* spp. and *Azadirachta indica* combined with food crops in an agroforestry system (Ogunfowora et al. 1975; Ochai 1995). Hocking (1998) reports also that about 300 000 rural households have planted over eight million trees of 135 species around their wetland homesteads in Bangladesh. Even though the farmers know that trees cause losses of undercrops, they nevertheless encourage and maintain valuable trees in their fields for the compensating tree products. He reports further that trees in wetland rice fields initially grow faster than in forest plantations on medium to good sites. The fastest growing trees are *Gmelina arborea*, *Eucalyptus camaldulensis*, *Faidherbia albida*, *Albizia saman*, *Melia azedarach*, *Cassia siamea*, and *Acacia mangium*. These are worth trying on wetlands of SSA.

Research should also be intensified in development, management, and economics of fodder banks of important pasture grasses and legumes such as:

Rhodes grass	-	*Chloris gayana*
Coastal Bermuda	-	*Cynodon dactylon*
Guinea grass	-	*Panicum maximum*
Elephant grass	-	*Pennisetum purpureum*
Bullrush millet	-	*P. typhoides*
Gambia grass	-	*Andropogon gayanus*
Carpet grass	-	*Axonopus cunpressus*

Gliricidia sepium
Calopogonium mucunoides
Leucaena leucocephala
Pueraria phaseoloides
Stylosanthes gayanensis

This is important, as fodder shortages have become acute in the semiarid zone where Le-Houeren (1982) reported that in Borno, Kano, Katsina, and Sokoto States alone there are estimated totals of 16 499 344 standard stock units. He reported that livestock populations have exceeded the carrying capacity of the fragile ecosystem. This has led to ruminants lopping and destroying trees and shrubs in shelterbelts. This has implications on biodiversity conservation.

Conclusion

In spite of the harsh production environment of the wetlands which makes working on them arduous, diversified food production on wetlands is viable. Given the need to extend farming beyond dry areas and dry periods of the year, concerted efforts should be encouraged to enhance the productivity and sustainability of our wetlands. There is also the need to look at gender issues in wetland agriculture. This will enable a proper assessment of gender contributions to various operations involved in the food production process on wetlands.

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Improved land-use systems through plantation renewal as opportunities for small-scale farmers

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Introduction

The humid forest ecoregion of West Africa (Fig. 1) represents from 99 millions approximately 300 million ha and stretches over 15 countries, from Guinea to the former Zaïre, the total area of which is twice as much. The population of these countries has been increasing in 1965 to 232 million in....., meaning an average annual increase of 2.9%. Nigeria is the most populated country in this region with 115 million, followed by the former Zaïre (Fig. 2).

But the main important feature of the last 30 years is the rapid growth of the urban population. The cities have absorbed two-thirds of the population increase.

Most cropping systems in the ecoregion are associated with annual and perennial crops. Among these, the oil palm has always been cultivated; the others have been introduced progressively since the 17th century, the first one being probably the coconut, brought from India by Portuguese sailors.

With the exception of the natural palm grove, the perennial crops only cover 7 million ha, representing less than 2.5% of the humid forest zone of the ecoregion. The first crop is cocoa, with almost 4 million ha, followed by coffee with 2 million ha.

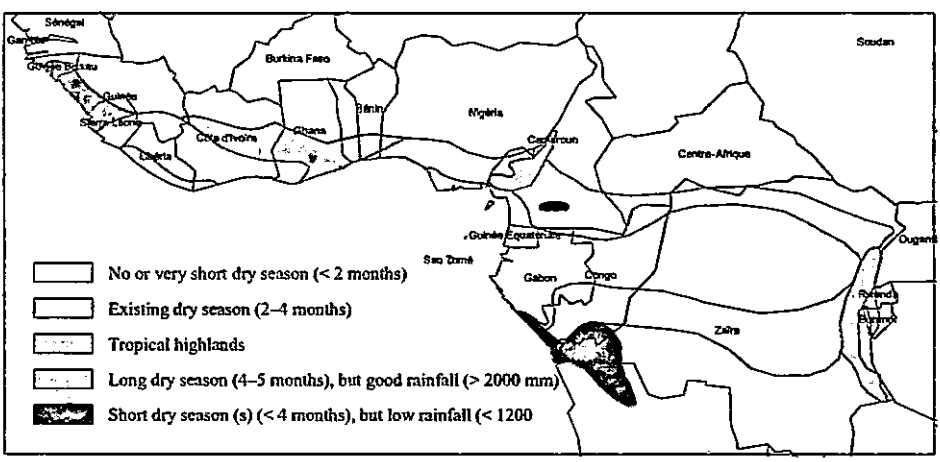
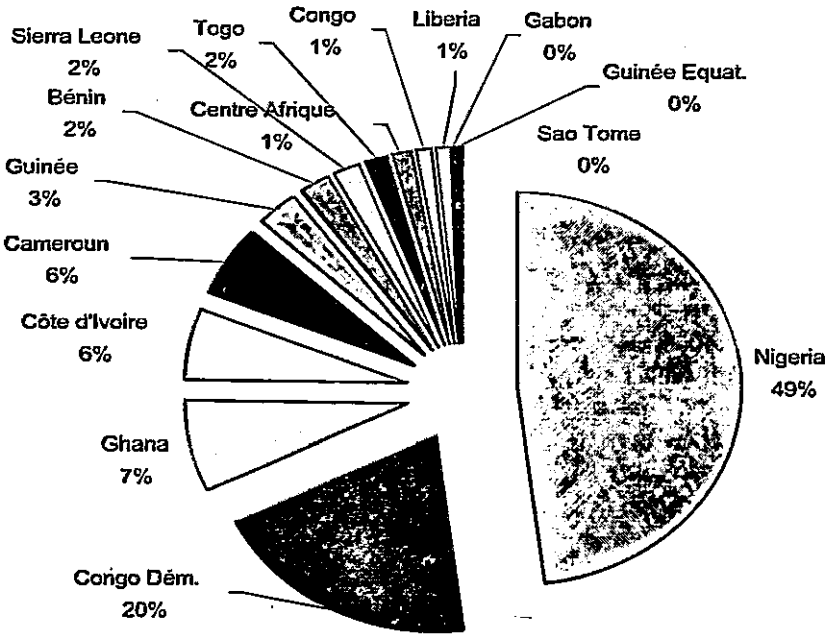


Figure 1. Humid Forest Zone of West Africa.



Source: Field survey (2000) by author.

Figure 2. Share of export income originating from perennial crops produce.

Table 1. Perennial crops hectarage.

Hectarage	Cocoa	Coffee	Oil palm	Rubber	Coconut	Total	% HFZ
Guinea	5 000	55 000	2 349	5 500	5 000	72 849	1.0
Sierra Leone	3 000	14 000			1 500	18 500	0.3
Liberia	5 400	15 000		25 000	2 400	47 800	0.5
Côte d'Ivoire	2 000 000	1 405 000	144 745	50 000	33 000	3 632 745	19.0
Ghana	850 000	10 000	31 597	22 000	40 000	953 597	14.0
Togo	25 000	18 000	5 594		4 000	52 594	3.9
Bénin		1 000	31 084		12 000	44 084	2.0
Nigeria	430 000	8 000	142 686	225 000	39 000	844 686	4.6
Cameroon	360 000	300 000	60 311	53 000	1 400	774 711	5.5
Central Africa Republic	1 000	25 000	2 516	1 200	29 716	0.3	
Equatorial Guinea	60 000	18 500			2 500	81 000	2.9
São Tomé	24 000	200			11 500	35 700	37.2
Gabon	15 000	750	7 459	9 700		32 909	0.1
Congo	6 000	3 800	6 786	2 500		19 086	0.1
Former Zaïre	22 000	240 000	65 000	40 000		367 000	0.2
Total	3 806 400	2 114 250	500 127	433 900	152 300	7 006 977	2.2
	54%	30%	7%	6%	2%	100%	

Though covering a relatively small portion of arable land, these crops have been of much importance providing cash income to rural populations. They also remain one of the most important sources of foreign currencies for countries deprived of oil or minerals (Fig. 2). Cocoa provides 69% and coffee 17% of these incomes, before rubber (11%), and palm produce (only 3%), even though it occupies 7% of the total land devoted to perennial crops. This fact is important from a macroeconomic point of view, when considering that planters presently tend to develop more palm products than cocoa or coffee. Now knowing that cocoa is the most important cash crop in the ecoregion, we can look at the situation of the cocoa sector in the various countries:

Côte d'Ivoire is the main producer. The total area planted in cocoa is estimated to exceed 2 million ha compared to only 745 000 in 1973, for a total number of planters estimated at around 700 000, meaning an average of 3 ha per planter. The population of trees is relatively young: two-thirds being less than 20 years. But this has been obtained through deforestation: the main producing area has moved westwards, from the former *boucle du cacao* (Abengourou-Agboville), where the average yield per ha has dropped to 216 kg, to the Bété country (Daloa–Gagnoa), and now the southwest where the average yield/ha is around 650 kg.

Ghana is the second largest cocoa producer, with approximately 850 000 ha, plus 900 000 ha abandoned plots. Of the plots still being exploited, 40% have been planted before 1960. The youngest plantations are found in the western region where 150 000 ha of hybrids have been developed in the 1970s thanks to international financing. All in all, one-third of the rural families (meaning approximately 600 000) are cocoa producers, with an average of 2 ha per planter; production is, however, declining.

Nigeria, though being the oldest cocoa producer, now ranks third in the ecoregion. But again, most of the stands are old. Only 100 000 ha have been planted since 1972, and production declines. Rubber exports have now overtaken cocoa exports.

Cameroon is the fourth cocoa producer, but, as for Côte d'Ivoire, the main producing area has moved from the central and southern provinces, where 40% of the trees have been planted before 1950 to the southwest province (department of Mémé), and within the center province from the Lékié to the Mbam department.

Plantation renewal and land-use systems

What are the main issues related to plantation renewal? There are not so many problems concerning rubber or oil palm. The development of *Fusarium* disease in old palm stands do not hinder their replanting as this problem has already been addressed by scientific research and solved through the breeding of tolerant progenies. But as previously assessed, the rubber and modern palm sectors are far behind cocoa and coffee. In the 1970s cocoa and coffee contributed about 300 billion FCFA to the public earnings. The Sodepalm group, controlling 90% of the modern palm sector, has only been contributing 2 billion FCFA on a yearly average basis from 1974 to 1995.

The real problem is with the renewal of old coffee and cocoa stands which suffer from fertility depletion, and increased pest load. Ivorian cocoa trees do not suffer much from *Phytophtora*. The main problem there comes from the capsids; Nigeria and Cameroon suffer a lot both from capsids and from *Phytophtora* (*palmivora* and *megakarya*), while Ghana is also facing a huge swollen-shoot problem.

Up to now, countries such as Côte d'Ivoire and Cameroon have been able to maintain or

increase their cocoa production through opening new territories to these crops (pioneer settlements). But this has come to an end in Ghana and Nigeria, and will soon be the case in Côte d'Ivoire. Moreover, it does not seem desirable to maintain the same development strategy in countries which still have enough forest. There is a need to find ways of replenishing soil fertility and controlling pest and diseases in the replanting of cocoa and coffee.

Coffee and cocoa plantations are very seldom in pure stands. Most of the time, the land-use system associates plantain/bananas in the beginning, together with various indigenous fruit trees or oil palms which were kept from the former vegetation. It also happened in Cameroon, for example, that the cocoa crisis undergone in the early 1980s led planters to "enrich" their cocoa farms with *Citrus* and other cultivated fruit trees. Farmers are usually reluctant to fell their old trees, but prefer to replace them progressively.

Another important aspect is that new market opportunities have been created by urban development. The local market for food crops, fruits, and palm produce has been increasing a lot these last 30 years.

There is a need to survey planters who want to renew their old trees and help them to replant or to diversify their farms with improved planting material (*phytophtora*-resistant varieties of cocoa, trees domestication) and train them in techniques such as vegetative propagation or IPM. It would also be useful to study the various annual and perennial crop associations which are supported by farmers, find ways of replenishing soil fertility, and determine the best options to maximize the overall output of the farm.

Such an enterprise may also lead to recommendations about the farm-gate purchase price of produce. Up to now, governments through their marketing boards, and then international traders have retained the bigger part of the margin in cocoa and coffee business. But the small-scale farmers should be allowed a share of this market so that they really have an incentive to face the replanting problems, otherwise, they will turn to more profitable crops which can meet local demand and production will go on declining.

Commercial importance of peri-urban enterprises and home gardens in West and Central Africa

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Abstract
Countries in the humid and subhumid areas of sub-Saharan Africa are still faced with major food and development problems with the continued increase in population. Peri-urban enterprises are varied and mainly agricultural based. Their growth is vital in the development of urban centers, which depend on them for most of their food, or raw material needs. Of all enterprises in the peri-urban areas, food production and processing are crucially important. The case of cassava and some wild fruit postharvest processing is identified as of high importance.
Important peri-urban enterprises include farming and small livestock rearing, trading, food processing, forest exploitation, handicrafts, and art.

Of all these, the one that has major relevance to EPHTA activities is market gardening and fruit tree culture in home gardens or small plantations. Others include trading, food processing, and wild food or extraction of non-wood resources from the forests. Extraction of non-timber forest resources, which had been the mainstay of rural economy for centuries also continues to be important despite the depleted state of most of these forests. Peri-urban enterprises provide added income to small-scale farmers who supply food or raw materials and create job opportunities for many more people. Home gardens or traditional farming systems evolved with most people of West and Central Africa. They are environmentally sound, economically efficient, and sustainable land-use systems.

The need to sustain the home garden system in this ecoregion is vital. Unfortunately, in some areas of southeast Nigeria, a process of fragmentation is creeping in; researchers will need to urgently look at the values or problems in smaller home gardens. EPHTA will play a major role in this.

As rural populations are provided with employment, the population shift is prevented and with this stability attained, population growth in these peri-urban villages takes place with this situation preventing migration to the available and few large cities, such as has been predicted for West and Central Africa by the African Development Bank (ADB).

Introduction

The humid and subhumid tropics of sub-Saharan Africa is still faced with major problems of development, particularly on food availability in urban centers and socioeconomic growth in rural areas. This situation still persists in the face of increase in rural–urban populations and the effects on various crops in Africa (Nweke 1992).

Africa, within the tropics, largely remains a rural society dependent on agriculture and pastoralism and even where other natural resources are available such as petroleum in the case of Nigeria, agriculture and agricultural enterprises continue to be the major producers of national income (Sinkam 1994).

Population determines the level of product demand and the size of markets and this

factor also determines the growth potential of many rural industries, particularly those producing the highly perishable farm produce that are typical of agricultural communities as those that exist in sub-Saharan Africa. For peri-urban enterprises, the opportunities for expanded market will continue to increase as urban population increases.

It is well known that 80% of Africans living in rural areas produce four-fifths of national output. Governments, unfortunately, have continued to focus resources more on urban centers and industrialization, and less on the rural areas or the development of rural enterprises particularly in peri-urban areas that are the "shelter belt" around urban environments. This situation in the case of rural small-scale farmers has been addressed variously by the Food and Agricultural Organization (FAO) of the United Nations.

Whereas urban dwellers and processors have undoubted advantages, especially in their proximity to large markets, operators of small peri-urban enterprises also have a sure market in urban centers.

Rural dwellers have, over the years, identified and exploited the advantages inherent in peri-urban enterprises vis-à-vis urban markets because of low production costs and other advantages of nearness to raw materials. The rapidly expanding populations in urban areas and the expansion in the trend of the informal urban food sector provide opportunities for consumption of a large proportion of rural production. These opportunities will increase as the proportion of the total population living in urban areas also increases. A perspective study by the Club du Sahel, the African Development Bank, estimates that 270 million of the expected total of 430 million people in West Africa in 2020 will be living in 6000 urban areas of more than 5000 people and that there will be more than 300 "large centers" with populations in excess of 100 000 (Fig. 1). These will continue to provide just as many enterprise opportunities for marketing rural or peri-urban products now and in the future (2020).

Peri-urban enterprises

Agriculture

Crop production within the rural/peri-urban area constitutes a major enterprise in West and Central Africa. In most cases, this sector is ecologically specific, as adopted major crops such as yam, cassava, cereals, and pulses are cultivated and crops are closely targeted to urban centers as markets (Mollet et al. 1995).

- Rhizomes—cocoyams (*Xanthosoma mafaffa* and *Colocasia esculenta*)
- Tubers—yams (*Dioscorea* spp.), sweetpotato, and cassava (*Manihot esculenta*)
- Plantains and banana
- Grains and legumes—maize *(Zea mays)*, rice *(Oryza glaberima)*, groundnuts *(Arachis hypogea)*, *Mucuna cochinchinensis*, *Phaseolus lunatus*, and cowpea (*Vigna unguiculata)*.

Peri-urban enterprises in developing tropical countries, such as in sub-Saharan Africa revolve around agriculture. The various activities include:

- crop production and small livestock rearing
- tree crop plantations
- market gardening
- trading (farm product—wholesale and retail)
- food processing

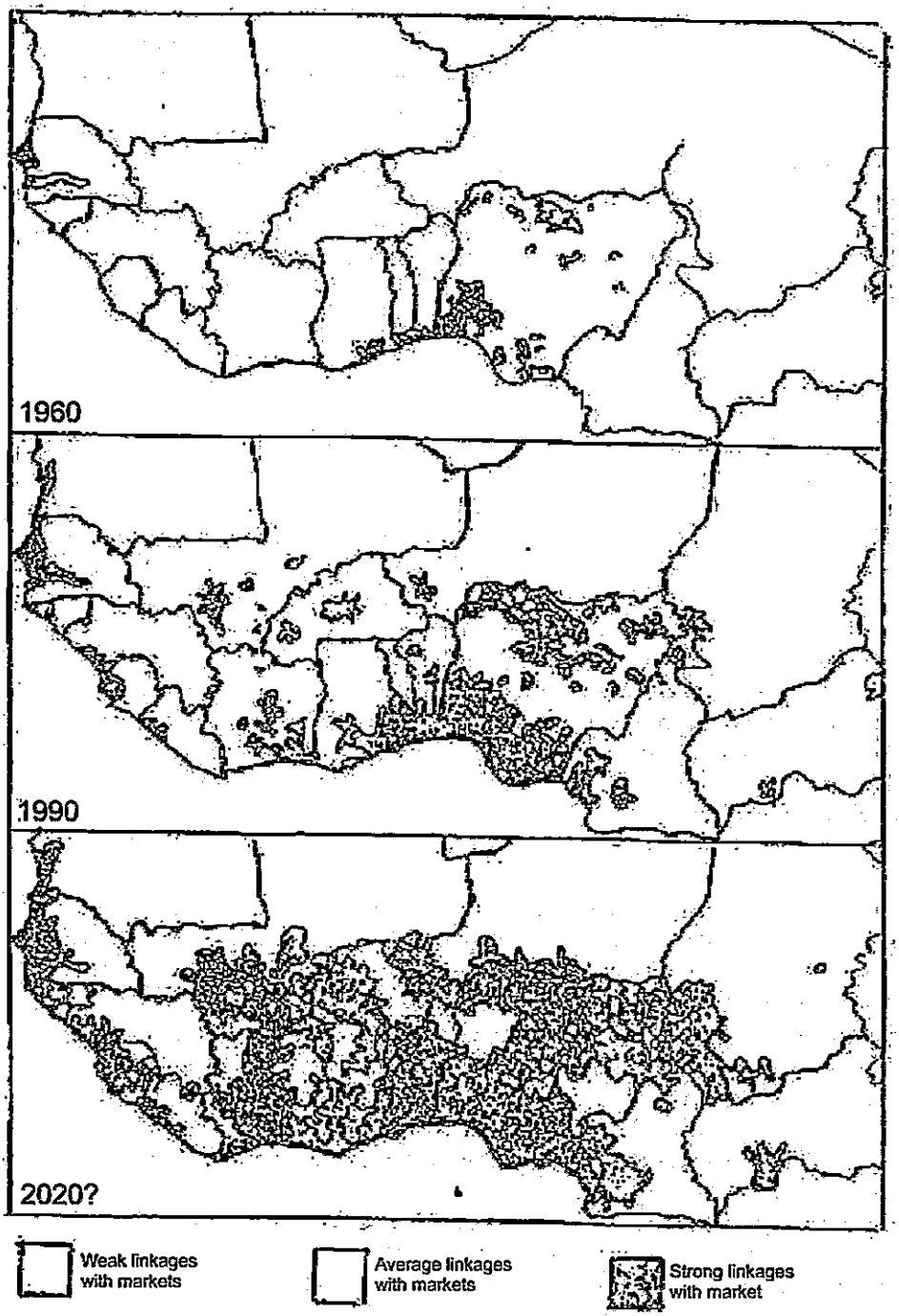


Figure 1. Increase in population in West Africa.

Note: Rapid expansion of cities will create new market opportunities for more and more West African rural areas ADB, Club de Sahel, and CILSS).

- fruits, food, and livestock products
- forest exploitation, including extraction of fruits, and specific wood for cosmetic production

Farming and small livestock rearing

Food crop production or farming in West and Central Africa has been described by many researchers in this subregion. Shepherd and Okafor (1992) described farming activities in Cameroon and particularly in the southern forest zone and Okigbo (1987) has described the situation in Nigeria.

Crops produced follow agroecological zones and these include tubers, cereals, and vegetables, which are produced in market gardens near cities because of their high perishability (Ladipo 1997). Produce is marketed through rural wholesale markets from where the produce goes to the urban retail markets. This whole process has its strength and weakness. These have also been described by various researchers in Cameroon (Shepherd and Okafor 1992) and particularly in the Korup Project area in Cameroon where highly diversified crop mixtures are produced for sale in large marketing centers. The crops produced in Korup include green vegetables, potato, other vegetables, and fruit and tree crops, which will be addressed under a separate section in this report.

Small livestock rearing enterprises

Apart from the relatively large-scale Fulani pastoralist system, which is basically rural but actively nomadic, small ruminants are also kept in the humid and subhumid areas of West and Central Africa. Pigs, goats, sheep, and poultry are mainly kept by women who use them as sources of small credit, or for sociocultural reasons (Fernandez and Nair 1986).

These, in most cases, are used as cultural methods of saving funds (banking) as the animals are sold to generate immediate cash as the needs come. In Cameroon, goats are transported from peri-urban areas to urban centers to be sold (Degrande personal communication).

Commercial importance of crop production in peri-urban areas

Over 80% of urban dwellers within peri-urban areas are farmers who produce food crops for urban consumption. Their basic socioeconomy thus rotates around the marketing of these farm products, and the success of profitable markets determines their socioeconomic growth. Both older and younger farmers engage in the production enterprise and women too play a vital role in this process.

Peri-urban crop production, being within the immediate neighborhood of urban conurbations, does not have market problems so long as transportation is good and production does not exceed demand. This is so because as urban centers grow, so also market opportunities for these farm products will continue to grow under the same conditions. The vital factor here is the need for production at the level of demand and with the farmers having the dynamic capability to respond to local increases in demand in future. This situation has been well demonstrated by the Oyo State (Nigeria) Agricultural Development Program (ADP) which reports that excess crop production over demand has negatively affected the economy of some farmers. In this case, it explains that the cost of yam tubers that used to be ₦1500 per 100 average-sized tubers fell to ₦350 for the same size and

quantity of tubers during the September–October period in 1994 when markets were flooded (ADP 1994).

Food processors (yam flour producers) were the better for this, however, as they bought more fresh yam for processing and storage in the dry form for subsequent sale during the period of "scarcity". Where processing is not possible or not well understood, farmers experience these major losses if they over-respond to demand. The case of okra and tomatoes is like recurring decimals in this case. (Olanrewaju personal communication).

Tree crop plantation

Commercial tree crop plantation culture started in West and Central Africa over 70 years ago, and most of the plantations established at this period are still existing in their old age, resulting in very poor yields. Most of these plantations were induced by colonial governments who required products for overseas industries and these also determined then and now the prices to be paid for the produce.

Tree crops established in plantations at this time include:

- citrus (various types)
- cocoa (*Theobrona cacao*)
- kola (*Cola acuminata and C. nitida*)
- coffee (*Coffee arabica* and *C. robusta*)
- rubber (*Hevea brasiliensis*)
- first generation improved oil palm trees

Cashew and only recently wild fruit trees are gradually coming into the level of plantation culture, (Ladipo et al. 1997). Fernandez and Nair (1986) have both looked at the culture of these tree crops within the villages or communities.

The commercial importance of these tree crops cannot be over-emphasized if we consider that they were the primary sources of village economy or that they were the national economic mainstay in countries such as Nigeria and Cameroon for over 30 years when most of the crops were exported and farmers were paid promptly.

The impact of these tree crops (Shepherd and Okafor 1992) had significantly raised the socioeconomic status of the rural areas of many countries (Cameroon) before the fall in international prices started. Okigbo (1975) clearly stated the sociocultural impacts of this development earlier, emphasizing the utmost importance of trees in rural economies, and the need for more efforts in understanding the value of these for environment and the livelihood of rural dwellers.

A local survey in Nigeria revealed some interesting factors. One of these was the listing of the problems of tree crops (Table 1). This list is capable of helping the direction of EPHTA.

Table 1. Problems of major plantation tree crops in Nigeria.

	Species	Problems
(a)	Cocoa	Existing plantations now old (age between 25 and 60 years)
		Only 1–3% of existing plantations are new planting
		Urban population drift affecting availability of labor input at harvesting, etc.
		No genuine agrochemicals
		Agrochemicals now very expensive
(b)	Cashew	No sufficient stock for planting
		Only poor planting materials available
		Plantations presently poorly managed
(c)	Mango	Disease of trees (Ogbomosho zone particularly)
(d)	Coffee	Crop is specific for different ecologies (upland and lowland types)
		No good seed materials
		No market (international) for present poorly produced beans (very limited local market available)
		Crop is generally old in the field and also poorly managed (most plants intercropped with old cocoa plantings)
(e)	Kola (both species)	Trees genetic quality still poorly understood by researchers
		Nut quality still irregular (non-uniform)
		Many field trees are sterile and non-productive (result of self incompatibility?)
		Major pest problems abound (on nuts)
(f)	Tea	Limited planting in the MAS only
		Land availability is a problem
		Cattle ranching compete with tea for land

Market gardening

Market gardening is a vital peri-urban enterprise, which is practiced by many people. This system is an enterprise that is specialized to produce leafy or fruit vegetables. Market gardening is usually practiced under rainfed conditions during the rainy seasons and in wetlands or inland valley systems near urban centers. In recent times, development in irrigation systems have further encouraged production (Ladipo 1997) but this has resulted in some overproduction (i.e., tomatoes, okra, etc.) which have caused tremendous losses of perishable produce (Table 2). Some localities have now specialized in dry season vegetable production on a small scale through traditional irrigation and this has also significantly increased rural economy (ADP Oyo State 1997) as produce attracts higher prices. Vegetables produced include native, traditional, and exotic types (Table 3) to cater for the needs of local and foreign populations in urban centers (Schipper 1997). Ladipo (1997) considered marketing and the postharvest constraints to development of these crops in sub-Saharan Africa. He enumerated the potentials and emphasized the research needs in this area with particular concentration on the traditional vegetables of Nigeria.

Earlier studies (Ladipo 1998) indicated the level of postharvest losses on fruits and vegetables in some African countries (Table 2) where a level of loss between 5 and 50% was indicated for Nigeria, Ghana, and Sudan.

Table 2. Level of postharvest losses in fruits and vegetables in three African countries.

Country	% loss	Produce
Ghana	30–35	Fruits and vegetables
Nigeria	10–50	Fruits
Sudan	50	Fruits and vegetables

Source: Ladipo (1998).

Table 3. Some native and exotic vegetables produced in peri-urban areas in Nigeria.

Species	Origin	Common or native (Yoruba) name
Leafy vegetables		
Celosia argentea		
Amaranthus spp	Native	Green
Corchorus olitorius	Native	Ewedu
Abelmoscus callei	Native	Okro (leaf)
Fruit vegetables		
Abelmoscus esculentus	Native	Okro
Solanum gilo	Native	Garden egg
Pulses		
Phaseolus lunatus	Native	Awuje
Sphenostylis stenocarpa	Native	Otili
Spices		
Capsicum spp.	Native	Pepper
Lactuca spp.	Exotic	Lettuce
Cucumber	Exotic	Cucumber
Cabbage	Exotic	Cabbage
Cauliflower	Exotic	Cauliflower
Green beans	Exotic	Beans
Sweet pepper	Exotic	Pepper
Chinese cabbage	Exotic	Cabbage
Water melon	Exotic	Water melon
Irish potato	Exotic	Potato
Carrot	Exotic	Carrot

Types of vegetables

As earlier mentioned, vegetables produced in market gardens are both exotic and native to the various countries where they are produced, but in Kenya, more exotic vegetables are produced. Both native and exotic species are produced in Nigeria, as listed in Table 3.

Commercial importance of market gardening in peri-urban areas: the example from Southeast Asia

To discuss the socioeconomic or commercial importance of market gardening in West and Central Africa, it is vital to look at the classic case of southeast Asia vis-a-vis the African situation, as described by Grubben and Almekinders (1997). About 60% of Indonesia's population of 200 million is used to buying vegetables at street markets and the per capita vegetable intake (110 g/day) is increasing.

The top ten lowland vegetables commercially grown here (600 000 ha) are hot pepper, yard-long bean (*Vigna unguiculata* sp. *sesquipedalis*), shallot, red kidney bean (*Phaseolus vulgaris*), cucumber, egg plant, amaranth, kang kung (*Ipomea aquatica*), caisin (*Brassica rapa*), and pumpkins/gourds. These vegetables and others grown on the highlands make up 80% of the total sales, whereas all the 100 species of vegetables known and which are also consumed make up only 20% of the vegetables consumed in Indonesia.

The situation is similar to that in West Africa. Market gardens in peri-urban or rural areas are very small units < 0.25 ha and farmers often irrigate and use some agrochemicals. At present, as a consequence of urbanization and fast economic development, commercial vegetable farming is a growing industry. The consumption of vegetables shows a strong positive income elasticity. As a result of this, there is now a remarkable expansion of plant breeding activities in the private sector. This situation can also happen in sub-Saharan Africa if EPHTA provides the "seed" situation. In southeast Asia, local seed companies are developing and are making much progress in breeding all kinds of commercial vegetables. With all these developments, farmers are changing from using seeds from landrace sources with low rates of productivity to those produced by seed companies. Also, as a result of this development, a large number of vast vegetable production areas with skilled professional vegetable farmers have developed in peri-urban areas.

In comparison to the above, vegetable production in peri-urban areas in West and Central Africa may not be as developed, but the potentials are there to be fully exploited in this subregion. Despite the little advantages that have been recorded in Ghana, Cameroon, and even in Nigeria (Schipper 1997), the need to follow the Asian example cannot be over-emphasized.

The Jos Plateau is a good example in vegetable production in Nigeria. Because of the low temperature, a lot of temperate vegetables are grown. Irish potatoes, cabbages, carrots, and cauliflower are grown in peri-urban areas of Jos and Bauchi, and from the urban centers these farm produce are transported to almost all other urban centers in Nigeria. The perishable nature of these vegetables not withstanding, wholsalers have devised methods of keeping the produce green and crisp for transportation to over 700 km from the point of production. This enterprise which is practiced by over 3400 small-scale rural farmers is now the socioeconomic mainstay of the Jos and Bauchi area of Nigeria.

The same is correct for Otte village which supplies Ogbomosho and Ilorin with vegetables and also from where far-out urban areas (Lagos) are serviced (Ladipo 1997). In the present disposition, EPHTA needs to consider the following steps:

1. Increase ways to raise awareness (nutritional values, etc.) and status of vegetables in diets.
2. Support the evaluation and selection of better performing varieties of vegetables now grown.
3. Improve cultivation practices (can agroforestry or tree-based systems help?)
4. Improve processing, preservation, and marketing, as already emphasized by Ladipo (1997).
5. Extend market gardening to other areas with women as targets.

I will want to consider a 1964 initiative in West Africa on vegetable production, which EPHTA can build on.

Trading

Trading in the developing world is a major enterprise. It is the basis of commerce and it determines the success of enterprises. Trading within the peri-urban areas is mainly at two locations, farm fringes and local village markets (Fig. 3).

Tropical home gardens

According to Okigbo (1987), a farming system is an agricultural enterprise and a bio-economic activity in which the farmer manages resources and orchestrates inputs in numbers, amounts, timing, and sequences with increasing efficiency in the growing of crops and rearing of animals to satisfy human needs for food, fiber, feed, and miscellaneous products. Farming systems vary from one location to another in relation to the prevailing physical (climate, soil), biological (crop, weed, pests, and diseases), socioeconomic (land tenure, credit, education), technological (inputs), and management experience, factors which interact to achieve the farmers' objectives in a given environmental situation.

The tropical home garden is a well-known traditional farming system. Home gardens are agroforestry land-use systems with multipurpose trees and shrubs in intimate associations with seasonal and perennial agricultural crops and livestock, within the compounds of individual houses, and under the management of family labor (Fernandez and Nair 1986). The diagram (Fig. 2) describes this system clearly (Fernandez and Nair 1986).

However, because there could be some home gardens that do not contain trees, Torquebiau (1992) suggests that the tropical multistrata home gardens should be refered to as tree home gardens. Michon (1983), however, had earlier described forest gardens (or village forest garden) which are much larger, less densely planted, and not so well tended as proper home gardens.

Fernandez and Nair (1986) and Landaver and Brazil (1990) have also described home gardens as a sound, efficient, and a sustainable land-use system which fulfils the basic needs of the local population, and which will avoid environmental deterioration, etc.

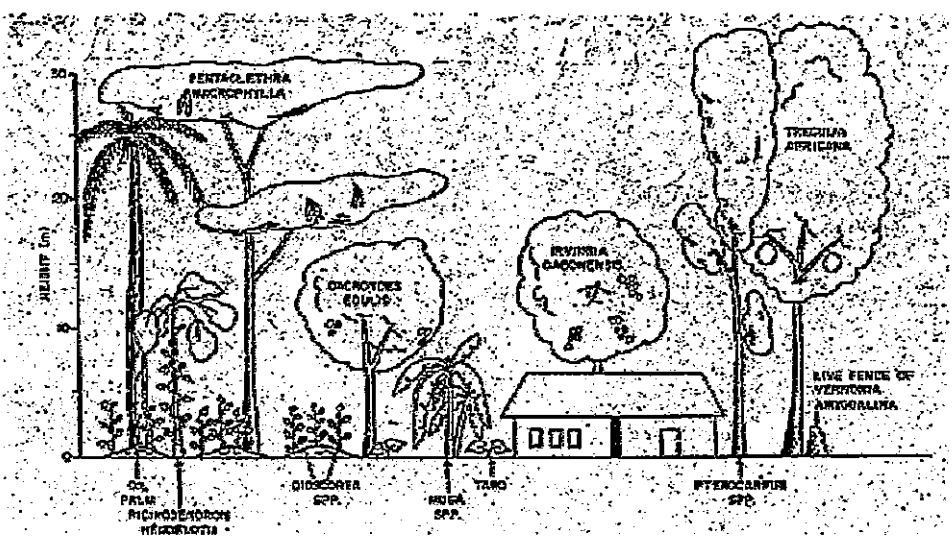


Figure 2. Schematic representation of the structural composition of a compound farm in southeast Nigeria (Fernandez and Nair 1986).

Fernadez and Nair (1986) have described ten selected home gardens. Their analysis included those gardens located in Southeast Asia, Pacific, South Asia, Africa, and American tropics.

The analysis of available data shows that home gardens are found in most ecological regions of the tropics and subtropics but a majority of them are in the lowland tropics. Home gardens also exist in the drier tropics (Burkina Faso—semiarid). Population is usually high where they occur. The average size of a home garden is usually less than 1 ha, indicating the basic subsistence value of the system.

Commerce is also part of the reasons for the establishment of some home gardens or at least for their high number of plant components, but this is subsidiary. All home gardens contain some sort of food crop and many trees also producing fruits or other forms of food, indicating the basic food production role of the system.

The production of fuelwood cannot be underestimated in some home gardens and this is true of some other auxiliary values such as poles and medicine, with this indicating the multipurpose value of most species in the home garden.

Plant species in home garden agroforestry system

In spite of their small size, home gardens are characterized by a high species diversity and usually 3–4 vertical canopy strata. This is clearly shown by the diversity of plant species in the Chaga home garden on Mount Kilimanjaro, northern Tanzania (O'Ktingati et al. 1984), where over 100 crop and plant species were reported. They included 53 tree species, 29 food crop species, 21 economically useful non-woody plant species, and 8 weed species. This author stated that except for the weed plants, the other species were carefully interplanted on the same unit of land to form a very dense multistorey ecosystem which can today be easily refered to as the multistrata agroforestry system. Most of the plants are maintained on the farm for two or more uses. For the trees, the main uses were fuelwood (90% of trees) and medicine for human and livestock (30% of tree species).

Present state of home gardens in Nigeria

Home gardens as described by Fernandez and Nair (1986) are viable and ecologically stable but the state of home gardens in Nigeria (southeast Nigeria) in present-day conditions are threatened. A recent visit shows a process of fragmentation as limited land is divided among all the children. This calls for additional research input to this system to examine the impact of smaller fragmented compound farms in southeast Nigeria. Similar sociocultural pressures may cause similar developments in other tropical areas where the compound farm system has been successfully established in future.

An input of high value trees and shade tolerant crop species into the system to make it a more commercially viable enterprise is required in the humid lowlands of West and Central Africa.

Forest gardens

This report will be incomplete if this system is not mentioned. As defined by Michon (1983), they are less efficient than tropical home gardens and are also less well cared for. In Nigeria and Kenya, Aiyelaagbe (personal communication) reported in a comparative study of function and structure that a close similarity exists between the systems in both countries in their profiles although different tree crops have been used. However,

in Venezuela, forest gardens exist as multispecies plant associations in integrated coffee production systems. In Venezuela, forest gardens are practiced mainly in the premontane moist forests of the Andes region but these forest types are also found in other areas of the country. Various trees species are used for shade and as fences in big coffee plantations whereas in small units with traditional production patterns, coffee is planted along with many other species often constituting a 3–4 tier (layer) canopy. Yield data and some socioeconomic information showed that this system can be productive, sustainable, and socioeconomically viable.

In addition to the Nigerian, Kenyan, and Venezuelan examples there is that of West Sumatra (Indonesia) described by Michon et al. (1986). Here, the system is characterized by an intensive integration of forest species and commercial crops, forming a forest-like system as described for the Kandyan gardens of Sri Lanka where spices, fruits, medicinal plants, and timber species are produced (Jacob and Alles 1987).

The intimate association of different species provides both subsistence and commercial products, which supplement rice production. Here indeed is the commercial importance of this system for rural development. This forest is managed by the combination between cultural practices and respect for natural processes of vegetation production and reproduction. Michon et al. (1986) concluded that it represents a profitable production system and constitutes an efficient buffer between villages and protected forests.

Apart from the commercial values of this system, Michon et al. (1986) suggested that these agroforests can be good models for an association between integration of forest resources and the cultivation of cash crops in a flexible and sustainable system.

Finally, if this system will support rice cultivation efficiently and the production of cash crops, (coffee, cashew, oil palm, etc.) then it is a commercially viable rural enterprise which will support rural dwellers to generate resources from selling to the markets in urban centers in a sustainable manner and at the same time protecting the environment. Michon et al. (1986) provide information on the values of products obtained from agroforests in two villages in southeast Asia and they described the role of this agroforestry system and rice fields in satisfying the needs of the farmers. In West and Central Africa, the commercial values of forest gardens as described by Aiyelaagbe (personal communication) are clear. Home gardens are also basically for subsistence, and commercial purposes are only subsidiary.

This also agrees with the vast comparison done by Fernandez and Nair (1986) where home gardens in Southeast Asia, Pacific, South Asia, and the American tropics were compared for their commercial values. This system also basically serves subsistence and commercial values in these other locations.

Experience of the FAO/CPRO-DLO home gardens project in West Africa (1964–1975)

Grubben and Almekinders (1997) reported on the experiences of a Dutch horticulturist (Terra) who pioneered research on the Indonesian backyard home garden ecosystem project. He started a home garden project in Nigeria (Ilesha) and in Bénin (Porto-Novo) in 1964 with the strong involvement of CPRO-DLO. The objective was to promote the Indonesian concept of home gardening in Africa in order to improve human nutrition by using local vegetables to supply essential micronutrients and proteins to the people's diet. We must remember that local vegetables include a significant amount of leguminous

tree leaf-bearing species such as *Pterocarpus milbraedii* and shrubs such as *Vernonia amygdalina*. These two projects greatly stimulated national and international attention for traditional African vegetables. Conclusions from the two projects were that the principles of home gardening are the same in Africa as in Asia, i.e., no external inputs (purchased seed/special tools/mineral fertilizers/pesticides); mixed cultivation of vegetables, fruits, and other useful species (maize, cassava, medicinal plants, etc.) often in combination with small livestock, fertilization by recycling of organic waste.

Intensive participation of local people, especially women, in the project set-up is needed to make maximum use of their experience. The success of home gardening is based on traditional vegetables; introduction of new species (exotics) is not needed.

Vegetable consumption is promoted by nutritional education of teachers (for school gardens), rural extension workers, and health workers (demonstration gardens at health centers). The establishment of demonstration/experimental home gardens in the villages and the supply of planting material stimulate production of vegetables.

At present, research and experimental work to start or promote the production of local vegetables in home gardens generate enough knowledge. However, support from research organizations is useful.

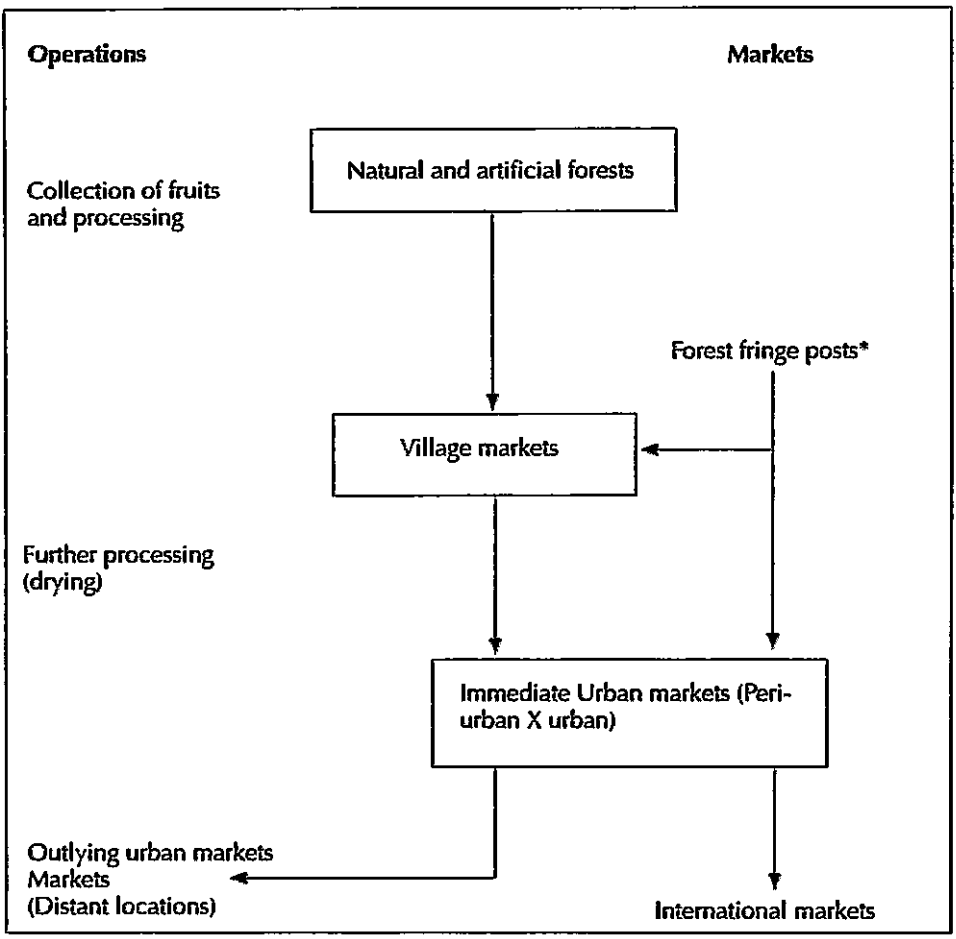
These market systems are both mainly patronized by the middlemen and women groups who buy cheap wholesale produce to transport to the urban centers to sell on retail basis. When this arrangement has been well developed traditionally, it becomes a major process in the viability of the enterprise. Shepherd and Okafor (1992) described the local marketing system around Mbalmayo-Yaoundé in Cameroon. Farm produce that is traded includes food crops, vegetables, fruits and nuts, plantain and banana, wild life (bush meat), small livestock, and spices. Shepherd and Okafor (1992) described details of these transactions but the commercial value of this enterprise is worth emphasizing.

Advantages include:

- Ease of sales of farm produce by farmers
- Generation of employment for middlemen
- Reduction of the transport costs which farmers would have had to pay to reach the urban market
- General increase in the value of crop production enterprises as competition or quality standards are set by middlemen
- Increase in village socioeconomy, etc.

Food and other product processing

Apart from *Irvingia* (Fig. 3), other small-scale food processing enterprises are known. They consist of three main areas, i.e., food and fruit processing, livestock product processing, and general processing of other industrial raw materials such as African locust bean (*Parkia*), maize and wheat/or soybean, etc. These village industries contribute greatly to rural economy (Spore 1996) or African national economies. One of the conclusions of a workshop held in April 1996 in Stuttgart, Germany, under the auspices of FOOD-NET/RESAA (a network of NGOs and European institutions that promote appropriate technology) was that food processing accounts for some 4.0% of the value added by all manufacturing industries (Quisumbing 1996). Most of these enterprises which are, for the most part, small informal businesses are a major source of rural employment because they create jobs and income for about 60% of the sub-Saharan African labor force, most



Source: Ladipo (1998).

Figure 3. Production and marketing of bush mango (*Irvingia gabonensis* and *I. wombulu*) kernel in West and Central Africa (Nigeria and Cameroon).

of whom are women, who thereby earn the money needed to support their families. This strong emphasis on women is a characteristic of the sector but may act as a brake on small business development in so far as women unfortunately also tend to have less access to improved technology, extension information or services, and credit. Other forms of processing undertaken by women include:

- food processing (e.g. African locust bean)
- fruit processing (juice or fruit drying—*ogbono*, mango, guava, citrus, etc.)

Very little will be said about the other food processing industries mentioned but the case of fruit drying will be specially addressed. This is because it is the least cash intensive and the least practiced system in Africa where solar energy is available throughout most of the seasons.

In Guinea, dried banana, pineapple, and mango are produced. Annual production of 20–25 tonnes is reported. This represents about 300 tonnes of fresh produce brought

from about 100 small producers from near rural locations who are organized in three cooperatives.

This very appropriate rural enterprise employs mostly women and has the potential of commencing in other African countries if strict EEC conditions on cleanliness are followed, as in Guinea.

Food processing enterprises (refers to Nigeria, Ghana, Togo, Côte d'Ivoire, Guinea, Kenya, Tanzania, Zambia, and Uganda).

Other food processing operations carried out in peri-urban sites are:
Vegetable (leafy) drying (okro, *Gnetum*, etc.)*
Cereals grinding (maize)***
Oil extraction, palm oil processing**
Palm kernel oil extraction**
Egusi oil extraction
Ricinodendron heudelotti(Jangsang) oil extraction*
Aionella torisperma (Moabi) oil extraction*
Livestock product
Milk processing
Cheese making
Butter
Others: African locust bean (*Parkia biglobosa*) processed as soup ingredient in one or two countries (Nigeria/Cameroon)
**Undertaken in West Africa.
***Undertaken in West, Central, and East/South Africa, etc.
Unmarked: very general in small or average quantities only.

Advantages of peri-urban food processing enterprises

These enterprises contribute greatly to the development of the rural economy. In addition, it is generally accepted for easy accessibility to markets. Processing of highly perishable products helps to reduce loss through early treatment, which is also a major advantage for successful storage.

Milk and fruit are good examples of these; cereals store better as grain than as flour. Food processing can also provide added income to the small-scale farmers who supply raw materials and create job opportunities for many other people. Examples of perishable products and their processing locations are shown in Table 4.

Table 4. Perishable products and their peri-urban processing locations.

Country	Product	Location	Large and nearest urban center
Kenya	Cheese	Nakuru	Nairobi
	Fruit processing	Thika/Kitale	Nairobi
Uganda	Fruit processing	Mbarara	Kampala
Rwanda	Milk processing	Nyanza	Kigali
Nigeria	Gari	Many sites	Many urban sites
	Tomato	Dakin Kowa	Bauchi
	Fruit	Dakin Kowa	Bauchi

Commercial importance of food processing enterprises

Spore (1996) in a review provided a succinct account of the commercial value of food processing and rural industries. Some of these have been mentioned earlier but they include the fact that peri-urban food processing industries:

- provide added income to the small-scale farmer
- provide income for labor force involved in production or processing
- encourage farmers to establish more crop plants to produce more fruits for market and industry, thus increasing the industrial base
- create more jobs opportunities
- stimulate development of industries and enforce standards for quality improvement

High quality attainment can generate international recognition and market openings while all these together can contribute to viable rural commerce and enhanced national economy in general.

In West and Central Africa many examples of specific food processing are known. The problems in successful food processing in sub-Saharan Africa include the non-availability of credit and access to technical and commercial know-how in addition to unavailability of infrastructure, water, and electricity. These problems need to be overcome in order to make peri-urban enterprises more attractive.

Handicrafts and art

This area of peri-urban industries will be treated now before forest exploitation because it is a distinctive operation although the wood used is extracted from the forests.

Many West and Central African countries have cultures that are closely woven into art and crafts. Danta, mahogany, and ebony extracted from the forests are commonly used for carving and for making other items.

Shepherd and Okafor (1992) working in Cameroon described the commercial importance of cane and its products in the rural or national economy of Cameroon. Their report shows that the value of cane products is usually understimated. The same situation is true for Nigeria where over-exploitation of cane resources has resulted in substantial genetic loss, and the industry now relatively depends on smuggling cane materials from Cameroon to keep the industry alive in Nigeria. The carving or cane furniture sector accounts for over US $20 000 000 of the gross economy of sub-Saharan Africa.

Forest exploitation

Forest exploitation is an old enterprise in Africa. This enterprise is very active in all ecologies but it is more accentuated in the lowland humid forests, where most people live almost solely on the forests and their products from wood and non-wood materials.

Food gathered and hunted in the wild is important and will continue to have an important place in the diet of many farming families. Taking examples from outside the subject region, the Bokusu of Kenya, for example, consume at least 100 different species of fruits and vegetables and the Tswana of Botswana and South Africa use 126 species of plants and 100 kinds of meat as a source of food (Tym personal communication).

As urban drift takes place, forest people move to larger cities and form the core of specialized forest product consumers.

Peri-urban forest extractors thus become important operators who run important and viable commercial activities in these countries particularly in Kenya, Uganda, and Tanzania,

etc., near the Miombo woodlands and in West and Central Africa where forest non-wood exploitation is a major enterprise, as products are collected, sold, and transported to major cities such as Yaoundé, Douala, (Cameroon), Lagos, Ibadan, Calabar, Enugu, Owerri, and Port Harcourt (Nigeria). The annual trade in *Gnetum africana* leaves in West Africa (Nigeria and Cameroon) is now $120 000 000 (Shiembo personal communication).

Common resources extracted from forests in peri-urban areas include the following stated in Table 5.

An example of a forest resource commonly extracted and marketed in urban markets is *Irvingia* kernel. *Irvingia gabonensis*, the bush mango, is the source of *Ogbono*, the commercial product (kernels) which have recently received substantial commercial and research attention in West Africa.

Irvingia gabonensis, is intraspecifically variable and this is a viable potential for the improvement of the species (Ladipo et al. 1997). *Irvingia* kernels are collected from the forest (60%) and from the compound garden and outlying farms (40%) and many families depend on this enterprise for survival. Local trade in rural (collection centers) and urban centers where they are sold on the retail market is very lucrative. International trade has commenced within West and Central Africa and recently, a substantial quantity is exported to Europe and the USA (Ladipo and Boland 1994).

The commercial importance of this product has been substantial to the rural collector or cultivator as the gross international and local trade has been estimated as $50 000 000 by the International Center for Research in Agroforestry (ICRAF 1995).

Table 5. Common resources extracted from forests in peri-urban areas.

Country	Some products extracted from forests
Nigeria	Snails and other wildlife. Mushrooms, vegetables, (*Gnetum*) fruits, honey, chew stick species spices, stimulants, and masticants medicinal plants, colorants, and dyes.
Ghana	Snails and other wildlife. Honey mushrooms, sweeteners fruits, colorants, dyes spices, stimulants, masticants medicinal plants, and vegetables.
Cameroon	Mushrooms, snails, and other wildlife. Stimulants and masticants, vegetables (traditional types), honey, medicinal plants sweeteners, colorants, and dyes.

The commercial importance of the chew stick trade in Ghana

Many tree or shrub species are used for teeth cleaning in Africa. In West Africa they include *Garcinia manii*, *Millettia griffoniana*, and *Massularia acuminata* (Table 6). There are many more which are traditionally used in Kenya, Ghana, and Nigeria. In Ghana and Nigeria, the collection of chewstick wood for processing and sale from forests has become a very large and important business enterprise. Sticks are collected mainly by youths that are thereby provided with employment. Processed chewsticks are sold in urban markets and in motor parks where travellers gather to go to their urban work places.

The commercial value of chewsticks has been enhanced recently as stated by Amponsah (1978) who reported on the structure and economics of the chewsticks industry in Ghana. The main species sold are *Garcinia afzelii* and *Garcinia kola*. These and the harvesting processes, etc. are shown in Figure 4. This peri-urban enterprise is very profitable with a 50% gain estimated by Amponsah (1978) for his study site in Ghana.

Table 6. Species used for chew stick "manufacture" in some countries in West Africa.

Country	Species used	Commercial status (S, A, L)
Ghana	*Garcinia afzelii* Engl.	L
	G. kola Heckel	L
	Randia acuminata	A
Nigeria	*G. manni*	L
	G. kola	–
	G. afzelli	L
	Masularia acuminata	L
	Millettia griffoniana	S
	Baphia nitida	S

S = small A = average. L = large-sale (national use).

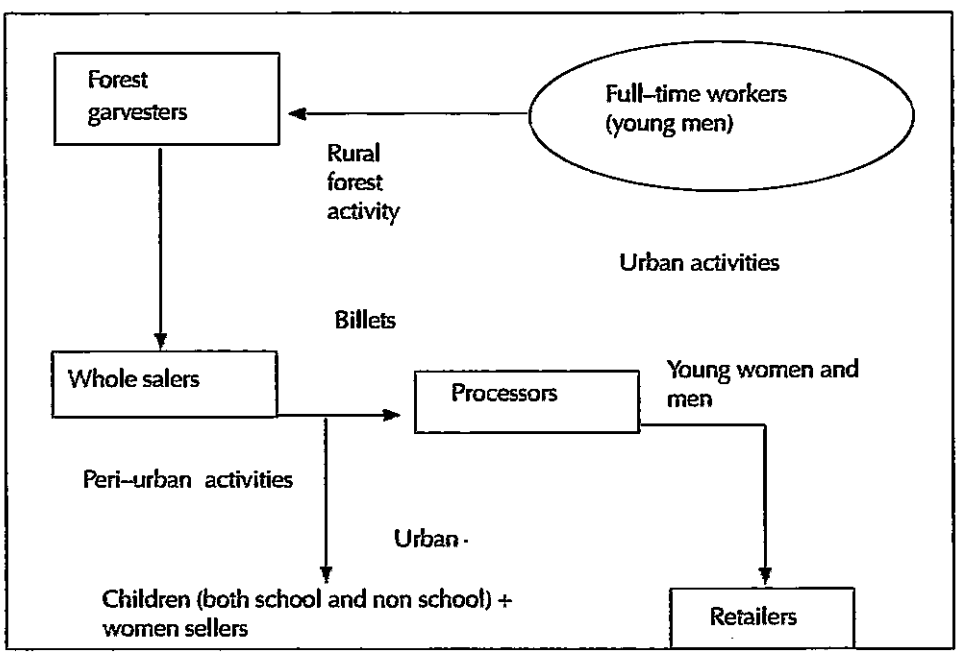


Figure 4. Harvesting/processing of chewsticks.

Commercial importance of forest products

Adequate attention has not been paid to the actual cash values of non-timber forest products in West and Central Africa. This has caused substantial problem in the development of policy and the articulation of necessary protective laws for the forests in most countries. However, the FAO is already mobilizing resources to generate this vital information. (Vantomme personal communication). However, from the above account on the varied resources that are found in forests, and the specific accounts given on *Irvingia* kernels and the traditional chewstick species, it is clear that forest resources are indeed variable and that their collection from the forests is a specialised activity, which can clearly be refered to as a traditional and profitable enterprise. To use an East African example, the value of honey produced from bees in the forests of Tanzania is several times greater than the value of the wood the forests contain.

In Ghana and Nigeria, many women earn their living by selling *Marantaceae* leaves collected from the wild or cultivated in cola/cocoa-based systems as a diversification and intensification input into these plantation systems. In the Central African Republic, traders sell over 700 tonnes of meat of forest animals and birds annually (Spore 1995).

Unfortunately, there are no accurate statistics or estimates of yield on income obtained from forest exploitation but new developments are now commencing varied efforts at the generation of data. Recent efforts of ICRAF and the Center for International Forestry (CIPOR) are gradually generating such data, as is presently being done for *Irvingia* and the chewstick industry in Ghana.

Fat extracted from the shea butter tree fruits now forms a vital export market, which is now well recognized in Europe and America. Gum arabic collected from peri-urban Sahel forests in Kano State now forms part of a major export product commodity for Nigeria. It is the same situation with Sudan and Niger Republic, with the urban centers being centers for grading (processing) and exportation of these forest products overseas. The sale of these and other non-wood forest products may indeed be a means of improving the welfare of the rural forest dwellers who engage in these enterprises. However, EPHTA will need to support efforts at generating high value stocks of these products to achieve this feat.

Conclusions

If development is to succeed in Africa, and if Asian or African economic decline is to be properly addressed, more effort by the various governments is required. Peri-urban industries are a service and a developmental issue, and compound farms are a basic, inherent (cultural), and sustainable agricultural system which must be encouraged to grow and to be sustainable. Governments must reexamine priorities; FAO must provide the mechanism for a participatory review approach on these activities and systems that have great potential to positively drive national economies upwards and to ensure the sustainability of the farming unit in all of its ramifications. The goals of the ecoregional program (EPHTA) must be emphasized in research and development efforts to ensure the further development of peri-urban enterprises, provide better processing systems, and enhance the process of market development based on higher standards of products such as has been done for cassava and *gari* in Nigeria and some other West African countries where this food processing enterprise has become very high quality based on good technology.

The compound farm in its own case requires support too, as mentioned above, in the enhancement of its plant components so as to improve its present secondary enterprise

value to a primary status capable of enhancing the livelihood of the rural farmers or rural producers in the peri-urban environment of sub-Saharan Africa.

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Renforcement de la capacité des SNRVA à mener des activités de recherche ecorégionales

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Abstract
In the early 1990s, IITA, in collaboration with CORAF and other research partners within the ecoregion developed a cooperative framework called the "Ecoregional Program for Humid and subhumid Tropics of sub-Saharan Africa". This program includes three major ecoregions: (a) humid lowlands, (b) moist savanna, and (c) forest zones. The success of these collaborative efforts will depend on the quality of participants, so efforts are on capacity building based on indepth understanding of the strength and weakness of the institutions in the West and Central Africa. The present paper also looks at the problems inherent in the Sahel areas. All these are fully discussed in this paper, towards a successful cooperative effort in Africa.

Introduction

Dans le cadre de la mise en oeuvre de l'approche écorégionale définie par le CGIAR (1992) au début des années 90, l'IITA, en collaboration avec la CORAF et d'autres partenaires de recherche dans la sous région de l'Afrique de l'Ouest et du Center a élaboré un programme de coopération régionale appelé "Programme Ecorégional pour les Tropiques Humides et Sub-Humides de l'Afrique au Sud du Sahara" (EPHTA). Ce programme qui comporte trois pôles (consortia):

Consortium bas-fond
Consortium savane humide
Consortium forêt humide

est basé sur les principes de prise en compte globale de la production et de son environnement physique et socio-économique. Il met en oeuvre pour sa réalisation un mécanisme original de partenariat sur toute la chaîne de production, de transfert et de consommation de technologies. Il en résulte donc que son succès dépend essentiellement de la qualité de partenariat mis en oeuvre. Les principaux acteurs de ce partenariat au niveau national se retrouvent au sein des SNRVA.

C'est donc à juste titre que parmi les 11 produits attendus de la mise en oeuvre du programme EPHTA, figure le renforcement de la capacité des SNRVA à conduire les recherches écorégionales.

L'objectif de la présente étude est d'analyser les conditions de réalisation de ce renforcement en s'appuyant sur 2 ou plusieurs pays de la sous région.

Pour cela, il nous parait opportun de voir le panorama des expériences de partenariat vécues dans la sous région de l'Afrique de l'Ouest et du Center, de focaliser l'analyse au niveau national en tirant leçon des forces et faiblesses des systèmes nationaux et de dégager les éléments de renforcement et si possible, les moyens à mettre en oeuvre. Les exemples pris pour argumenter l'analyse ne se limitent pas seulement à la zone de prédilection de

EPHTA, mais va jusqu'aux pays du Sahel dont les SNRVA ont les mêmes problèmes que ceux de la zone EPHTA.

Contexte de partenariat dans la sous region

L'histoire du partenariat de recherche en Afrique de l'Ouest et du Center montre qu'il a existé par le passé et qu'il existe encore beaucoup d'initiatives de coopération régionale autour de problématiques diverses.

En effet, que ce soit en période coloniale ou en période post coloniale, des regroupements formels ou informels ont été faits généralement autour des filières mais quelques fois aussi autour des systèmes de production et des thématiques écologiques.

En période coloniale

Certaines institutions de recherche ont été bâties dans l'objectif affiché de rayonner sur une zone écologique dépassant les frontières du pays de leur installation ; c'est le cas des instituts créés dans les pays anglophones comme le Nigéria et le Ghana et qui devaient développer des technologies sur les principales cultures d'écologie forestière pour toute l'Afrique de l'Ouest (anglophone). Un tel système induisait une coopération de fait avec les autres pays de la sous région.

L'exemple de l'Institut français de recherche sur les Huiles et Oléagineux est également un exemple très édifiant de ce type d'organization transnationale avec les pays abritant des stations principales (Bénin, Côte d' Ivoire) et d'autres, des stations secondaires (Cameroun, Congo Brazzaville). Ceci a donné lieu à un réseau informel sur le palmier à huile qui dépassait même la sphère des colonies françaises pour toucher le Zaïre, la Malaisie, l'Indonésie. Ce réseau existe encore de nos jours. Il a été pratiquement repris en compte en Afrique par l'ADPH.

En zone de savane, nous avons le même exemple sur le coton pour lequel la coopération s'est poursuivie au delà de la période coloniale pour donner lieu au réseau formel coton de la CORAF.

De nos jours

L'évolution récente de la coopération dans la sous région de l'Afrique de l'Ouest et du Center a été fortement marquée par les efforts de la CORAF, les initiatives du SPAAR et celles des centers internationaux basées en Afrique sans compter les bailleurs de fonds comme l'USAID.

CORAF

Les réseaux de la CORAF, en raison des contraintes à la sécurité alimentaire au moment de sa création ont été orientés sur les filières vivrières les plus importantes (maïs, manioc, riz, arachide) mais aussi sur la problématique de l'eau donc de gestion des ressources naturelles avec le réseau R3S. Par la suite, la CORAF a développé des projets coopératifs relatifs à la gestion des ressources naturelles. C'est le cas du projet jachère et du Pôle système irrigué.

SPAAR

Les cadres d'action définis par le SPAAR pour la promotion de la recherche en Afrique ont été faits sur la base de réalités écorégionales. Même s'ils coïncident avec une

certaine répartition géopolitique, en ce qui concerne l'Afrique de l'Ouest et du Center, on retrouve bien les deux grandes zones écologiques qui sont le Sahel et la zone humide et sub humide .

Centres internationaux

Les centers internationaux basés en Afrique ont aussi pris beaucoup d'initiatives avec les bailleurs de fonds. C'est le cas par exemple de :

L'ADRAO qui a mis en place des groupes d'action couvrant divers aspects de la culture du riz. Elle est fortement impliquée dans le consortium bas-fonds créé bien avant le programme EPHTA et qui constitue aujourd'hui l'un des trois consortia à travers lesquels sont menées les activités de ce programme.

L'IITA qui a initié, géré ou participé à plusieurs réseaux et projets collaboratifs tels que les réseaux WECAMAN sur le maïs, RENACO sur le niébé, et AFNETA sur l'intégration agroforesterie élevage, les projets ESCaPP sur le manioc, RRPMC sur le maïs et le manioc, PEDUNE sur le niébé, EU/RAMR pour le transfert des technologies.

La liste n'est pas exhaustive.

Toutes ces initiatives, quels que soient leurs auteurs et leur motivation, visent outre le renforcement du partenariat, des objectifs spécifiques.

L'approche écoregionale proposée, par le système CGIAR au début des années 90 vient compléter les initiatives précitées et se veut plus globalisantes.

La table ronde entre les Responsables des SNRA de l'Afrique Subsaharienne (ASS) et les Directeurs des CIRA, sur le renforcement des partenariats de recherche en ASS tenue à Nairobi en a posé les premiers jalons. La Réunion des Responsables des SNRA de l'ASS tenue à Cotonou en Septembre 1993 a donné le consensus sur la réaction positive de ces derniers qui ont même proposé un schéma d'organization de la coopération écorégionale.

Le programme EPHTA, élaboré à l'initiative de l'IITA pour les régions humides et sub-humides de l'Afrique répond à ce principe holistique plus au moins déjà admis.

Consensus sur quelques concepts clé

Pour la suite de l'analyse et pour s'assurer que nous avons la même compréhension du développement qui est fait dans cette étude, il parait important de revenir sur certains concepts clé et d'en préciser le contenu. L'objectif n'est certes pas d'imposer une certaine compréhension mais plutôt de présenter le cadre logique de discussion. A cet effet, deux concepts me paraissent particulièrement importants. Il s'agit de :

- Systèmes nationaux de recherche et de vulgarisation agricole
- Recherches ecorégionales

Recherches ecorégionales

En prenant les deux composantes de l'attribut écorégional, il parait évident qu'il s'agit de recherches pour résoudre les problèmes (Agricoles) d'une région donnée et que la région est confondue avec un espace écologique (plus au moins homogène).

L'objectif semble donc être d'orienter les investigations sur l'ensemble des préoccupations des paysans de l'écorégion en prenant en compte dans la mesure du possible :

- Les problèmes liés à la production agricole en terme de produits, de systèmes de production et des technologies post-récoltes,

- Les contraintes environnementales et socio-économiques qui limitent ou entravent la production et la productivité agricole,
- Les risques de dégradation des ressources naturelles liés aux pratiques agricoles.

La première conséquence d' une telle compréhension est que le principal acteur dans l' identification des problèmes est le petit paysan, qui occupe la plus grande partie de cet espace écoregional.

La deuxième conséquence est qu'il faut à tout prix réussir à dialoguer avec ce principal acteur c'est à dire utiliser les compétences (regroupées dans le SNRVA et autres) et les outils appropriés.

La troisième est que la grande diversité évidente des problèmes de cet espace impose une multidisciplinarité des scientifiques et autres acteurs qui pourraient intervenir.

En conclusion la recherche écoregionale non seulement doit porter une attention particulière sur l' environnement et les ressources naturelles mais elle doit se faire sur la base d'un intense dialogue entre toutes les parties prenantes.

Le SNRVA

La communauté des chercheurs est plus habituée à la notion de SNRA. Le V de la vulgarisation est certainement introduit à cause de la nécessité de dialoguer avec les producteurs, par l'intermédiaire des vulgarisateurs.

La notion de SNRA elle même a commencé à voir le jour il n'y a pas si longtemps (moins de 10 ans) et s'utilise avec un contenu varié. Mais si l'on s'en tient à la logique de l'ISNAR qui dans le contexte du CGIAR, a beaucoup travaillé sur ce concept, il faut distinguer le SNRA et les partenaires du SNRA.

De cette logique, l'ISNAR définit la composition du SNRA comme un ensemble d'institutions ou organismes s'occupant de la recherche au niveau national. Il s'agirait des institutions publiques ou privées de recherche et de recherche-développement, des universités et des ONG ayant pour mission la production et ou l'adaptation de technologies. Les partenaires étant les institutions de vulgarisation incluant les ONG de ce secteur, les Sociétés de développement publiques ou privées et les organizations paysannes.

Mais l'existence des composantes d'un système suffit- il pour parler de l'existence du système lui-même? Certes non.

A force de parler de SNRA étendu maintenant au SNRVA, on a l'impression qu'il s'agit d'une réalité évidente à tous les pays en développement et à l'Afrique en particulier.

Un système est supposé avoir des composantes mais qui ne sont pas isolées. Entre elles s'établissent des liens dont la nature dépend de la nature du système lui-même. Dans le cas du SNRVA, on ne saurait parler de système sans mécanismes d'interaction entre les composantes.

On peut affirmer dès lors que nulle part en Afrique, il n'existe encore un SNRVA en tant que tel. Dans le meilleur des cas, certains pays considérés parmi les plus avancés dans ce domaine tentent de bâtir leurs systèmes nationaux de Recherche Agricole. Parmi ces pays, nous pouvons citer le Kenya qui fait un gros effort dans ce sens.

Renforcement de la capacité des SNRVA à mener des activités de recherche écoregionales

En supposant que les SNRVA existent réellement et soient fonctionnels, il n'est pas acquis qu'ils soient aptes à réagir à l'approche écorégionale avec la même efficacité, non pas

seulement parce qu'il s'agit d'une nouvelle approche mais surtout parce que du fait de son caractère holistique, du fait de la multiplicité des partenaires, de la multidisciplinarité du partenariat et de grande différence entre les partenaires, il est extrêmement important d'accorder une attention particulière aux méthodes utilisées et aux outils de mise en oeuvre.

Un aperçu général sur les forces et faiblesses des SNRVA pourrait fournir des éléments utiles à ce renforcement.

Les forces et faiblesses des SNRVA

En tenant compte du thème de l' étude, les forces et faiblesses des SNRVA peuvent se situer à trois niveaux :

- Au niveau des institutions de recherches prises isolément
- Au niveau du SNRA c'est à dire de la capacité des composantes à utiliser de façon optimale les potentialités de l' ensemble du système.
- Au niveau du dialogue avec les partenaires notamment les vulgarisateurs et les organizations paysannes.

Au niveau des Institutions de recherche

D'après une étude de la FAO sur les SNRA de l'Afrique Occidentale et Centrale en 1993, les institutions de recherche disposent de deux atouts majeurs qui sont la disponibilité en potentiels scientifiques et l'attention accordée à la recherche agricole africaine par la communauté internationale (ISNAR 1997).

En effet cette partie de l'Afrique disposerait au moment de l'étude de plus de 4200 d'équivalents chercheurs à plein temps dont environ 85% seraient des nationaux. Alors qu'au début des années 60 la recherche en Afrique était essentiellement le fait des scientifiques du nord (voir Tableau 1).

Ces chiffres cachent cependant une très grande diversité d'un pays à l'autre. Ainsi parmi les pays côtiers de l'Afrique de l'ouest par exemple ; comme que le montre la Figure 1, le Nigeria dispose du potentiel le plus élevé avec 1200 équivalents chercheurs à plein temps, et de la proportion de chercheurs nationaux la plus élevée (98%) si l'on fait exception de la Sierra Leone où il n'y avait pas un seul expatrie au moment de l'étude. Si l'on compare la Côte d'Ivoire et le Ghana qui ont un potentiel identique, la proportion d'expatriés est plus élevée en Côte d'Ivoire. Cette comparaison reflète assez bien la différence entre les pays anglophones et les pays francophones de cette sous région.

Ce potentiel a dû augmenter au cours de ces cinq dernières années, l'effort pour la formation étant partout soutenu avec un accent de plus en plus fort sur les sciences sociales

Tableau 1. Potentiel ressources humaines en Afrique occidentale et centrale exprimé en équivalent chercheur à plein temps (E.C.) par J. Casas et al. 1993.

	Nombre d'équivalents chercheurs			
Régions	Nationaux	Etrangers	Total	Proposition de nationaux (%)
Sahel	780	235	1015	77
Afrique Occ. Humide	2092	216	2308	91
Afrique Centrale	761	177	938	81
Total	3633	628	4261	85

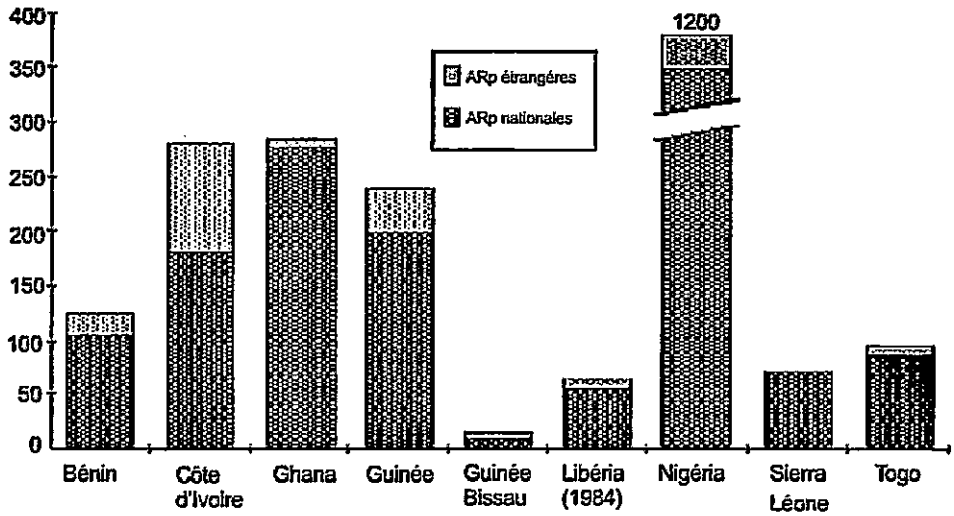

Figure 1. Les SNRA d'Afrique Occidentale Humide (1989/91); équivalents chercheurs (J Casas et al. 1993).

et économiques qui permettent d'avoir une meilleure connaissance de l'environnement du producteur et d'être mieux outiller pour le dialogue avec lui.

A ces atouts on peut ajouter l'effort de restructuration entrepris à partir de la fin des années 80 et renforcé depuis l'élaboration et la diffusion des cadres d'action du SPAAR dont l'une des recommandations porte sur la planification stratégique.

Ces plans directeurs permettent de définir les priorités. Ils proposent un cadre institutionnel plus favorable aux activités de recherche et de Recherche-Développement et donnent également une base formelle pour les actions de renforcement des capacités institutionnelles.

Par contre la plus grosse faiblesse des institutions de recherche de l'Afrique de l'Ouest et du Centre est de toute évidente la faiblesse des investissements et leur diminution progressive. Ce qui explique la triste conclusion de l'étude de la FAO sur la sous utilisation des équipes de recherche avec des taux d'occupation allant de 43% pour la zone humide à 55% pour le Sahel qui bénéficie de montants d'aide extérieure plus élevés.

L'effort d'investissement dans la recherche agricole selon la FAO (Tableau 2) s'élevait au début des années 90 à 221 millions de dollars US pour toute la sous région et représentait 0,58% du PIBA. Ramené au PIB, on se trouverait entre 0,20 et 0,25%. Ce qui reste relativement faible.

Tableau 2. Effort d'investissement dans la recherche agricole en Afrique occidentale et centrale (J Cass et al. 1993).

	Dépenses pour la R.A. (million de US$)					
Régions	Budget national	Prêts	Subv. extérieures	Total	Total pondéré	% Sur PIBA
Sahel	16,9	11,6	41,6	70,1	44,0	0,90
Afri. Occ. humide	52,7	10,1	29,5	92,3	71,4	0,45
Afrique Centrale	30,0	10,0	19,1	59,1	44,3	0,62
Total	99,6	31,7	90,2	221,5	159,7	0,58

Il est évident que la situation diffère d'une zone à l'autre et d'un pays à l'autre comme l'indique la Figure 2. Cette faiblesse du financement est confirmée par une étude plus récente de l'IFPRI qui montre que les ressources par tête de chercheur sont en baisse constante en Afrique. Une autre faiblesse (et pas des moindres) se trouve au niveau de la déperdition des ressources humaines, malgré l'effort indéniable fait au cours des 20 dernières années :

- Le déficit de chercheurs en sciences humaines et de l'environnement reste encore très grand.
- En raison du problème de faible investissement et surtout de manque de motivation pour les chercheurs, les plus qualifiés d'entre eux sont absorbés par le système international (c'est le cas typique du Nigéria, du Zaïre et de la Siérra Leone).

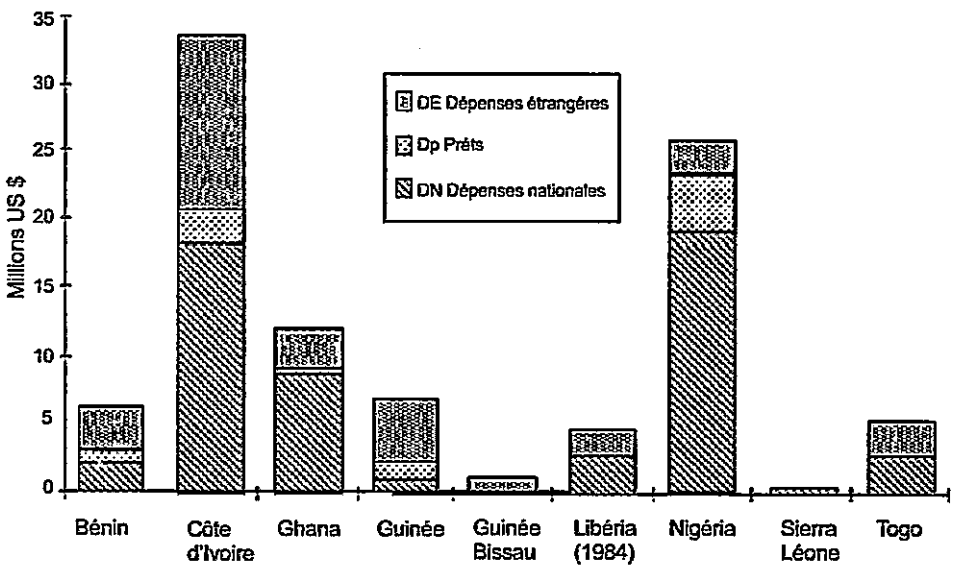

Figure 2. Les SNRA d'Afrique Occidentale Humide (1989/91). Les dépenses totales brutes de RA et leur répartition par pays (J Casas et al. 1993).

Au niveau des relations à l'intérieur des SNRA

S'agissant de la capacité des composantes du SNRA à utiliser de façon optimale les potentialités de l'ensemble du système, une étude de l'ISNAR sur le rôle des universités dans les SNRA en ASS faite dans six pays (Bénin, Burkina Faso, Côte d'Ivoire, Nigéria, Ouganda, et Zimbabwe) à révèle clairement que dans la plupart des pays, les principales composantes du SNRA restent les institutions publiques de recherche et les universités ; et que nulle part il n'existe une forte synergie entre elles. La situation est évidemment très variées d'un pays à l'autre.

Si dans les pays anglophones on peut parler d'une certaine intégration (exemple de l'Université Ahmadu Bello qui abrite non seulement une faculté d'agronomie, mais 3 des 18 instituts de recherche agricole du Nigeria—IAR, NAPRI, et NAERLS), dans les pays francophones les liens sont plutôt lâches. Mais dans certains cas comme au Bénin et au Burkina-Faso il existe des mécanismes formels d'interaction, mais peu fonctionnels.

Au niveau des relations avec les partenaires (vulgarisateurs et producteurs)

S'agissant du dialogue avec les partenaires, Il faut reconnaître que beaucoup d'efforts sont faits. Avec les sociétés de développement, la recherche a eu des relations privilégiées pour les développement des filières de rente en Afrique. Les plus connues en période coloniale, (Unilever dans les pays anglophones sur les cultures pérennes comme le palmier à huile et l'hévéa, en zone forestière, la CFDT dans les pays francophones sur le coton en zone de savane), ont permis de développer des recherches d'accompagnement très utiles à une fructueuse interaction recherche–développement. Cette tradition s'est maintenue et renforcée avec les nouvelles sociétés créés depuis les années 60. Les actions de la CMDT au Mali, la CIDT en Côte d' Ivoire, et la SONAPRA au Bénin ont un impact considérable sur la culture du coton qui a connu une croissance soutenue ces 10 dernières années. Il en est de même de la SODEPALM et de la CDC respectivement en Côte d'Ivoire et au Cameroun sur le palmier à huile.

Par contre dans le domaine des cultures vivrières il a fallu attendre les théories de « recherches systèmes » (farming system), « recherches appliquées en milieu réel ».pour intensifier le dialogue avec les vulgarisateurs et les petits paysans (Alston et al. 1998 ; SNRA 1997).

L'évolution dans ces domaines, n'a pas encore permis d'atteindre l'efficacité attendue de tous les SNRVA de la sous région. Mais il y a des indications visibles pour y parvenir grâce à l' appui et l'incitation de la communauté internationale très préoccupée par la question de la pauvreté, de l'insécurité alimentaire et de la dégradation des ressources naturelles. Ainsi, il est aisé de constater que des pays comme le Mali et le Bénin ont développé en collaboration avec le KIT au Pays-Bas des approches de transfert de technologies qui commencent à faire école. A titre d'exemple au Bénin, l'équipe de Recherche–Développement de l'INRAB, dans le cadre de son programme de gestion de terroir, a développé sur la base de la méthode MARP, une approche dite « Approche participative au niveau villageois (APNV) » dont l'application par la structure de vulgarisation dans la région nord du pays connaît aujourd'hui un engouement inespéré de la part des collectivités villageoises.

La Banque Mondiale sert déjà de facilitateur pour sa diffusion dans toute l'Afrique. Des formations ont eu lieu en Ouganda sous l'encadrement conjoint de KIT et de l'INRAB. Un atelier régional vient d' être organisé au Bénin par la Banque Mondiale sur ce thème.

Sur le plan institutionnel on peut constater également que les réformes engagées dans

certaines institutions de recherche agricole de la sous région traduisent bien la volonté d'instaurer ou de renforcer le dialogue avec les partenaires et les producteurs en particulier.

La plupart de ces institutions de recherche tentent de se soustraire progressivement de l'emprise administrative en adopter des statuts qui leur donnent une certaine autonomie de gestion. De tels statuts, permettent la souplesse nécessaire pour réagir rapidement aux sollicitations des utilisateurs.

La configuration du leur conseil d'administration ouvre la porte aux vulgarisateurs et aux organizations de producteurs . Les cas les plus frappants sont ceux du Togo et de la Côte d' Ivoire où la recherche agricole vient de prendre un statut de société d'économie mixte.

En ce qui concerne la Côte d'Ivoire, l'Etat a une participation minoritaire et les producteurs peuvent jouer leur rôle de client de la recherche en influençant les décisions du conseil d'administration. Un tel statut dans la mesure où on peut veiller à faire une place aux petits producteurs (à revenu faible), pourrait s'avérer extrêmement efficace pour le dialogue avec les partenaires.

Les actions de renforcement des SNRVA à mener les activités de recherche écoregionales

Il apparaît clair, au vu des forces et faiblesses recensées ci-dessus, que nous ne sommes pas sur un terrain vierge et que les actions à envisager doivent contribuer à renforcer les acquis, combler les Lacunes et explorer de nouveaux outils liés à la nature des recherches écorégionales.

Au plan institutionnel

Bien que régionales, les recherches faites dans le cadre du programme EPHTA se mènent au niveau des zones de référence et des sites pilotes identifiés dans les pays pour le compte de l'écorégion. Il est donc important de mettre un accent particulier sur les institutions nationales concernées et regroupées dans le SNRVA.

Réformes en cours dans les pays de la sous région

Citées comme force des institutions, ces reformes doivent se poursuivre en tenant compte du nécessaire dialogue avec les institutions de vulgarisation (y compris les ONG) et les organizations paysannes.

La détermination des priorités nationales en tenant compte de la gestion des terroirs est une condition favorable à l'identification des activités de recherche écorégionale.

Le cadre institutionnel approprié au dialogue inter-institutionnel est également une condition favorable. Il n'est certainement pas question d'imposer un modèle à adopter, mais l'important est que le cadre institutionnel permette d'avoir une marge de manoeuvre suffisante pour ne pas être bloqué ou retardé par l'administration centrale des ministères. Dans un tel cadre, les chercheurs doivent bénéficier de mesurés propices à éviter la fuite des cerveaux.

Les reformes devront également mettre un accent sur les mécanismes de financement durable. Ce type de recherche qui a pour principal client les collectivités villageoises constituées en grande partie de petits paysans, entre une grande partie dans le domaine public. L'effort des états et de la communauté internationale est absolument indispensable.

A cette effet, pourquoi l'IITA ne pourrait-il pas accorder à EPHTA une plus grande priorité et le mettre dans son budget principal au lieu d'attendre un financement additionnel qui retarde son exécution ?

Une attention devra être également accordée à la restructuration des institutions publiques de vulgarisation (comme c'est le cas des INRA) afin de les rendre plus aptes à participer aux nouvelles initiatives. Il en est de même de la promotion des ONG à participer au transfert de technologies.

Par ailleurs, les paysans organisés pourraient avoir une capacité d'interaction beaucoup plus élevée que pris isolément. Donc une incitation à la promotion des organizations paysannes fait partie des actions de renforcement des SNRVA.

Fonctionnalité des SNRVA

Le défi aujourd'hui pour l'efficience de la recherche, est de pouvoir passer des INRA aux SNRA en vue d'optimaliser le potentiel existant. En y ajoutant d'autres composantes (la vulgarisation) pour arriver aux SNRVA, le défi est encore plus grand. Cependant des cas de succès même embryonnaires doivent servir de point de départ pour consolider les SNRVA.

L'organization des ateliers nationaux entre les différentes composantes sur la problématique écorégionale parait être une des premières actions à mener.

Le groupe de travail sur le renforcement des capacités devra se saisir des recommandations issues de l'étude ISNAR sur le Renforcement du Rôle des universités dans les SNRA, s'en inspirer pour proposer des mécanismes d'interaction non seulement au sein des SNRA mais aussi avec les clients de la recherche que sont les vulgarisateurs et les producteurs.

Par ailleurs, l'échange d'expériences acquises sur le terrain étant un important élément de renforcement de ses propres capacités, il convient de promouvoir des échanges à l'intérieur de l'écorégion soit dans un mécanisme formel soit de façon ad'hoc l'un n'excluant pas l'autre.

Il faut également promouvoir la mobilité des chercheurs au sein d'un même consortium en créant des conditions favorables d'accès aux zones de référence et aux sites pilotes.

Au plan méthodologique

La capacité technique des SNRVA à mener les activités de recherches écorégionales résulte d'une part de leur maîtrise de l'approche participative permettant une bonne identification des contraintes, une participation effective des paysans à la recherche par la prise en compte et le développement des connaissances endogènes et d'autre part de leur maîtrise des outils spécifiques à une meilleure connaissance du milieu et aux thèmes de recherche à développer.

Avant toute chose il convient de mettre l'accent sur la poursuite de l'effort de formation au niveau des SNRVA pour combler le déficit dans les disciplines de sciences humaines et de l'environnement.

En ce qui concerne l'approche participative, les actions à mener peuvent être La capitalisation des expériences réussies en cours non seulement en Afrique mais aussi dans les autres régions du monde en développement.

L'adaptation de ces approches aux réalités de notre écorégion. Ceci ne signifie pas forcément une uniformisation des approches. L'adaptation pourrait être propre à chaque consortium ou même à chaque pays hôte des zones de référence et des sites pilotes.

L'adoption et la mise en oeuvre de ces approches ne pourraient se faire que si les chercheurs et autres acteurs de SNRVA maîtrisent la connaissance sur les méthodes de caractérisation du milieu, de diagnostic des contraintes, de communication en fonction des cible. Il importe donc d'établir et d'exécuter un programme de formation sur les connaissances de base.

En ce qui concerne les outils spécifiques aux thèmes de recherche, Il s'agit également d'exécuter un programme de formation établi périodiquement en fonction des thèmes retenus.

Rôle et responsabilité des différents acteurs dans les actions de renforcement des SNRVA

Les actions proposées sont de divers ordres et ne peuvent être réalisées dans le cadre exclusif du programme EPHTA. Aussi est-il important que tous les acteurs concernés puissent intervenir en fonction de leur domaine de compétence. Il s'agit notamment des décideurs politiques des pays de la sous-région, des structures responsables de la coordination interne des SNRVA, de la CORAF et bien entendu du programme EPHTA.

Les décideurs politiques

Il leur revient conformément à leurs priorités nationales d'initier et de poursuivre les réformes nécessaires, pour une plus grande efficacité des institutions publiques sous leur tutelle, et d'impulser celles des organizations paysannes et des ONG. La CORAF et le programme EPHTA peuvent à ce niveau jouer un rôle catalytique de sensibilisation.

Les gouvernements ont également un rôle à jouer dans la priorité à accorder à la formation en sciences sociales, économiques, et environnementales. Mais il appartient aux SNRVA d'en faire la planification et la proposition aux décideurs.

Ils peuvent également créer les conditions favorables à une plus grande synergie au sien des SNRVA en assouplissant les contraintes administratives et en acceptant de conférer aux institutions un statut plus favorable au dialogue entre les différentes composantes de SNRVA.

La CORAF

En tant qu'organization de coordination de la recherche au niveau de la sous région, certaines des actions identifiées, rentrent parfaitement dans le cadre de ses attributions. Il s'agit en particulier de (INRAB/ISNAR 1994) :

- Les échanges d'expériences entre SNRVA dans le cadre de la mise en oeuvre de la nouvelle approche dans sa globalité
- La capitalisation, l'adaptation, et la rediffusion des expériences réussies d'approche participative de par le monde et particulièrement en Afrique
- La mobilité des chercheurs à l'intérieur des consortia ou de l'écorégion. A cet effet la CORAF peut être d'une grande utilité en établissant et en mettant à la disposition du programme EPHTA et des SNRVA, des bases de données relatives à l'expertise existante
- La synergie entre les composantes des SNRVA. Cette activité fait partie des priorités actuelles de la CORAF car d'après les nouveaux statuts adoptés en mars 1996, la qualité de membre de la CORAF n'est plus conférée aux seules institutions nationales de recherche mais plutôt aux SNRA. Malheureusement, cette volonté affichée

de promouvoir la coopération au niveau national, ne s'est pas encore traduite en changement réel sur le terrain. La CORAF doit y travailler.

Le programme EPHTA et les SNRVA

Le programme EPHTA et les SNRVA ont le plus important rôle à jouer. Le groupe de travail sur le renforcement de la capacité des SNRVA à mener les activités écorégionales en étroite collaboration avec le coordonnateur EPHTA, les autres groupes thématiques, et les SNRVA devront établir un plan d'action pour la mise en oeuvre des actions envisagées, en commençant par les programs de formation. En ce qui concerne la synergie, la mobilité de chercheurs, les échanges expériences, et la capitalisation des cas de succès en matière d'approche participative, le coordonnateur travaillera en étroite collaboration avec la CORAF et les SNRVA.

Rôle des différents intervenant dans les actions de renforcement de SNRVA.

	Décideur	CORAF	EPHTA	SNRVA
• Mesures Institutionnelles				
Reformes INRA	x	-	-	x
Reformes Vulgarisation	x		-	x
Reformes Org. Paysannes	x		-	-
Synergie SNRVA	-	x	x	x
Echange d'expériences (y compris mobilité chercheurs)		x	x	x
• Plan méthodologique				
Capitalisation Succès				
Approche Participative		x	x	x
Formation en Science Sociale, Economique, Environnement	x		-	x
Formation aux outils spécifiques (diagnostic, communication, SIG...)			x	x
• Planification mise en oeuvre			x	-

X = Rôle actif de premier ordre – = Rôle catalytique

Conclusion et recommandations

Le renforcement de la capacité des SNRVA à mener des activités de recherche écorégionales nécessite des actions de divers ordres. Ce sont surtout des mesures institutionnelles qui appellent un dialogue constant avec les décideurs politiques et des actions de développement des ressources humaines.

La mise en oeuvre et le succès de ces actions dépendent fortement de l'importance accordée à l'approche écorégionale et au programme EPHTA en particulier. L'engouement né autour de l'approche écorégionale au début des années 90 n'a pas été suivi d'un soutien conséquent ni de la part du CGRAI ni de la part des SNRA ni de la part des organizations sous régionales qui sont tous concernés.

Le présent atelier me parait se situer à un moment stratégique des réflexions pour l'élaboration d'un plan stratégique au niveau de la région de l'Afrique de l'Ouest et du Centre par la CORAF. Il serait absurde que les priorités régionales de coopération en

recherche issues de ce plan stratégique ne comportent pas les préoccupations actuelles exprimées dans le programme EPHTA.

Le renforcement des capacités des SNRA étant l'une des raisons d'être de la CORAF, une action intégrée de l'IITA et de la CORAF est plus qu'indispensable en cette période-ci.

Au delà de la question du renforcement de SNRVA, se pose celle de la coopération au sein de l'écorégion qui en principe, devrait contribuer également à ce renforcement.

Le mode d'opérationnalisation du programme EPHTA (à travers les zones de références et les sites pilotes), et qui ne prend pas en compte tous les SNRVA au même niveau, permet-il d'assurer une coopération efficace et un renforcement équitable ?

Si ce mode devrait être maintenu il conviendrait peut-être de réétudier la forme de partage des technologies acquises dans les zones de référence.

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Annexe 1

Sigles

ADPH	Association africaine pour le développement du palmier à huile
AFNETA	Réseau africain de cultures en couloir
ASS	Afrique au sud du Sahara
CDC	Compagnie de développement du Cameroun
CFDT	Compagnie française de développement des textiles
CGIAR	Groupe consultatif pour la recherche agricole nternationale
CIDT	Compagnie Ivoirienne de développement des textiles
CMDT	Compagnie malienne de développement des textiles
CORAF	Conférence des responsables de recherche agronomique de l'Afrique de l'Ouest et du Centre
EPHTA	Programme écorégional pour les tropiques humide et subhumide de l'Afrique subsaharienne
ESCaPP	Projet de protection écologiquement durable du manioc
EU/RAMR	Projet union européenne de recherche appliquée en milieu réel
IAR	Institut de recherche agricole
IITA	Institut International d'agriculture tropicale
INRA	Institution nationale de recherche agricole
INRAB	Institut national des recherches agricoles du Bénin
ISNAR	Service international pour la recherche agricole nationale
MARP	Mécanisme accéléré de recherche participative
NAERLS	Service national pour la liaison recherche et vulgarisation.
NAPRI	Institut national pour la production animale
PEDUNE	Protection écologiquement durable du niébé
RENACO	Réseau de recherche sur le niébé pour l'Afrique Centrale et Occidentale
SNRA	Système national de recherche agricole
SNRVA	Système national de recherche et de vulgarisation agricole
SODEPALM	Société de développement du palmier à huile
SONAPRA	Société nationale de promotion agricole
USAID	United States Agency for International Development
WECAMAN	Réseau maïs de l'Afrique de l'Ouest et du Centre

Role de la transformation des produits et des systèmes post-récolte ameliorés dans le développement des systèmes de production

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Abstract
The importance of local farmers involved in food production has always been recognized in Africa. Early efforts tried to improve production capabilities to ensure food self-sufficiency and national food security although not many countries that tried to enhance food production succeeded. Even those who did faced a major problem of spoilage, which was up to 50% in some countries. Several improved technologies were introduced or encouraged by the FAO to ensure that wastage was reduced. Product transformation and improved postharvest systems were introduced. This paper describes the various efforts over the years and the results obtained. It finally looks at the potentials of EPHTA to further help positive advancements in the ecoregions.

Introduction

Depuis les années 80 les pays africains se sont fixés pour objectif l'auto-suffisance alimentaire et par la suite la sécurité alimentaire en vue de réduire la pauvreté. Les effort ont été alors faits pour que l'Afrique accomplisse aussi sa révolution verte. Mais les résultats n'ont pas été en général à la hauteur des objectifs. Certes des technologies nouvelles ont été mises au point et vulgarisées. Certaines cultures ont connu une augmentation de leur production. Mais les producteurs doivent faire face aux contraintes des pertes après récoltes allant parfois jusqu'à 50 % de la production. Et finalement, les gain de productivité au niveau des systèmes de production se trouvent en partie absorbés par une mauvaise gestion du système post-récolte.

Au lieu de concenterr tous les efforts à augmenter la productivité des systèmes de cultures, la FAO va envisager aussi, l'approche de l'accroissement de la production par une bonne gestion du système post-récolte. L'idée est que le problème de la crise alimentaire en Afrique ne vient pas seulement de la faible performance des systèmes de production, mais également des pertes après récolte. S'il est exact que les nouvelles technologies n'ont pas adoptées comme on pouvait s'y attendre, il n'est pas moins vrai que les producteurs subissent des pertes depuis les récoltes jusqu'à la commercialisation.

Dans la perspective qu'une bonne gestion du post-récolte permettra de réduire les pertes, la FAO incite les institutions nationales de recherche à s'investir également dans l'amélioration du système post-récolte. Un meilleur système post-récolte ne va certes pas provoquer une augmentation de la production brute mais il permettra de rendre plus disponible la plus grande partie ou la quasi-totalité de la production. Depuis lors, les programs de recherche post-récolte ont été créés dans différents pays, des réseaux, des colloques se tiennent pour faciliter la diffusion des résultats. En terme de valeur ajoutée

au produit, 70 à 85 % vont aux activités post-récoltes et les producteurs perçoivent seulement 15 à 30 % (Golti and Wolff 1998).

Plusieurs technologies améliorées ont été développées. Elles ne sont certes pas toutes vulgarisées ? Quel est l'impact de celles qui ont été vulgarisées sur les systèmes de production agricoles ? Quels sont les facteurs qui limitent leur impact sur les systèmes de production ? Quelles actions EPHTA peut entreprendre dans le court, le moyen et le long terme pour lever ces contraintes et accélérer le développement durable dans les zones agro-écologiques.

Le reste du document est divisé en quatre sections. La première donne une description théorique du système post-récolte. La deuxième session présente une brève analyse du processus de développement du système de production. La troisième session fait une revue des résultats de différents travaux sur le rôle des technologies améliorées des activités post-récoltes dans le développement des systèmes de production.

La quatrième session présente des conclusions et recommandations en terme de recherche.

Analyse descriptive du système post-récolte

Le système post-récolte peut être défini comme l'ensemble des opérations portant sur les produits récoltés depuis le champ jusqu'à son transfert au consommateur. Les différents éléments présentés d'un système post-récolte sont présentés à la Figure 1. Les opérations post-récoltes peuvent être regroupées en trois groupes : les opérations liées aux producteurs, les opérations liées au marché (assemblage, transformation, et distribution) et les opérations liées au consommateur.

Opérations liées aux paysans

Elles comprennent les activités de séchage pour les céréales et les légumineuses, les activités de battage et vannage, de déspathage, de décorticage et de stockage paysan au champ ou au village. Ces activités, si elles sont effectuées aux moyens de technologie non adaptée, deviennent des sources d'importantes pertes de la production récoltée.

Le séchage en milieu paysan

L'objectif du séchage est de réduire l'humidité des grains de manière à favoriser leur conservation et leur transformation. Avant de pouvoir conserver les produits, les producteurs doivent les sécher. Les produits qui demandent un tel traitement sont généralement les céréales et les légumineuses. Les tubercules et les racines sont également soumis à cette opération lorsqu'ils doivent faire objet de transformation en farine ou en cossettes. Un séchage bien fait permet d'éviter les pourritures, la contamination par les mycotoxines lors du stockage du maïs arachide et haricot, les brisures lors du décorticage pour le riz paddy etc.

Le battage, le vannage et le déspathage en milieu paysan

Le battage/vannage des céréales telles le riz, le maïs, le mil, et le sorgho est une activité exercée par les producteurs avant la mise sur le marché des produits. Ces opérations constituent également une occasion de perte importante de la production lorsque les techniques utilisées ne sont pas efficaces.

Le stockage en milieu paysan

Son objectif est de différer l'offre du produit dans le temps afin de répondre à une demande ultérieure. L'activité de stockage est exercée par la majorité des producteurs qui détiennent souvent la plus grande partie des produits (Lutz 1994). Ce faisant, ils peuvent bénéficier de prix meilleurs mais aussi assurer la consommation à un moment où on a déjà tout récolté du champ. A ce niveau, lorsque le système de stockage est défaillant, il va en résulter une perte de produits qui se traduira par une réduction de revenu pour les producteurs. Or une baisse de revenu d'une culture par rapport aux autres cultures constitue un facteur désincitateur ou décourageant sa production. Ainsi un mauvais stockage peut bien constituer un frein au développement d'un système de production. De la même manière, une système efficace de stockage constitue un facteur incitateur pour la production, s'il permet de réduire ou d'éliminer les pertes au cours du stockage.

Les opérations liées au marché : commercialisation et exportation

La commercialisation assume une fonction essentielle celle de l'échange. Ce faisant, elle constitue une importante source d'incitation de la demande des produits. Plusieurs auteurs ont montré que l'exportation des produits peut accélérer la croissance économique du pays exportateur. En effet, les secteurs exportateurs, face à la compétition internationale, sont incités à investir davantage et à améliorer la qualité de leur produit afin de pouvoir conquérir des parts de plus en plus importantes du marché mondial. Il va en résulter des gains de productivité résultant des économies d'échelle et des économies externes pour les secteurs non exportateurs du pays.

L'emballage

L'emballage représente pour les produits agricoles en général et pour les produits transformés en particulier un facteur préalable à la réalisation efficiente des activités de transport et de stockage. Il consiste à choisir les produits adaptés à la clientèle et à la transformation des lots de production en lots de vente.

Le transport et la manutention

Une fois que les produits sont conditionnés ou emballés, il faut les transporter depuis les zones de production jusque dans les zones de consommation. Le transport permet de faire l'arbitrage spécial entre régions déficitaires et régions excédentaires. Deux éléments peuvent constituer des freins au transport des produits : le mode/les moyens de transports et les voies de communications. Si la zone de production ne dispose pas de voies de communication, il est évident que les producteurs ne pourront pas écouler leur produit sur les marchés. Il en est de même pour les moyens de transport. D'où la nécessité pour les décideurs d'accorder une importance au développement des voies de communications.

Le stockage

Outre les paysans producteurs, le stockage est aussi assuré par les commerçants grossistes ou semi-grossistes dont l'objectif est de faire l'arbitrage dans le temps. Il s'agit d' un entreposage dans des magasins ou assimilés en vue d'ajuster les quantités demandées et les quantités offertes à toutes les étapes du circuit de commercialisation. Cette activité n'est rentable que lorsque les pertes sont minimisées. Ce qui nécessite des techniques de stockage adaptées et à faible coût.

La transformation permet la diversification de l'utilisation du produit et crée une valeur ajoutée au produit brut. En créant de la valeur ajoutée, la transformation contribue à la création de la richesse nationale. C'est une étape indispensable pour les produits qui ne peuvent parvenir au consommateur sans une transformation préalable (par exemple, le riz paddy). Elle permet également l'élargissement de la gamme de produits transformés par le biais du développement de nouveaux produits. Citons en exemple les cas du manioc qui est transformé en plus de cinq produits (le gari, le tapioca, l'emploi d'amidon, le foufou, et autres) et du maïs est transformé par exemple en plus de 18 produits au Bénin. La création de nouveaux produits permet d'augmenter le nombre total de consommateurs et donc la demande du produit. L'augmentation de la demande va entraîner l'augmentation du prix du produit de base et inciter par conséquent la production qui à son tour va stimuler le développement du système de production. Toutefois l'opération de transformation peut constituer une importante source de perte de produits. Pour éviter de telle perte, il faut des technologies appropriées.

Les opérations d'emballage, de stockage, de transport/manutention et de transformation contribuent à mettre à la disposition du consommateur un bon produit. Mais le produit ne pourra conquérir des marchés que s'il y a, en plus de ces opérations, un prix adéquat et une communication efficace en d'autres termes, un système adéquat de marketing mix.

Beaucoup de nouveaux produits transformés développés dans la zone d'intervention de EPTHA l'ont généralement été sans tenir compte d'un système de marketing mix.

Le marketing-mix

Il s'agit de la composition commerciale axée sur quatre variables contrôlables par l'entreprise en vue de mettre au point toute stratégie de marketing : le produit, le prix, la distribution, et la communication. On parle de composition commerciale parce que le succès dans la mise en marché dépend d'un dosage judicieux voire optimal de ces quatre éléments. Par exemple, un mauvais produit, même à bon prix avec un bon réseau de distribution et une bonne promotion ne connaîtra pas le succès commercial espéré.

Caractéristiques d'un produit

On peut définir les caractéristiques d'un produits à trois niveaux :

- la *qualité* perçue ou attendues par le consommateur : poids, performances, composition, esthétique, facilité d'emploi par exemple
- le *contenu symbolique* : prestige, liberté, simplicité, robustesse, à la mode, puissance, par exemple
- *le service rendu par le produit* : gain de temps, distraction

Lorsque les caractéristiques d'un produit correspondent aux attentes des consommateurs du segment de marché choisi, on dit qu'il est bon parce qu'il se vend avec profit pour le vendeur et l'acheteur.

Les opérations liées au consommateur

Dans le système marketing, le consommateur est l'élément-clé du marché. Pour cette raison, c'est par rapport à son comportement d'abord et par rapport au produit ensuite que l'entreprise définit sa politique de marketing.

Le consommateur est le demandeur du produit sous forme brute ou transformée. Il fait généralement la transformation secondaire mais parfois la transformation primaire.

Le produit doit répondre à ses goûts et préférences. Par ailleurs, le succès de nouveaux produits dépend de l'implication du consommateur dans le processus de développement dès le début.

La description du système post-récolte nous a permis de faire ressortir de manière sommaire les liens qui existent entre les activités post-récoltes et l'incitation de la production agricole par le prix. Mais comment le système post-récolte peut-il décourager ou stimuler le développement des systèmes de production agricoles ? Pour répondre à cette question nous allons analyser le lien entre le système post-récolte et le développement des systèmes de production agricole. Cette analyse nous permettra de comprendre comment les activités de recherche au niveau des différents éléments du système post-récolte contribue à l'augmentation de la production agricole.

Processus de développement des systèmes de production et systèmes post-récolte

Quel rôle la transformation et les opérations après récolte peuvent jouer dans le développement des systèmes de production ? Pour répondre à cette question, nous allons d'abord analyser les liens qui pourraient exister entre la transformation des produits et le développement des systèmes de production avant de définir le concept de développement des systèmes de production.

Processus de développement des systèmes de production agricoles

D'après Norman et al. (1995), le développement des systèmes de production résulte d'une série d'actions entre différents acteurs (chercheur, paysans, vulgarisateur, etc.) qui caractérisent l'approche "Farming System" de développement agricole. Cette approche compte quatre phases par lesquelles passe un système de production pour subir une modification ou un développement.

La première est celle de l'émergence des problèmes ou contraintes qui bloquent le système de production actuel. L'objectif de la "Recherche et Développement" est de faire un diagnostic qui va conduire à l'identification des problèmes. Durant cette phase, des données secondaires et primaires (par enquêtes exploratoires) sont collectées et utilisées pour décrire les caractéristiques du système, élaborer le plan de développement de l'exploitation, analyser l'impact microéconomique des politiques macroéconomiques du gouvernement.

Par ailleurs les initiatives d'actions visant le changement du système de production peuvent provenir soit des groupes cibles soit des systèmes et politiques de soutien[1]. Ainsi, par exemple, une amélioration de la technologie de transformation des racines de manioc va emmener les producteurs à adopter les variétés à haut rendement.

La deuxième est celle d'identification ou d'élaboration de technologie nouvelle pouvant permettre de résoudre les problèmes ou contraintes identifiées lors de la phase "diagnostic".

Les technology peuvent provenir de trois sources: paysans, les recherches en station et si nécessaire des parcelles de démonstration des chercheurs.

La troisième est celle du test où les paysans vont vérifier les meilleures technologies sélectionnées à la deuxième phase. Le test permettra de choisir les technologies les plus appropriées à chaque environnement et les systèmes et ou politique de soutien à la tech-

nologie, à l'adoption et à la production en quantité suffisante sans compromettre l'avenir ou dégrader l'environnement.

La dernière phase est celle de la dissémination de la technologie adoptée. La recherche à ce niveau veut savoir quel est le niveau d'adoption, l'impact de la technologie ? et quels sont les changements apportés au système de production qui a internalisé la nouvelle technologie.

Le système de production qui résulte des actions précédentes est amélioré par rapport au système dont on a fait le diagnostic à la phase 1. Le système amélioré sera à son tour soumis à des changements provenant soit du système de soutien, soit des activités de recherche des chercheurs ou des paysans.

Lien entre système de production et système post récolte

Après avoir défini le mécanisme de développement d'un système de production, nous avons cherché à identifier à quel niveau la transformation et les autres opérations post-récoltes peuvent influer sur les systèmes de production. Si nous nous référons à la définition précédente du système post-récolte, il doit être considéré comme étant un élément du système et /ou de politique de soutien au développement du système de production agricole.

Et là, on peut distinguer deux cas de figures exclusives : le cas où le système post-récolte influe directement sur le système de production et le cas où l'influence est indirecte.

Cas de l'effet direct

Dans ce cas le bénéfice va directement aux producteurs individuels ou organisés en groupe. Une amélioration technologique dans le système post-récolte va provoquer un accroissement du profit du producteur ; ce qui peut l'inciter à investir davantage dans le secteur concerné. Dans cette catégorie, on retrouve :

- les innovations concernant les technologies pour le séchage, le battage des grains sur la ferme, les techniques de stockage et les infrastructures routières ;
- et les politiques d'accès au crédit.

Cas de l'effet indirect

Dans ce cas, l'influence du système post - récolte ne va pas directement à l'agriculteur mais à d'autres agents tels que les transformateurs, les commerçants qui le reflètent consciemment ou inconsciemment sur le producteur. En effet, une innovation dans la technique de transformation d'un produit (pour l'exportation ou pour la consommation intérieure) peut avoir pour effet d'augmenter la demande du produit. Aussi par la création de nouveau produit, la transformation permet d'élargir la base des consommateurs, donc augmenter la demande. Par conséquent il en résultera une augmentation du prix qui va inciter les producteurs à produire davantage et donc à choisir un système plus efficace. De même une amélioration de l'infrastructure routière, en facilitant le transport et l'écoulement du produit vers les zones déficitaires, peut constituer une incitation positive à produire.

Par ailleurs pour que le système de transformation puisse soutenir durablement le système de production, il faudrait que ce dernier parvienne à répondre positivement à la demande des transformateurs. En effet, si le système de production évolue de manière à ne pas pouvoir approvisionner régulièrement les usines de transformation alors ces derniers finiront par fermer leur entreprise par suite de rupture de stock ou de pénurie de matière première.

Aussi la recherche de produit de meilleure qualité (riches en nutriments ou contenant moins ou pas d'éléments anti-nutritionnels) par les consommateurs et par les transformateurs peut -elle amener les producteurs à adopter de nouvelles variétés de produits agricoles.

La transformation et le stockage ne sont pas les seuls éléments du système de soutien, il y a également les politiques du changement et les autres éléments du circuit de commercialisation à savoir : (le transport, l'emballage).

Enfin, une amélioration technologique post-récolte peut conduire à une augmentation de la rentabilité du système de production, mais en même temps modifier l'allocation des ressources en défaveur des femmes ou des hommes selon sa spécificité. Pour éviter que la promotion de nouvelle technologie ne contribue à agrandir le fossé entre l'homme et la femme, les développeurs doivent tenir compte des conséquences sociales liées à chaque technologie.

L'impact des systèmes post-récoltes améliorés sur la production et le système de production

Dans cette section nous allons analyser les actions de recherches empiriques ou de développement qui sont orientées vers des activités post-récoltes. Le premier paragraphe définit les différents axes de recherche, le deuxième analyse les activités empiriques liées à la qualité des produits, le troisième décrit les résultats sur les technologies de récolte et de stockage dans quelques pays d'Afrique.

Activités de recherche du système post-récolte

Les activités de recherche sur différents éléments du système post-récolte peuvent être analysées suivant quatre axes à savoir : la récolte et le stockage, la qualité du produit, l'utilisation et la commercialisation du produit, les politiques, et institutions.

- L'activité de recherche sur la qualité du produit s'occupe de la qualité nutritionnelle et les caractéristiques de la transformation artisanale et industrielle des produits, l'identification de leur gène et son amélioration.
- L'activité de recherche sur la récolte et le stockage s'occupe des pertes postes récoltes dues à la mécanisation de la récolte, des possibilités d'améliorer les moyens de stockage, le control des ravageurs et maladies et l'amélioration génétique en vue d'accroître la résistance aux attaques.
- L'activité de recherche sur la transformation et l'utilisation des produits concerne les possibilités de diversification et de développement de nouveaux produits par la transformation des produits bruts ou transformés. Elle prend également en compte les caractéristiques des consommateurs en matière de nutrition et de consommation.
- L'activité de recherche sur les politiques et institutions analyse et détermine le cadre politique et institutionnel adéquat pour l'augmentation de la production agricole (les prix, les infrastructures, les petites et moyennes entreprises) par le biais des analyses micro et macroéconomiques des politiques macroéconomiques et commerciales.

Amélioration de la qualité des produits et développement des systèmes de production

Dans ce domaines, les activités de recherche se sont concentrées sur l'amélioration de la valeur nutritionnelle, des caractéristiques culinaires des produits et du comportement des produits face à la transformation. Plusieurs Institutions Internationales ont œuvré dans

ce sens ; il s'agit notamment du CIAT, du CIP, de l'IITA, de l'IFPRI, du CIMMYT, et de l'IRRI.

L'IITA a développé des variétés améliorées de manioc à faible teneur en acide cyanhydrique pour les Institutions Nationales de Recherche Agricole d'Afrique de l'Ouest. Cette action a beaucoup contribué à l'augmentation de la production du manioc dans la zone. Pour le maïs, Yalhou et al. (1995) ont présenté un exemple de variété nouvellement créée qui combinent de bonnes aptitudes à la transformation et au stockage. Une telle variété, si elle répond aux goûts et aux préférences des consommateurs constitue un important facteur de développement.

Système de stockage/conservation amélioré et développement des systèmes de production

Un système de stockage efficace permet de limiter les pertes et encouragent les producteurs à produire davantage. Le système de conservation varie selon le type de produit (céréales, légumineuses, racines, et tubercules). Nous avons distingué le cas des grains et celui des racines et tubercules.

Cas des grains

Dans la littérature existante plusieurs auteurs ont identifié et analysé les systèmes de stockage et de conservation traditionnels.

Ils sont, dans la plupart des cas, arrivés à la conclusion que les systèmes traditionnels sont bien aérés et limitent les pertes en cours de stockage. Le Tableau 2 montre les taux de pertes calculés par différents auteurs sur différents produits.

Tableau 2. Pertes annuelles au cours du stockage dans les greniers traditionnels.

Pays	Etat de la denrée	Taux de perte %	Auteurs
Mali	Mil en épi	2–4	Guggenheim 1978
Nigér	Mil sorgho	4,6	Dave et Elterich 1978
Sénégal	Mil en épi	2,2	Yaciuh 1977
	Sorgho	5,3	Idem
Nigér	Niébé	30	Alzuma 1994
Togo	Maïs	10	Panthennin 1988
Bénin	Maïs	17	Multu et Hountondji 1994

Les taux de pertes au niveau du maïs au Togo et au Bénin sont dû à la présence du *grand capucin*. Et ces taux atteignent 20 à 30 % lorsqu'il s'agit de variétés améliorées.

Ces différents taux peuvent ne pas correspondent à la réalité, étant donné que chaque auteur utilise la méthode d'estimation selon sa convenance.

Les pertes ne sont pas seulement quantitatives, les produits stockés perdent aussi leur qualité nutritionnelle. Bokossa (1993) arrive à la conclusion que le maïs stocké dans les structures traditionnels au Bénin garde tous les acides aminés mais leur quantité se trouve sensiblement réduite. Les pertes proviennent selon lui des attaques d'insectes. Par ailleurs, il se révèle que les producteurs utilisent des produits chimiques dans leurs greniers, mais ils ignorent les produits naturels tels que les feuilles du neem, du sable, et du piment.

Nago et Agbo (1981) ont également étudié le stockage du maïs en milieu rural du Bénin. L'étude demandée par le Center africain pour le Stockage Rural ARSC basé à Ibadan. Cette étude visait entre autre à quantifier les proportions de la production stockées dans les systèmes de stockage et de conservation améliorés. Selon ces auteurs trois types de systèmes de stockage améliorés ont été introduits dans le milieu grâce à des projets de développement.

Le crib métallique, au début, a subi plusieurs modifications ayant abouti à la réduction de son coût. Ainsi les éléments métalliques ont été progressivement transformés en éléments locaux (végétaux). Ce crib n'est pratiquement pas utilisé par les paysans individuels, seules les structures coopératives et les sociétés de production agricole l'avaient adopté.

Le silo en métal : Il comprend un toit conique où se fait le remplissage et un corps cylindrique. Ce silo a été adopté la société agro-industrielle qui en a construit plusieurs exemplaires.

Le silo en maçonnerie est un gros cylindre avec un orifice de remplissage sur le toit et un orifice de déchargement vers le bas. Il est fait de parpains spéciaux, agencés l'un à côté de l'autre et retenus extérieurement par une courroie métallique. Tout ce système est posé sur un monticule également en maçonnerie. Ce silo a été utilisé pendant plusieurs années par les paysans de la région d'Allada dans le cadre des structures coopératives.

Au Togo, un grenier traditionnel dénommé Bli-va a été amélioré pour une conservation efficace du maïs. Selon Henault (1994) ce grenier a été identifié en collaboration avec les paysans et permettrait de réduire les pertes de 30 %.

Cas des racines et tubercules

Deux principales cultures de cette catégorie se pratiquent dans les pays qui font l'objet de cette étude à savoir le manioc et l'igname.

Le manioc

Le manioc est un produit rapidement périssable. Sa détérioration commence 2 à trois jours après la récolte. Selon FAO 1998, les pertes varient de 40 % en 42 jours à 80 % en 63 jours. Des technologies nouvelles visant la réduction de ces pertes ont été testées dans différents pays sans succès. En faisant le bilan des technologies améliorées en Afrique actuellement en matière de stockage et conservation du manioc. FAO (1998) relève deux innovations qui pourraient être vulgarisées. Il s'agit de l'emballage des tubercules dans les films plastiques au Ghana (Gallat et al. 1995) et la conservation des tubercules dans la sciure humide (Agboola 1994). Les caractéristiques des deux technologies sont présentées au tableau 2.

Ces innovations ont été mises en œuvre, mais on ignore leur impact sur les systèmes de productions correspondantes.

L'igname

En ce qui concerne l'igname deux structures améliorées ont été identifiées une au Nigéria et l'autre au Bénin.

Au Bénin deux structures de stockage de trois tonnes ont été construites avec des matériaux locaux et expérimentés dans le cadre du projet système de stockage décentralisés.

Il est composé d'une paillote montée sur pilotis muni de protection anti-rats, d'une fosse-paillote (cave de 4 m sur 1,80 de profondeur), les murs en banco sont à 60 cm des

Tableau 2. Innovation technologique de stockage du manioc frais.

Technologies	Caractéristiques	Pays	Durée de stockage	Diffusion
Emballages dans des films plastiques	film plastique et produits chimiques mobile	Ghana	2 à 3 semaines	Diffusion lente
Conservation dans de la sciure humide	Sciure de bois humide Caisse en compartiments 170 x 65 x 80 cm	Nigeria		Négligeable

bords de la fosse pour délimiter un espace circulaire. Des ignames stockées dans ces structures sont traitées avec du kouffa (fongicide) à 2,5 kg /tonne de tubercule. Cette structure permet de créer une valeur ajoutée de 222 % contre 44 % en stockage traditionnel. Mais correspond-elle au besoin des utilisateurs ?

Au Nigéria, il s'agit d'une cave ventilée de pour le stockage des ignames conçue par l'Université de Nsukka. Cette nouvelle structure est conçue pour la conservation d'environ 200 tonnes de tubercules et a été testée pendant six ans et comparée à la structure traditionnelle. Elle permet de réduire les pertes par échanges respiratoires des tubercules.

Conclusión partielle

Ce qui ressort de l'analyse des structures de stockage et de conservation, c'est que ce sont des innovations introduites dans le milieu sans la participation des groupes cibles. Les structures qui ont connu un début d'adoption au Togo et au Bénin ont connu la participation des paysans. Par ailleurs aucunes études ne permet de dire quel est le niveau d'adoption l'impact des différents systèmes sur les systèmes de production.

Transformation des produits et développement des systèmes de production

La transformation des produits peut être considérée comme une méthode de sauvegarde et de conservation des récoltes. En créant de nouveaux produits, la transformation favorise l'accès du produit de base à d'autres consommateurs et de manière indirecte, la transformation augmente la demande du produit par la prise de part de marché national et ou international.

Par ailleurs la transformation des produits crée de la valeur ajoutée et constitue par conséquent un facteur de croissance économique. Sewanou (1990) estimant la valeur ajoutée au produit agricole par la transformation artisanale trouve que la transformation traditionnelle du maïs en Akassa crée une valeur ajoutée de 121 %, celle de l'igname en cossette 48 % et cette du manioc, en gari 133 % ; en cossettes d'igname 122 % et celle des arachide en beignet et huile 23 %. Et une amélioration des technologies améliorerait le niveau des valeurs ajoutées actuelles.

Pour analyser l'impact des technologies de transformation nous allons distingué trois catégories de produits : les céréales, les racines et tubercules et les légumineuses.

Racines et tubercules

Igname

Dans la littérature, on ne trouve pratiquement pas de travaux abordant la transformation de l'igname. Récemment et dans le cadre du projet de valorisation des cossettes d'igname pour les villes une étude comparative a été effectuée entre le Bénin, le Nigéria et le Togo (Bricas et al 1997). L'étude a entre autre procédé à un diagnostic des systèmes techniques de transformation des ignames en cossettes et autres dérivés (couscous :"wassa-wassa" et farine d'igname) et au test de certaines solutions d'amélioration. Les résultats montrent qu'on peut introduire un éminceur dans le procédé technologique de fabrication de la farine d'igname en vue d'avoir des chips faciles à moudre. Cette innovation évitera aux transformatrices le concassage préalables des cossettes avant mouture. Par ailleurs l'essai de mécanisation du roulage du couscous d'igname, a montré que le rouleur Afrem est indiquée pour réaliser un produit pratiquement identique à ce qui est fabriqué traditionnellement (Hounhouigan et Akissoé 1997).

Ces résultats ne sont pas encore bien affinés pour être vulgarisés.

Manioc

Des efforts pour améliorer les technologies traditionnelles de transformation du manioc en gari ont connus beaucoup d'échecs.

Pour arriver à bout de ces problèmes l'IITA a développé de petites machines simples à faible dose de travail de bas coûts, et adapter aux petits transformateurs et avec des matériels locaux.

Ces outils développés en collaboration avec les transformateurs ont connu un essor sur place. Mais il n'existe pas de travaux permettant de mesurer l'envergure de l'adoption et leur contribution à la forte progression du manioc au Nigéria. Au Bénin, les recherches se sont surtout consacrées à l'amélioration du produit.

Des technologies de transformation du manioc ont été développé par IITA pour répondre aux spécificités des variétés améliorées du manioc. Plusieurs technologies ont été testées en 1990.

La transformation du manioc en farine qui apparemment facile poserait beaucoup de problème au transformateur qui préfère transformer le manioc en gari. La difficulté exprimée par les transformateurs du Nigéria proviendrait de la faible mécanisation dans la fabrication de la farine dans la zone étudiée. Une vulgarisation des outils développés par l'IITA pourrait permettre de lever cette contrainte.

Au Bénin la faculté des Sciences agronomiques a développé une technologie pour fabriquer du gari amélioré au soja.

Au Nigéria, la farine du manioc entrerait dans la fabrication commerciale de certaines industries (biscuterie, distillerie d'alcool) etc.

Les céréales : le maïs

Au Bénin, le maïs est transformé en plusieurs produits commercialisés. Le transformation primaire regroupe les farines non fermentées, les farines fermentées et les pâtes. Selon Nago et al. (1989) la transformation secondaire à partir de ces trois produits conduit à une vingtaine de produits vendu sur le marché Béninois. Hounhouigan et Akissoé (1997) ont dans les travaux faits le diagnostic de la transformation du maïs en pâte fermentée

et testés le roulage et la stabilisation des pâtes. Pour répondre à une demande urbaine croissante, certains produits ont été modernisés et leur cuisson est rapide. C'est le cas du couscous du maïs, de la farine du maïs fermentée et roulée pour la préparation de bouillie "aklui" (Hounhouigan communication personnelle). Ces produits nouvellement développés se vendent dans les supermarchés à Cotonou et ne sont pas toujours connus du grand public.

Pour la mouture du maïs, sorgho, mil et les cossettes les transformateurs utilisent des moulins à céréales qui ont adoptées depuis des décennies.

Les légumineuses : exemple du soja

Le soja a été introduit dans plusieurs pays africains et depuis lors des recherches sont menées pour assurer sa transformation en aliment consommable.

Pour apprécier les efforts déployer pour promouvoir le soja, le CRDI a initié en 1987 un programme Projet d'utilisation du soja qui s'est effectué en trois phase.

La première phase à Ibadan; la deuxième à Lagos, Zaria, et Nsukka; et la troisième phase au Ghana et en Côte d'Ivoire. Ce projet vise à déterminer le statut de la production et l'utilisation, dans la pays du projet, développer des technologies et des équipements de transformation, former du personnel dans la transformation et l'élaboration des technologies, transférer par vulgarisation et disséminer les résultats aux utilisateurs. Les résultats de cette études indique seulement que les produits du soja ne sont pas encore acceptés et des efforts sont en train d'être faits pour y parvenir, mais il y a eu d'impact dans la région.

Au Bénin, DANA (1994) vulgarise une dizaine de transformations et préparations à base de soja. Au Nigéria, plus de 90 000 personnes ont été formées à la technique de transformation et d'utilisation des produits du soja à travers tout le pays. Et plus d'une trentaine d'industries de transformation se sont développées favorisant ainsi le développement d'un marché de produits issus du soja et par ricochet l'expansion de la production de soja dans la zone du projet. Depuis 1987 le prix du soja n'a cessé d'augmenter et le nombre de points de vente est passé de 2 à 32 (Osho et al. 1995).

Pour stabiliser les instruments utilisés dans la transformation du soja, les ingénieurs et différents transformateurs ont développer une combinaison de techniques utilisant des instruments moins chers adaptable facile d'utilisation pour les différents phases de la transformation du soja. Mais il subsiste une mauvaise information sur le produit. Des observations sont faites à l'encontre des grands transformateurs qui sont inhabiles à faire fonctionner les machines à leur pleine capacité et à l'encontre des consommateurs pour des biais ou préjugés envers le produit. L'approche participative du projet aurait pu permettre de trouver des solutions durables aux activités de transformation. Le problème ici, est lié à un manque de publicité pour faire connaître le produit au public. Pour ces raisons, un grand effort doit être fait en vue d'intensifier la vulgarisation, la formation et l'information sur la technologie.

Conclusion partielle

La transformation des produits agricoles constitue une importante source d'incitation à l'augmentation de la production et des exportations. La transformation du manioc a favorisé une expansion de la production et il est possible aux pays africains de conquérir une grande part du marché mondial. Et comme l'avantage comparatif est un phénomène dynamique, les pays Africains ont intérêt à profiter au maximum des exportations des cos-

settes de manioc au moment où les pays asiatiques sont en train de perdre leur avantage comparatif.

Des technologies améliorées ont été mises au point et de nouveaux produits ont été développés. Mais pour que ces produits puissent conquérir les parts de marchés national et international, il faut un système de marketing actif et efficace ; ce qui n'existe pratiquement pas dans les pays étudiés.

Politiques économiques et institutions

Les activités de productions post-récolte ne seront rentables que s'il existe des institutions d'appui et des politiques adéquates. Plusieurs études (Lutz 1994) ont montré que les offices de commercialisation ont contribué pour beaucoup dans la stagnation des productions agricoles. Et lorsque le commerce d'un produit est libéralisé, alors ce produit connaît une expansion de sa production et une modification de son système de production.

Les producteurs peuvent réaliser une grande production en quantité et en qualité, toutefois le manque de moyens de communication peut occasionnée la perte d'une importante proportion de cette production. La taille des exploitations agricoles étant souvent faible pour permettre au producteur de supporter avec bénéfice la commercialisation, les coopératives de services ou de commercialisation entre producteurs devraient être encouragées. Une telle approche permet de créer un point d'accumulation central pour les produits récoltés, les moyens de stockage plus faciles et agissent comme une unité commune de vente.

- Dans plusieurs pays en Afrique au sud du sahara, les infrastructures routières sont faibles, or l'élasticité de l'offre par rapport à ce facteur est forte. Par conséquent l'État doit veiller à la construction des infrastructures routières.

Conclusions et recommandations

De nos investigations il ressort que des technologies après récolte ont été développées et vulgarisées au Bénin comme au Togo mais généralement en dehors des systèmes de production. Toutes les technologies améliorées développées n'ont pas été identifiées et celles qui sont identifiées ne sont pas encore évaluées.

La première recommandation à l'EPHTA est de procéder dans chaque pays et `court terme à une analyse de la rentabilité sociale et financière des différentes technologies déjà identifiées, et à moyen terme, faire un inventaire des technologies nouvelles disponibles.

L'analyse de l'utilisation des technologies de transformation et des structures de stockage et de conservation améliorées, a révélé que ce sont des innovations introduites dans le milieu sans la participation des groupes cibles. Les structures qui ont connu un début d'adoption au Togo et au Bénin ont connu la participation des paysans.

La deuxième recommandation à l'EPHTA est d'encourager les chercheurs post-récoltes à utiliser une approche participative lors de la mise en œuvre de nouvelle technologies.

Les nouveaux produits souffrent d'un manque d'un système de marketing efficace ce qui limitent leur demande nationale et leur exportation.

La troisième recommandation est d'encourager les institutions nationales de recherche à faire des études de marchés pour les nouveaux produits développés et à tenir compte des goûts des consommateurs lors de la mise en œuvre de ces produits.

La quatrième recommandation est d'inciter les gouvernements des pays membres de

l'EPHTA à accorder beaucoup d'importance aux infrastructures routières et à prendre des dispositions favorisant l'exportation de produits transformés notamment les cossettes d'igname.

La cinquième recommandation à moyen terme est la création d'un center régional de collecte, d'information et de diffusion sur les nouvelles technologies post-récoltes disponibles que les chercheurs et développeurs peuvent consulter.

La sixième recommandation est de tenir compte du genre dans l'évaluation de nouvelles technologies en vue d'éviter une plus grande paupérisation des femmes.

Et enfin il faudra encourager la recherche sur les technologies améliorées.

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Session 3

Institutional and Policy Issues

Policy and institutional incentives for smallholder farmer adoption of technologies for sustainable production

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Abstract
This paper discusses the policies and institutional incentives that have affected smallholder farmer adoption of technologies in the EPHTA subregion. Agriculture accounts for more than 20% of GDP and 70% of employment in sub-Saharan Africa. The agricultural sector is divided into cash and food crop sectors. Policies and institutions have targeted mostly the cash crop sector. Small-scale producers are mostly in the food crop sector. Productivity has continued to remain low because of the low levels of technologies being used by these farmers.
Although there is a lot of on-shelf technologies, small-scale farmers have not been adopting these technologies because policies and institutional frameworks continue not to be conducive to farmer situations. These policies include production, research, macro-economics, financing, etc. Smallholder farmers have attempted to circumvent these constraints through expanding areas under cultivation, leading to environmental degradation. With growing environmental awareness, smallholder farmers may be locked into a low level of production if policy and institutional frameworks do not provide incentives for the adoption of new technologies.

Introduction

The agricultural sector is the most important sector in the economies of sub-Saharan African countries, contributing 20–30% to registered gross domestic product (GDP) and about 70% to employment (Lipton 1976). The economic growth and development of these countries depend largely on the growth of the agricultural sector. This dependence on agriculture is because of the current nature of land, capital, and labor endowments, and the level of development. This makes agricultural output the single most important determinant of overall economic growth. It has been the major source of capital for the rest of the economy in that sales of agricultural commodities are the prime source of foreign earnings used for the purchase of capital goods needed in other sectors of the economy. The agricultural sector is so large relative to other sectors of the economy that incentives to agriculture affect the behavior of other sectors and, in turn, incentives to these other sectors affect the economic performance of agriculture. Yet, in sub-Saharan Africa, food output growth per capita has been declining. Although the cultivated land per capita varies across the continent, the average is only 0.3 ha. This small farming area seems at odds with the usual perception of a vast, unlimited expanse of African land. It reflects the uneven distribution of the population, as well as the low level of technology and the unsuitability of wide areas for farming. The dependence on shifting cultivation makes the area needed for cropland many times larger than the average given above. When scarcity of good land is coupled with soil degradation and low levels of inputs

and technology, the result is an increasing deficit in food production. The World Bank (1996) identified a number of factors that are largely responsible for the low productivity of African agriculture to include:

- agricultural and economic policies and institutional frameworks that are non-conducive to increasing output
- neglect of agriculture by government
- misallocation of investments
- rapid population growth, which has pushed cultivation into marginal and less productive land
- inadequate technology to raise productivity
- deficient research output
- a shift in consumption that led to the importation of food items that are too costly to grow locally
- the absence of phosphorus in the soils

To increase the productivity of African agriculture will require considering the issues raised above. This should lead to farmer adoption of improved integrated soil, water, and nutrient management technologies. These technologies are essential to increasing productivity to meet food demands while adequately sustaining continuous cropping as fallow periods are shortened or eliminated due to the increasing population pressure. Farmers also have to adopt a package (in varying degrees) of agricultural innovations—high yielding variety (HYV) seeds, fertilizers, irrigation, and mechanical land preparation innovations. To adopt these innovations, farmers need the incentive to produce at higher levels than the subsistence level. Farmer incentives depend on sociopolitical institutions. These sociopolitical institutions condition the potential opportunities facing the farmers. For example, policies that affect the financial markets, interest rates, lending restrictions, etc., will affect the agricultural commodity markets, and vice versa. Cheap food price policies of governments serve as a disincentive to the production of more food and to the adoption of new technologies.

This paper discusses the policy and institutional incentives that affect smallholder adoption of technologies that will allow for sustainable production in the area covered by EPHTA. Policies for agriculture consist of government decisions that influence the level and stability of output and input prices, public investments affecting agricultural revenues and costs, and the allocation of research funds to improve farming and processing technologies. While some of these policies such as fertilizer subsidies and tariffs on food imports are specific to agriculture, others such as fiscal and exchange rate policies affect all sectors of the economy.

Other policies, which affect agricultural development, have to do with gaps in knowledge. At independence, many governments saw industrialization as the key to economic development, and resources and policies were consequently focused on the promotion of industry, and the agricultural sector was thought of primarily as a pool of resources for the development of the nonagricultural sector, through capital and labor supply (Sikod 1985). Some 30 years later, these nations have realized the inappropriateness of such policies, as the agricultural sector is no longer able to support the food needs of the nations and the supply of other resources.

Characteristics of smallholder farming

- Size of farms—small. As mentioned above, the average size of the farm of a smallholder is about 0.3 ha. This small size has very serious implications for technology adoption.
- Land preparation. This is done mostly through burning, and use of the hand held hoe for tillage, because the level of technology use is low.
- Soil resilience. This is done mostly through fallow, even if, because of the population pressure, fallows are becoming shorter. Mulch is also used in some areas to restore soil fertility.
- Productivity is low, because of the farming practices.
- Cropping system is mixed. In Cameroon for example, food crops are interspersed between cocoa and coffee trees. Even where there are no tree crops, beans, groundnuts, and maize are often mixed in a single cropping season. Relay cropping is often practiced also.
- The majority of smallholder farmers are without formal education, and continue to rely heavily on traditions and skills handed down to them by their parents (Cleaver and Schreiber 1994).
- The average age of the smallholder farmer is increasing, as the younger and more educated people migrate to the urban areas to seek other types of employment.
- The system of production is relatively simple and depends on the interplay of the climate and the topography, together with the soil type and the availability of land, labor, tools and agrochemicals. The basic production unit is the family, and depending on their means, some families hire some labor.

The productivity of a smallholder farmer may be considered in terms of its resource-deployment capacity and the level of output derived from the use of those resources. This productivity level is illustrated by comparing the rate at which input requirements are converted into outputs by the farmer. Thus, productivity is a measure of efficiency. The low productivity of smallholder farmers points to an inefficiency in the use of resources. This inefficiency has been attributed to the lack of appropriate or poor or no policies that give incentives to these farmers. This issue is discussed more fully below.

Most sub-Saharan African countries have a traditional food sector and an export or cash crop sector. The cash crop sector is concerned mostly with cash or export crops, while the traditional sector produces mostly food for local consumption. The traditional sector dominates, and is the sector with the smallholders. In Cameroon, for example, the traditional sector is responsible for over 90% of all agricultural production. Productivity under the traditional sector is very low because of the low use of modern technology (Ministry of Agriculture 1995).

Traditional farming methods rely on the clearing of vegetation using mainly machetes and fire. During the first season after clearing, even on poor soils, crop yields are high because of the nutrient-rich ash left by burning. Taller, deeper-rooting and/or less nutrient-demanding crops are planted in subsequent years to cope with declining soil fertility and increasing weed competition. Some trees may be planted before the plot is left to fallow. Traditionally, land has been left to fallow for 10–25 years before being cleared again, depending on soil type and availability. This cycle has usually been long enough to permit the soil to recover sufficient fertility to produce acceptable farm yields in the

next phase of the cycle. Currently, the fallow periods are being significantly decreased, with consequent soil degradation and decrease in productivity.

The dominant farming system in the forest zone is based on permanent cultivation of cash crops–cocoa, coffee, oil palms, tea, etc., combined with shifting cultivation of food crops. The major cash crops, coffee and cocoa, are perennial and can be cultivated indefinitely with no significant soil degradation. Most food crops, on the other hand, are annuals. Because they are typically cultivated using little or no fertilizer or other inputs, they rapidly deplete natural soil fertility hence the continual need for fertile virgin land. Rotation will not damage the land in the long run, provided that exhausted plots are abandoned long enough to recover their fertility under a natural bush fallow.

In Nigeria, Côte d'Ivoire, and parts of Cameroon, the system of long rotations has been compromised in recent years by increasing demands for land, leading to reduced fallow periods. Recent expansion of agriculture in the forest zone of central and eastern Côte d'Ivoire reflects massive migration and land clearing for production of coffee and cocoa. The technology has changed little. Although there are a few large, modern plantations, most farms remain small and continue to rely on traditional, extensive, low-input, low-output production. Soil degradation has accelerated owing to the depletion of soil fertility under food crops and disease afflicting the major cash crops. The natural forest has been virtually eliminated outside the reserved areas, and is evidenced by the fallow land that exceeds the total cultivated surface by about 30%.

Traditionally, extensive agriculture may have been sustainable at one time, but it is clearly not suited to the current high density of farming. Moreover, in addition to degrading soil fertility, agricultural expansion may have jeopardized productivity in other ways. There is some evidence that as agriculture expands and the natural forest area declines, local hydrological and climatic conditions may change, to the detriment of crop yields. The ability of farmers to adapt to such changes by planting drought-resistant varieties may be severely limited. For example, the major cash crops coffee and cocoa require many years' tending before they bear fruit. In addition, these crops are heavily promoted in the forest zone by tied credit schemes, extension services, and crop marketing programs (Gbetnokom and Sunday 1998).

Agriculture continues to be the sector that employs the largest number of people. With the economies of the countries in this subregion suffering economic hardships, more and more people will continue to seek employment in the sector. Policies aimed at improving productivity in the smallholder sector, and diversifying agriculture will improve the quality of life for most people.

Policy and policy incentives

The rational for policy intervention usually depends on the objectives that policymakers want to achieve. These may include income distribution, price stabilization, food security, and self reliance on locally produced food, revenue for the government, etc. Economists consider most of these objectives to be non-efficiency objectives. They are more of social policy objectives. Efficiency interventions will lead to either improvements in the optimum, or to higher levels of production. A government intervention to correct market failures is an efficiency measure. If market imperfections are present, the prices of goods and services will not reflect their true scarcity values because the private sector may be unable to develop the institutions necessary for efficient market functioning. This will have an

impact on smallholder producers: there may be no incentive to encourage proper production. If higher income as well as greater self-sufficiency is desired, policymakers may make tradeoffs between objectives; they have to make some compromise. For example, governments could tax nonfood crops and subsidize food crops.

Identification of appropriate tradeoffs between efficiency and non-efficiency objectives is complicated because governments hold many non-efficiency objectives and impose many policies simultaneously. Commodity policies (taxes, subsidies, and quantitative controls on commodities), macroprice policies (wage rate, interest rate, land rental rate, and exchange rate), and macroeconomic policies (fiscal and monetary management) will exert simultaneous impacts on the commodity system, and send mixed signals to the farmers. The net impact of government policy can be assessed only through aggregation of these incentive effects. The expansion of a staple food production may be a stated objective for the agricultural sector, for example, but if producers are taxed heavily on production, farmers may be some skeptical about the priority of policymakers for this objective.

Production

Policymakers usually express the wish for increased production, self-sufficiency, etc. These wishes are hardly ever accompanied by the appropriate policies. Cameroon, for example, has enjoyed self-sufficiency, not as the result of an adequate food policy, but rather as the consequence of the dynamism of its rural population, the diversity of its climate, and farmers' desire to beat the economic crisis. Although the land quality based on the agroclimatic conditions is favorable for the production of a great variety of crops, the agriculture is mostly rainfed, and so crop production is subject to the vagaries of climatic conditions. This has led to the expansion of the area cultivated. Smallholder farmers dominate the production of both the traditional cash crops—coffee, cocoa, cotton, and the production of food crops.

The indicator of the absence of appropriate policy is that farmers use outdated farming methods along with obsolete production technology. This contributes to the low level of harvests, when compared with international standards, for the majority of food crops. Average yield per hectare of cassava, one of the most widely cultivated tubers in the region, is less than half the achievable rate. This low average yield is an indication that much still needs to be done in terms of disseminating improved varieties for adoption. The generally low productivity is because there is currently not enough investment to bring out the commercialization potential of the crop. Because yields are generally low (or very low) the output of individual farms is consequently not much above subsistence needs. Even crops such as grains and pulses, which could be traded over long distances, are primarily grown for own-consumption. Considering these low levels of yields, the production potential is still very high, but exploiting it requires the intensification of farming. Yields have to increase to keep pace with the rapidly growing population.

Production is either of cash (export) crops or food crops. Given the cash and subsistence sectors, different policies have targeted the different agricultural sectors. Policymakers have placed more emphasis on the cash crop sector, to the detriment of the subsistence or local consumption sector. This is understandable. Governments derive a lot of revenue from taxing export agriculture. Non-export crops have benefited from production policies indirectly in that some farmers who grow export crops also grow non-export crops. Even where these farmers do not grow the two types of crops, their spouses grow them. These

farmers transfer policies targeted at the production of export crops to the food crops. Some farmers transfer the incentives from export crops to food crops because with the sale of food crops, there is instant cash income. For the cash crop, they have to wait for sales to be made at the world market (Monke and Scott 1989).

Macroeconomic policies

Macroeconomic policies comprise fiscal and monetary policy, and policies that govern the economy-wide or macro prices, the exchange rate, the interest rate, and the wage rate. Macroeconomic policies have a major impact on the profitability of agricultural systems and the welfare of farmers. Until the Structural Adjustment Program (SAP), governments typically extracted a greater amount of tax revenue from agriculture than they spent on agricultural subsidies or investments. This bias against agriculture in budgetary allocations was then complemented with a pervasive tax on the farmers, levied, sometimes unintentionally, through the exchange rate by poor macroeconomic management. As a result, attempts to provide positive incentives to agriculture with commodity policies can be overwhelmed by negating macroeconomic policies that transfer resources away from agriculture and the rural economy (Livingstone et al. 1987).

Macroeconomic policy has its most direct influence on agricultural profitability through decisions to collect and spend government budgetary resources. Budgetary policy deals with the allocation of total revenue. Budgetary decisions constrain the levels of government resources available for agricultural development production, marketing, research, extension, etc. Other categories of expenditure military and defense, education, health, and social welfare, etc. account for much larger shares of the budget. These budgetary allocations are indicators of policymakers' priorities among the competing sectors.

Some of the specific policy measures are:

i) *Taxes.* African farmers have faced the world's heaviest rates of agricultural taxation (World Bank 1994). This has been partly because agriculture has been such a crucial source of revenue for African governments. Farmers have been taxed explicitly through producer-price fixing, export taxes, and taxes on agricultural inputs. Most countries have depended on high export taxes to cover public investments that quite often are selected on nonconomic bases. A study of some 18 countries worldwide showed that Côte d'Ivoire, Ghana, and Zambia taxed their farmers 70% more than the average for developing countries (Schiff and Valdes 1992). The high rates of taxation have contributed to the decline in the average rate of agricultural growth and the decrease in farmer incomes. By depressing farm incomes, the historical pattern of heavy taxation on agriculture has had negative environmental impacts. It discouraged investments and locked producers in traditional low-input low-output, extensive farming. It also forced rural populations to exploit any available open resources (e.g., forests) to supplement farm income. Heavy taxation may also have persuaded some of the rural population to leave for the city. This migrating population is usually the young and educated. Better prices to producers would have encouraged adequate care of plantations and new plantings, and tree stock would not be in the degraded condition in which it is today. Reducing the taxation of farmers has been a top priority in agricultural reform, which has been high on the adjustment agenda because of its importance in the GDP, exports, and employment.

ii) *Subsidies.* This is payment from the government treasury. The purpose of a subsidy

is to separate domestic prices that differ from world prices. While subsidies on fertilizers, agricultural extension services, and other incentives encouraged export agriculture, food crop agriculture had no such luck. Concurrent with the subsidies was the heavy taxation of the sector through low producer prices fixed by a monopsony public marketing board in many countries in the region. While the governments derived revenue from this taxation, the marketing boards were supposed to use the revenue to provide a stabilization mechanism to the farmers. Price stability under the state marketing system may have had some positive incentive effects by mitigating producer price volatility risk, even though domestic prices were consistently below world market prices. The use of farm inputs such as fertilizer is extremely low in sub-Saharan Africa—9 kg of plant nutrients per ha in 1990 (World Bank 1994). This is substantially lower than the 69 kg used in South Asia and 262 kg in China. This is not necessarily due to the paucity of irrigated land in sub-Saharan Africa; India uses three times more fertilizer on rainfed land. In Cameroon, fertilizer use per ha on permanently cultivated land is even lower. It was at the level of 4.1 kg/ha before the removal of subsidies. With the removal of subsidies following SAP, this use has reduced considerably. The important deterrents to fertilizer use have been identified to be supply shortages and inefficient distribution systems, outcomes of excessive government intervention. The lack of education, the size of farms, etc., make it difficult for smallholder farmers to invest in farm inputs such as fertilizers. The quantity of fertilizer needed by most of the smallholder farmers is so small that many of them find it difficult to find the input in retail quantities of maybe a couple of kg. Before the removal of subsidies and the privatization of the fertilizer subsector, the cooperatives in Cameroon, under the auspices of the marketing board, distributed fertilizer to farmers in a tied credit system. Under the privatized system, private suppliers have had to import fertilizer, since it is not produced locally. Conditions of sale have also changed, and sales are now on cash basis only. Given the level of sales and the uncertainty of the smallholder farmers, the use of fertilizers has dropped drastically. This drop means that smallholder farmers without enough land for fallow may lose soil fertility because of the intensity of cultivating the same parcel of land.

iii) ***Exchange rate policies.*** Many of the EPHTA countries (all the francophone countries) belong to the CFA franc zone, where the currency is pegged to the French franc. Exchange rate issues arise because it is linked to domestic production costs and the competitiveness of the economy. Because of the high costs of domestic production, especially in the non-tradable sector (public sector, construction, etc.) many economies became overvalued, leading countries to accumulate large deficits. In the late 1980s, the two largest CFA economies, Cameroon, and Côte d'Ivoire, accumulated huge deficits in the operational accounts with the French treasury. It is estimated that France spent 20 billion French Francs to support the CFA Franc parity (Amin 1996). This action was taken because of the overvaluation of the CFA, and also because the countries in the CFA zone tended to have passive exchange rate policies. Overvaluation contributes to the distortion of domestic incentive structures. In 1993, Cameroon carried out two salary cuts in the public sector in an attempt to reduce its fiscal imbalance. In January 1994, the parity of the CFA franc to the French franc was changed from 50 FCFA : 1FF, to 100 FCFA: 1FF. How

did this affect the smallholder farmer? Some export farmers were able to increase their exports: their competitive positions improved. Prices of imported inputs such as fertilizers increased. This had a dampening effect on the profit position of these farmers. Another depressing piece of news for the farmers was the severe drop in the world prices of cocoa and coffee, the main export crops of many countries. In Cameroon, the impact of the salary cuts and devaluation on public servants was that many turned to farming, mostly food crops, to supplement their incomes. Although this group is educated, and should be able to apply modern farming technologies, the limited funds available to them means more extensive farming. This does not augur well with sustainable production. Many such farmers in Cameroon were able to buy or rent chainsaws, an enemy to the forest, for clearing. There are other policy instruments such as quotas and tariffs that could be used to influence agriculture, but these have hardly been used, except in controlling imports. Countries importing cocoa, coffee, cotton, etc. from EPHTA countries have, from time to time, imposed quotas. All the EPHTA countries belong to the ACP countries, and enjoy certain rights as far as their exports to European Community (EC) countries are concerned. These rights limit the quantity of exports to the EC countries. This is a situation where even if the quotas are through negotiations, ACP countries are takers. Their influence of the policy is limited. Theoretically, the smallholder is constrained by the export quota imposed by the importing countries. Policies have targeted mostly the export crops.

Marketing

One of the ways to help farmers minimize price risks due to supply/demand fluctuations is to develop a market information system which informs farmers of the demand and prices of various commodities. In Cameroon, the local radio stations often announce the prices of various commodities as obtained in the local markets. Although this is not systematic and regular, and does not represent official policy, it serves a very useful purpose in informing farmers of those areas of need, and the prices their produce can fetch in the local markets. What is not known is whether the farmers listen to the programs.

In Cameroon, the food crop marketing sector has always been left to the private sector. Food reaches the urban consumer through a complex operating network of mostly private small traders. The people in urban areas are fed through the efforts of thousands of mostly individual women farmers who have succeeded in growing, processing, and marketing more and more food without the assistance of public services.

Because of the bottlenecks in this process, postharvest loss is quite high. This usually has an impact on the smallholder producer. Production is usually reduced mostly to subsistence level, in cases where evacuation facilities are not available. Marketing is more developed and well organized in the export crop sector. After independence, many countries created marketing boards to handle the marketing of cash or export crops. Later, some boards also handled food crops. These boards had to ensure the stability of farmer or producer prices, supply inputs at a subsidized rate to the cash crop farmers, and also provide some extension services. The boards later became a major source of revenue for the government. Most studies show that the marketing boards paid the farmers sometimes less than half the world market prices for the commodities they produced (Fig. 1). From 1986, the producer prices rose steadily and approached 100% because the policy had been

to increase these prices annually, irrespective of the world prices. In 1990, the producer prices for cocoa approached the world market prices. These prices dropped the following year because the marketing board could not pay producer prices above world prices. The rest of the revenue was supposed to be kept in a stabilization fund, to ease the effect on farmers of fluctuations in the world market prices. Unfortunately, when prices fell in the late 1980s, farmers could not get the relief they expected from the marketing boards because government had used up this fund for other projects.

Quite often, it is the marketing board that is responsible for organizing the collection of produce from the farmers. With SAP, this activity of the marketing board has been privatized, and the role limited mostly to the provision of information. This liberalization has included the marketing of staple food crops that were subject to extensive government control in some countries.

The food marketing and transportation system has not been organized to fulfill the important task of food distribution in an efficient manner. A recent study of the marketing infrastructure in Cameroon identified two systems in food crop marketing; the traditional marketing system made up primarily of the private local population, and the modern marketing system involving mostly government institutions and parastatals. The influence of the latter in the volume of trade is extremely limited, since the traditional marketing system handles more than 95% of marketed food. Specialization by type of product among the various classes of intermediaries is not common and the volume of trade of each of them is relatively modest. Ownership of vehicles is limited among intermediaries. Retailing of food commodities is mostly carried out in open-air markets. The various types of markets have very limited facilities to permit optimal operation of the marketing function (storage, cold rooms, market stalls, toilets, etc.).

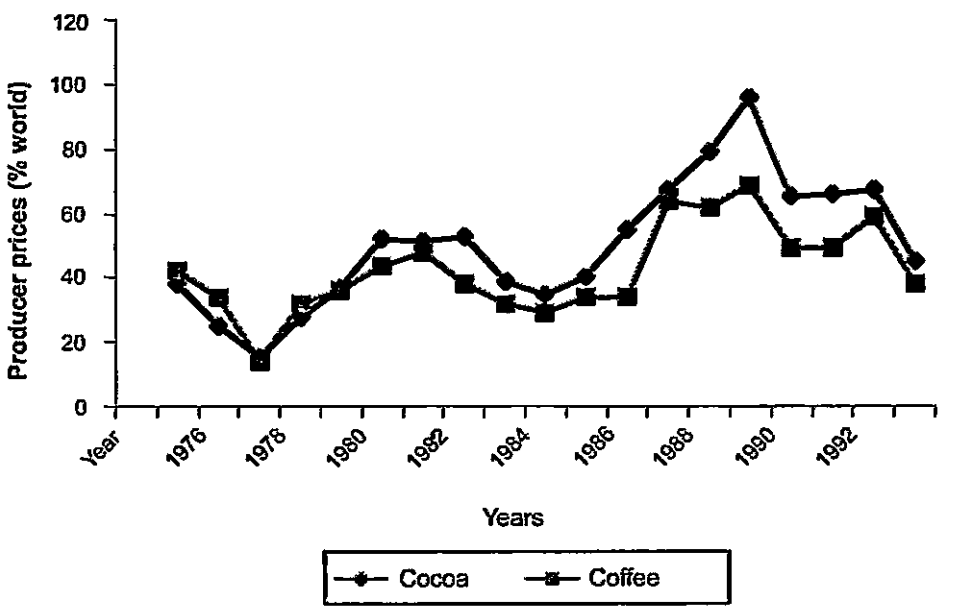

Figure 1. Producer prices as percentage of world prices, 1975–1993.

Exchange of food products between regions is fairly limited because of lack of access roads. There is also a limited flow of urban to rural food products. Competition is limited due to poor dissemination of information and lack of coordination between suppliers, marketing agents, and consumers. Gross margin is fairly high. In most cases, transportation accounts for more than 50% of the gross margin. Transportation of commodities and the role of intermediaries are shown to be the major handicaps of food marketing. The net margins suggest that the marketing of food commodities could be profitable if participants could be organized according to their responsibilities at the various stages of processing and marketing.

The role of women

In both production and marketing, women play a major role, but there are hardly any policies that target women. Until recently, Cameroon had managed to increase its food production to meet only part of the demand of a growing population and rapidly expanding urban centers. Most of this extra food has been produced on small farms by women farmers, using the simplest type of technology, and rarely benefiting from external agricultural advice, or from improved seeds, fertilizer, or credit. Women are also responsible for the marketing of over 60% of the food crops produced (Sikod 1990). Most of these women usually combine agricultural activities with child care and household work. Because of this division of labor in farm-families, men usually have more leisure time and access to obtain information on technological innovations or credit availability. They also have easier access to loan collateral because they own land, or tree crop plantations, and have higher incomes. In contrast, women are overworked, have limited or no information about the formal sector where they may have some credit facilities, and do not have significant possessions or connections to offer as collateral. Their level of education is generally low, their level of organization low, and their incomes quite small for the formal sector to handle. It is also true that these characteristics are changing as more women get educated and are returning to farming, but this group of women is still too small to make an impact. As a result of these intra–household economic relationships, women farmers are restricted to low productivity technologies and means of financing. These constraints make women wary of trying new technologies that may seem profitable, but have not been proven.

A summary of the constraints that limit women's access to improved farm facilities include:

- ***Access to resources and work opportunities***
  - *i) Land.* Due to institutional obstacles and cultural stereotypical perceptions, women rarely own land. The family land women cultivate is usually in the name of the husband. This discriminatory practice is evidenced by the practice whereby female children do not inherit land.
  - ii) *Finance.* The banking system has rigid procedures that are inappropriate for women who must come up with the necessary collateral that is not available to them. Credit is fragmented through diverse projects with limited impacts. Women are usually relegated to the informal financial market, where because of the limited savings, the amounts available for loans are quite small. This influences the size and technology women can use.
- ***Capacity (inability) of rural women to use resources***
  - i) Extension does not consider the needs of women.

ii) There is insufficient education and information among women.
iii) The austerity of SAP did not consider women.
iv) Governments have made relatively little effort to contain the demands of women.

Given that women constitute more than 60% of the small-scale food producers and marketers, policies directed at alleviating women's labor and credit constraints are likely to be very cost-effective approaches to meet national food needs. In Cameroon, there is a Ministry of Women's Affairs, with the responsibility to improve the condition of women. A major obstacle this ministry has found is how to convince men to recognize the important role women play in the economy and in food production and marketing in particular.

Institutions and institutional incentives

The institutional framework in many countries of the EPHTA region is the product of a political structure which is mostly centralist, hierarchical, and geared to the collection and distribution of rents. It is essentially multifarious, fragmented, inefficient, and quite often, uncoordinated and functionally and relatively distorted (Penn and Sikod 1994). In countries such as Cameroon, there are parallel structures in the Presidency and the Prime Minister's Office, and the technical ministry. This leads to duplication, waste of time and manpower, which is costly for countries with very limited resources.

There are also many ministries whose mandates impinge to a greater or lesser extent on the agricultural sector, such as Labor, Transport, Health, Commerce, Environment and Forestry, Security, etc. A lack of interministerial coordination affects the agricultural sector. Sometimes, there is no coordination between the different administrative branches within the same ministry. This poor institutional setting contributes to the poor performance of the agricultural sector, which is reflected in the continued low productivity of the smallholders. In fact, this institutional setting is reflected in the poor functioning of the economy.

Government intervention in the agricultural sector has been quite extensive (in Cameroon, between 20 and 32% of projected investments between 1961 and 1981 were devoted to agriculture). This is because this sector was perceived as the sector to serve as the springboard for economic development. Unfortunately, policy planning efforts have had little impact on the performance of the sector. This is because the emphasis has been largely on the export of cash crops, to the detriment of food crops. In Cameroon, for example, agriculture has always played a central role in development objectives, but the strategy for developing it has varied considerably over the years. Three phases have been identified; in the first phase covering the immediate post independence years, 1960–1968, the traditional sector received considerable attention, but through an extension service which followed the diffusion/modernization model. The impact on farm productivity was notably disappointing. The next phase saw massive state intervention in the form of an expansion in the plantation sector, rural resettlement, specialized crop development through bodies as the Rice Development Authority (SEMRY), the Cocoa Growing and Development Authority (SODECAO), etc., and integrated rural development projects. These were all created and managed by the state. The emphasis was thus on the modern rather than the traditional sector as the major force for development. This approach, too, was clearly unsuccessful due to inefficiency and high costs among the parastatals thus created.

The third phase began in 1977, when oil production diminished the importance of agriculture as a source of revenue, and taxation of export crops, which had become increasingly

severe, was eased. However, the oil revenue also eased the pressure to reform the parastatals and vigorously pursue efficiency in agricultural production, pricing, and marketing.

Now the agricultural sector is operating under a liberalizing system, following the implementation of SAP.

Institutional participation in food marketing

The efficiency of the marketing system is critical to the producers and everybody along the marketing chain. The signal producers receive from consumers to produce a particular commodity comes down through the marketing chain. Before the structural adjustment that led to the liberalization of the marketing especially of export/cash crops, marketing boards were the main institutions responsible for marketing these commodities. In some countries, the marketing board was also responsible for the marketing of crops produced mostly for local consumption. In Côte d'Ivoire and Cameroon, for example, cocoa and coffee were marketed through the government marketing boards Caisse de Stabilization des Prix des Produits Agricoles, (CAISTAB), and the National Produce Marketing Board (NPMB). At the beginning of the coffee and cocoa seasons, a Presidential or Ministerial order announced the producer prices. The marketing boards paid farmers these prices, which were usually about 40 to 60% of the prices at the world market. The difference between world and producer prices, net of marketing costs, was the marketing board surplus or the revenue from cocoa and coffee exports. This surplus was supposed to be kept in a stabilization fund to shield farmers from price swings in the world market. Unfortunately, this surplus became an important source of government revenue. By the late 1980s, world prices had dropped below producer prices and the marketing board surplus had become a deficit. This situation arose because of government policy not to let producer prices fluctuate with world prices. As part of the SAP measures, the marketing board activities were liberalized, and producer prices aligned to world market prices. In Cameroon, the marketing board was not eliminated; rather its activities were reduced to providing market information to farmers, and participating in the sale of cocoa. Some competition was introduced: interested persons were allowed to buy and sell these crops, but under license from the government. Some countries such as Nigeria completely closed down their marketing boards. Although initially this alignment caused uncertainty among farmers because of fluctuating prices, they have adjusted to the new system and cocoa and coffee production has actually increased in Côte d'Ivoire.

In the food crop sector, few public institutions are directly engaged in marketing. In 1973 the government in Cameroon created the Food Development Authority (MIDEVIV) to conduct studies relevant to the food sector, increase production, improve extension services, market food crops, and create food crop belts around urban centers. This was an attempt to respond to food shortages in the urban centers. MIDEVIV was not able to attain its major objective. Besides the problem of transportation, MIDEVIV was confronted with tough competition with the private sector, poor quality of products purchased, and poor management.

Unlike export products, the marketing of foodstuffs is now left entirely to the private sector. At the national level, the institutional structure is very complex among the Ministries of Agriculture, Livestock and Animal Industries, Commerce and Industries, Planning, Territorial Management, and Health. These ministries should normally have some influence on the marketing and transportation of food products, pricing, handling, weights and

measures, grades and standards, and food flows. At the same time, agricultural research institutions, cooperatives and development cooperations, some of which are involved in food crop production and marketing, are basically autonomous entities. Consequently, the lack of adequate coordination among these institutions and organizations has made it difficult to implement decisions and render marketing services in a coherent manner. This confusion is far from being an incentive to the smallholder producer. What the confusion does is increase transaction costs as private wholesalers and transporters have to make incentive payments along the way before the produce gets to the consumer.

Tenure systems

Tenure systems are very important to the way smallholders treat the land on which they work. The story of tenure policies is similar in most countries. It is based on the imposition of the colonial system on the traditional system. Unfortunately, due to weak central governments and sometimes the lack of the will to implement, countries are making do with makeshift tenure systems. The examples of Cameroon and Côte d'Ivoire described below, support this point of view.

Cameroon has enacted three laws that have nationalized all land and all natural resources on it. The 1974 and 1976 Land Tenure Laws effectively abolished traditional land tenure systems. The formal procedures for obtaining official title to national land set out in these laws are so tortuous, lengthy, and expensive that few can afford it. In the 24 years that have elapsed since enactment of the laws only 2.3% of rural lands have been registered to private title, and mostly by civil servants. Furthermore, in order to obtain title, land must be "mise en valeur," meaning that there can be no title to an intact piece of land; the land must be transformed into some agricultural or other use before title is granted. The result is that traditional systems of land tenure still flourish, but are not legally enforceable. Similarly, the 1994 Forest Law nationalized all natural resources, including all plants and trees. Villagers have usufruct rights (collection of specified non-timber forest products, trapping, and some limited use of timber) but the ownership of the principal resources, the timber and wildlife belongs to the state and can only be harvested with permission through the issue of concessions, licenses, or special permits. This alienation of land and resources is a source of considerable insecurity and is not conducive to sustained management of resources. Although well-defined property rights may be a necessary but not sufficient condition to guarantee sustainable management, insecure tenure often leads to the unsustainable use of land.

In Côte d'Ivoire, excessive logging and land clearing for agriculture is attributed in part to the failure of rural land tenure. The problem derives from a gradual breakdown and growing inadequacy of indigenous common property management systems that have been aggravated by the failure of government to develop effective land tenure institutions either to complement or to replace traditional systems.

Indigenous land tenure systems in Côte d'Ivoire vary according to culture and circumstances in different regions. Nevertheless, most traditions share certain fundamental features. At the risk of oversimplification, indigenous systems of land management in West Africa are based on the collective territorial claims of a family or clan. These claims are justified in terms of initial occupation and land clearing or outright conquest. Under traditional management, the chief and elders of the ruling family or clan hold all land in trust. Members of the family as well as any others must apply to the chief or elders for

usufruct rights (i.e., the right to clear unoccupied land for cultivation, according to their needs and the availability of reserves). In principle, user rights are valid only so long as land is under cultivation, but allowance may be made for occasional fallow. User rights are also transferable, but only within the family or clan.

Indigenous systems of common property management were adequate when population densities were relatively low and most exploitation was carried out to meet subsistence needs. Traditional land tenure systems have not adapted well to the pressures of rapid population growth, heavy immigration, and high population mobility, and the resulting increased demand for arable land. They have also failed to deal effectively with the advent of commercial land use.

The official government stance vis-à-vis indigenous land tenure system has alternated between direct contradiction and benign neglect. With independence and the promulgation of the constitution, government reaffirmed the system of land tenure law inherited from the colonial power. This law basically declared all unoccupied land to be state land, to the detriment of the indigenous land system. Subsequent attempts to codify a comprehensive rural land law for Côte d'Ivoire have been largely ineffective. The government is unable to reconcile indigenous land tenure custom with the legal framework and pattern of land ownership left over from the colonial period. In particular, there remains a fundamental conflict between indigenous customs, which hold that land ownership (as opposed to usufruct) is inalienable, and the emphasis on private freehold maintained by European legal traditions.

The unfortunate result of such prolonged ambiguity and inconsistency in rural land law is that secure tenure over land remains elusive. Many farmers resort to wholesale clearing of forest land simply to stake a claim and gain recognition from civil authorities.

At the other extreme, migrant farmers cultivating small plots are particularly disadvantaged under the current system. With little social or political influence and even less economic clout, they have few means of acquiring secure formal title to land. Access to land under indigenous systems may also be difficult to obtain, given the reluctance of traditional chiefs to allow land to pass permanently outside the clan. Migrant farmers are thus often reduced to itinerant tenant farming or wage labor on plantations. In both cases, they risk arbitrary eviction at a moment's notice. Under such circumstances, they can hardly be expected to concern themselves with land husbandry and conservation.

The lack of secure tenure systems is based on the weakness of the central political system. The smallholders are invariably among those with no political clout, and so tend to face eviction quite often. This makes it difficult for some of them to have long-term development plans about any land they may be occupying. Even under the indigenous system, there is usually so much fragmentation of the land that the parcels of land sometimes become too small for proper husbandry.

Until colonial times, customary law regulated the use of land and natural resources. Colonisers, especially the French and the British, introduced tenure policies to favor their interests. Most of the elements of these tenure policies, especially with regard to land ownership have survived virtually intact into the present government statutes.

Financing

One of the major reasons why productivity among smallholder farmers remains low is because of the lack of financing. The lack of financing does significantly limit the ability of

these farmers to adopt improved technologies even when fixed costs are not large. Even in cases where these technologies are seemingly profitable, some smallholder farmers are still not able to adopt them because of the inability to finance the adoption (Lopez 1998).

Institutional financing to the agricultural sector has varied among countries, not only because of differences in resource availability, but also because of the different objectives pursued by countries. Countries such as Cameroon and Côte d'Ivoire had ambitious plans of rapidly transforming the agricultural sector from a subsistence system into a modern one. In the early 1970s, these countries created special banks to offer credit to farming and rural development. In Cameroon it was the National Fund for Rural Development (FONADER), while in Côte d'Ivoire it was the Banque National de Développement Agricole (BNDA).

Countries in this region produce basically the same suite of crops. In the mid 1980s, due to overproduction and a weak demand, world market prices for cocoa and coffee fell and these countries that relied heavily on revenue from these crops suffered from liquidity problems. This, coupled with other structural problems in the economies, led to a severe economic crisis. This was followed by structural adjustments, which led to the liquidation of most state banks, including the development banks set up to cater to the interest of the farmers and the rural populations. In Cameroon, the liquidation of FONADER led to the creation of another farmers' bank, Crédit Agricole. This bank was short-lived. Today there is no bank catering to the interest of the farmers (Munkner 1987).

Even if the banking sector did not collapse, the smallholder farmer cultivating food crops could not benefit because of the size of his operations, and the lack of collateral. Women and rural uneducated farmers dominate this sector. The conditions for obtaining loans were usually too difficult for smallholder farmers to fulfil. This sector has relied more on informal financing.

What then are the sources of financing available to the smallholder farmers? The rural finance system can be very complex, involving a multiplicity of institutions, informal groups, and private individuals. Some of these institutions are only incidentally involved in rural finance but, nevertheless, play an important role. One way to categorize the different entities involved would be to distinguish between the formal and informal sectors.

Beside the banks, financing was also done through parastatals created specifically for rural development. Some parastatals with funding components in Cameroon include:

SODECOTON (Société de Développement du Coton du Cameroun), established in 1974 to replace the French Textile Development Cooperation (CFDT). The objectives of SODECOTON are:

- the promotion of cotton production through technical assistance and the supply of inputs and credit in the cotton growing areas of North Cameroon
- the purchase and processing of raw cotton from smallholders, and the domestic and export marketing of cotton fiber and other products including oil extraction
- the promotion of traditional food crops, mainly sorghum, millet, maize, rice and groundnuts through extension, input supply, and credit

SEMRY (Société d'Expansion et de Modernisation de la Riziculture de Yagoua).

The government, the Marketing Board, and the Cameroon Development Bank own SEMRY. SEMRY promotes the cultivation of rice in irrigated areas of the Sudano-Sahelian zone of Cameroon. SEMRY promotes the cultivation of rice through credit arrangements

to small-scale farmers to take care of inputs, cultivation, irrigation, and transportation services. Farmers get the credit at especially low interest rates.

Channeling agricultural credit through these development organizations has usually functioned fairly well, although credit extension is usually limited to their zone of influence. These too have built up an effective extension service. Together with their tight control over the marketing of crops, which allows them to deduct credit repayments from the farmers' sales revenues, extension and credit operations function fairly well within these areas.

Cooperatives: Cooperatives play an important role in channeling formal funds to farmers.

Unfortunately, cooperatives are confined mostly to cocoa- and coffee-growing areas. As locally-based institutions, cooperatives are, in principle, suitable institutions to reach the small-scale farmer. Cooperatives used to receive funds from either FONADER or other formal sources (the government, foreign donors, etc.). These funds are given as loans to farmers for:

- ***fertilizers:*** the cooperatives sell fertilizers to farmers both on cash and on credit basis. Usually they add 10–12% as interest to the value of the fertilizer sold on credit, regardless of the period of the loan, which is generally less than one year.
- ***sprayers:*** these are used mainly for the treatment of the tree crops against pests. Farmers buy sprayers at a subsidized rate.
- ***advances:*** these are short term loans disbursed to farmers by the cooperatives. The loans are interest-free. These loans are very important to farmers because of the need for cash to meet children's educational and other family needs.

Development organizations as credit channels

Agricultural and rural development organizations and projects also serve to influence production by smallholder farmers. International donors and the country's government usually jointly fund these rural development organizations. Some of those in Cameroon include:

- ZAPI de l'Est (Société regionale des Zones d'Actions Prioritaires Intégrées de l'Est), was created as an integrated rural development authority in the 1960s. It had to carry out extension activities, infrastructure development, health services, food crop marketing, and the marketing of export crops, specifically, cocoa.
- MIDENO (Northwest Development Authority) was founded in 1981 to coordinate existing public services within the framework of an integrated rural development program. MIDENO collaborates with the Northwest Cooperative Association, the Ministry of Agriculture, and FONADER.

These development organizations provide low interest loans to small-scale farmers, depending on the need. While all of these development organizations were created in good faith, the functioning of the organizations has not been smooth. The fundamental problem has been that of manpower management. At independence, many countries did not have enough qualified manpower, and so civil servants were appointed to manage these private sector setups. Politicians also used appointments to manage these organizations for political ends. The end result has been poor management that has led to the liquidation of some of the organizations.

This is the financial institution that caters most to the interest of the smallholder farmers.

This is a self-help financing system of rotating savings and credit by the farmers. This is an informal association of a homogenous group whose goal is to promote solidarity among members and to have an informal closed financial market which allows members to put their savings at the service of other members as credit, that is, they agree to make regular contributions to a fund which is given in whole or in part to each contributor in rotation or otherwise. They borrow from the group savings to meet not only agricultural needs, but also other needs. The degree of development of this system varies from one country to another. Homogeneity—ethnic, tribal, same profession, friends, etc.—is a fundamental criteria for membership into any ROSCA. Figure 2 shows the preferences of a rural farming community in Southern Cameroon for saving and borrowing. When asked why they do not operate bank accounts, nearly 60% of the respondents said they had no knowledge of how banks function. Other reasons for not operating bank accounts were that there was too much hassle, they did not have enough money, it took too much time to carry out transactions in banks, and they had no confidence in banks. Figure 3 supports their reasons as only 19% of respondents said access to loans outside ROSCAs was the banks.

The informal financial markets

Small-scale farmers rely on this source of financing because of the conditions of getting loans. No collateral is demanded, transactions are conducted verbally, and quite often records may not be kept, and the terms of repayment are quite flexible.

Considerable effort has been made in sub-Saharan Africa to eliminate or reduce the factors that impede access to credit by smallholder farmers, even if they have met with limited success. These have been through special programs as some of those mentioned above, improving traditional group savings schemes, savings/credit associations and cooperatives, etc. The objective of these approaches is to simplify credit procedures, relax guarantee requirements, and bring credit facilities down to the village level. Donor resources and participation have been most active in these ventures. Even the Grameen Bank approach

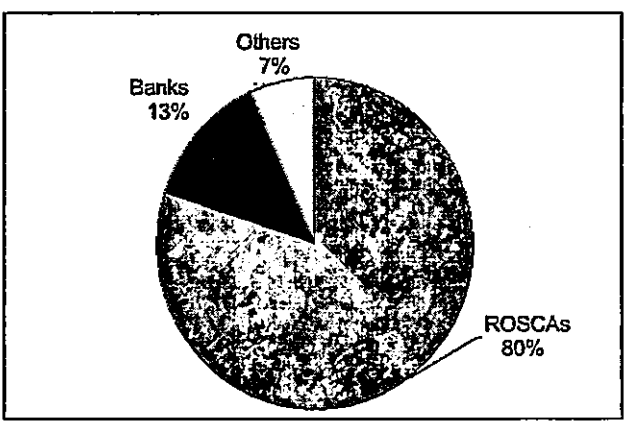

Figure 2. Preferences for saving and borrowing.

of Bangladesh has been explored. Although the process seems slow and tedious, it does appear that targeting NGOs and women groups would yield faster results.

Research and extension

As with output, growth in yield and labor productivity has been very slow compared with population growth. Agricultural (labor) productivity has not changed much because the area cultivated per labor hour is small. Since a substantial proportion of the labor resources is in food production, it is necessary to raise the productivity of this resource. Labor productivity is a function of the underlying technology. Given the present situation of the countries, to change the production function so that the output will increase requires the adoption of improved technologies (machinery, irrigation, fertilizer, and high yielding (HYV) seeds), as well as improving the quality of labor.

Researchers have so far encouraged mostly methods that have aimed at increasing the productivity of the land (fertilizer and seed packages). This has been a necessary, but not a sufficient condition for improving the productivity of smallholder farmers. To develop adoptable technologies for small-scale farmers, it is necessary to understand farmer conditions and priorities. Often, government policies occur at higher systems' levels but analysis is done mostly at the farm level. These analyses tend to show that farmers have problems adopting technologies because of the lack of complementarities and also because the technologies may not be profitable (Besong and Bakia 1997).

Policymakers usually rely on the various national and international research institutes for research into particular crops. This reliance allows not only for the transfer of technology, but makes available to farmers various on-shelf technologies. On-shelf technologies for improving soil, water, and nutrient management are however, hardly integrated. More importantly, they may not as yet have experienced widespread adoption. Farmers may also have problems adopting these technologies which may be seemingly profitable, not only because of the lack of complementarities, but also because of their limited knowledge of the existence of such technologies.

At the level of the smallholder producer, research is more likely to be profitable if developed by the public sector than by the farmers. Smallholder scale of operations is so small that it may not be profitable to develop the technologies themselves. Successful technologies have, however, been those done in collaboration with the farmers. In Cameroon, the rate of technology adoption has remained relatively low because of the poor or quite often nonexistent relationship between research and the diffusion mechanism of the research. Farmers are risk-averse, and are reluctant to adopt technologies whose outcome they do not know. And yet, these technologies are essential to increasing productivity to meet food demands while adequately sustaining continuous cropping as fallow periods are shortened or eliminated due to an increase in the population pressure.

Labor productivity can be improved by mechanization. The rate of mechanization is unfortunately generally low, even among cash crop farmers. Consequently, farming relies heavily on hand labor. The 1984 agricultural census in Cameroon showed that 85% of the farms use only hand labor, 12% use cattle to cultivate the land, 2% use tractors, and 1% use donkeys/animals. The total dependence on hand labor decreases as farm size increases but even on the larger farms (> 1 hectare of cultivated area) over 60% of the farmers depend on hand power only. This is worse than in Côte d'Ivoire, where tractor use is over five times that of Cameroon, indicating a better mechanization policy (FAO 1996).

Even here, tractor use is only about one-third of the world average. The use of non-hand labor decreases as one considers other countries in the region. However, countries in the Sahelian zone use more animal power than countries in the forest zone.

The majority of small-scale farmers do not have the financial means to buy expensive machinery and equipment. In addition, large agricultural machines are ill adapted for use on small farms. Considering the preponderance of small farm holdings, only 1050 tractors were in use on farms in Cameroon in 1992. Compared with the 1970 level, this represents a seven-fold increase in tractor use.

The degree to which these countries use non-human power can be said to indicate the degree to which government policy encourages their use. Tractor use and implements such as winches are used more in the cultivation of cash crops than food crops. This stems from policy bias, which favors cash crop production, as this provides governments with foreign earnings.

Other problems of mechanization have been the diverse ecology and topography of the land, which make use of certain technologies difficult. This provides a challenge to policymakers to encourage research in mechanical technologies that are adaptable to the different environments and ecosystems.

Extension

The extension service usually provides the link between research outputs and the end users, the farmers. It also provides an opportunity to monitor and assess the impacts of technologies adopted by farmers. For smallholder farmers to be informed of the technologies to improve productivity, the extension services have to be functioning well. In most countries, the Ministry of Agriculture, through its regional services, carries out extension activities. This is direct intervention by the state. Apart from this direct involvement by the Ministry of Agriculture, others are location- and objective-specific. Many countries have specific projects targeting the growth of particular crops, such as the soybean project in Côte d'Ivoire. This is a donor-supported project aimed at solving food needs in the short run, and transferring technology to smallholder farmers on how to grow soybean in a specific environment for the long term. SODECOTON and SEMRY perform the same type of function for cotton and rice in Cameroon.

In Cameroon, extension coverage is quite low, 1 : 326. In 1989, in recognition of this problem, Cameroon put in place an extension and training program to support government efforts to increase productivity, ensure increased farmer incomes, and help to modernize smallholder agriculture. Agricultural extension in Cameroon has been in diverse forms:

- SODECAO. This is a parapublic structure set up specifically to intervene directly in extension and training of cocoa farmers. The parastatal was also responsible for the maintenance of the farm to market roads, to facilitate the evacuation of cocoa.
- MIDENO. This is a mixed set up, with funding from the state, the Marketing Board, and a commercial bank. Its mission was to supervise rural development projects within the Northwest Province, to improve on the extension worker/farmer ratio, and to help smallholders increase productivity.

There are a few NGOs that are beginning to participate in extension activities.

Environmental issues and sustainable food production by smallholder producers

Since the 1992 Rio Summit, environmental issues have become very important. Human activity is being blamed for the climate changes that are occurring. In the developing countries the main human activity leading to climate change is land use, specifically, the conversion of natural environments (forests) to agricultural or other land uses. This is partly because the population is growing much faster than the economies are transforming, and so farmland is not being used intensively. The dilemma of sub-Saharan agriculture, therefore, is to meet the challenge of food production for the increasing population without depleting the natural resource base. Farmers have so far sought to increase production through extensive farming by colonizing more virgin land. This has worked in the past, as this type of colonization allowed for the fallow system to work. Soil fertility was restored. Today the fallow system is either greatly reduced, or is no longer practicable. Many countries are responding to this potential environmental catastrophe by developing environmental management plans to ensure the sustainable use of natural resources. This is bound to have profound effects on the smallholder farmers. They will have to modify their farming practices to accommodate the management plans.

Governments tend to intervene in agricultural markets by controlling prices, especially producer prices. This turns the terms of trade against agriculture and hence depresses the price of land. Farmers can be motivated to invest in soil conservation, tree planting, etc., if returns to such investments show up in capitalized form in land prices. By depressing prices, government policy lowers the rate of return to conservation measures. The need to ensure food security, and to shield farmers from the volatility of cash crop prices in the world markets is leading governments to promote the development of subsistence crops. This development has to be done in an integrated way to ensure soil conservation. Pearce and Warford (1993), have shown that subsistence farming has a higher erosion factor than cash crops, with groundnut and cassava being the leading culprits. Soil erosion is probably the most severe environmental hazard that smallholder farmers in sub-Saharan Africa face. A consequence of soil erosion is siltation of waterways. The soil which is washed off from the agricultural fields is carried down by streams and rivers (LEEC 1992).

As our knowledge of the environment increases, and as we realize the need to conserve the environment, farming systems will have to integrate conservation into their practices. This will require modernizing farming practices that are already fairly elusive to many African farmers.

Scientists in sub-Saharan Africa, however, caution against the wholesale adoption of new technologies because some may accelerate the use of non-renewable resources, and contribute to various forms of pollution.

The top-down approach to conservation (conservation methodologies developed by experts) is what has been sold to small-scale farmers so far. This approach typically does not do justice to the root causes of soil degradation. It is important for researchers and development planners to integrate farmers into the development of farming methods that conserve the soil.

Conclusion

To meet food needs, raise incomes, and provide foreign exchange, the rate of growth in agricultural production over the next few decades would need to be twice the past decades. Much of the increase will have to come from raising production in ways that conserve

natural resources and thus ensure sustainable growth. Policies and incentives so far, have not favored the smallholder farmer, especially the majority that operates in the food crops sector. Policies have been heavily skewed toward the cash or export crop sector, because this sector has provided foreign earnings for governments. The consequence has been that smallholder productivity has often, though not invariably, been low at least in food crop production. Smallholder production is in many areas on a very extensive and apparently inefficient basis, with considerable use of shifting cultivation and very little use of fertilizers or modern inputs. In general, where fertilizer or modern inputs are applied, they are restricted to the export or cash crops.

Technology applied in agriculture is simple, if not rudimentary, and represents a very low level of capital intensity. There is limited use of tractors or even animal power for cultivation. While there is a low degree of capitalization in smallholder production, there is also a general lack of access by these farmers to credit.

The peasant mode of production dominates, with subsistence output as a major feature. The land tenure system is not clearly defined to allow the farmers to use the land in a sustainable way.

These points show that the policy designed to support smallholder agriculture has not been effective. To ensure food security, it is necessary to develop the smallholder and peasant sector. This will require modifying policies that discriminate against this sector.

Countries in the region are richly endowed with a variety of agricultural lands and a largely favorable range of climates. There is considerable potential to expand cultivation in regions with good soils and adequate rainfall, or to improve on the irrigation systems. Research results have to move from the shelves to the farmers. A lot of research has been done, but quite often adoption does not seem to go beyond the sample used for testing the results. This is due both to the lack of proper extension policies, and complementary inputs needed by farmers to ensure the outcome are as required.

These changes require reforms in policy. Reform processes are inherently political and confrontational, because some parties may not like to reform. There are always losers and gainers in any reform process. This means that the sustainability of reform is always precarious. The reformed policy regime has to be generating enough benefits to its stakeholders and beneficiaries to withstand the pressures of those who would like to derail the reform. This means that for smallholders to accept policies that would lead to changes in their status, they have to be certain of an outcome that will be beneficial to them. This is because small-scale farmers tend to be risk-averse, and would be wary of trying new technologies that have not been properly tested.

Recommendations

A number of policy and institutional issues that have an impact on the incentives of smallholder farmers have been discussed in this paper. In this section, some of the points are highlighted as recommendations as a way of underlining their importance.

1. Policy factors

- Production. This has been identified as a problem. It is important that the appropriate policies be put in place to ensure that the production of the smallholder farmer increases. Currently, there are no policies to address productivity issues.
- Subsidies and the supply of inputs. It does appear that the structural adjustment program

was too brutal in the way subsidies were removed. Smallholder farmers need some form of subsidy for inputs. The removal of subsidies has to be phased out gradually, or there should be some alternative to ease the plight of these farmers.

- Government taxation of exports and attempts to influence prices of both exports and local foodstuffs should be discontinued. This policy has tended to be urban-biased because the policy tries to ensure that the urban sector has food at lower prices, without considering the farmers. If the private sector is allowed to handle exports and marketing of foodstuffs, farmers will get the right signals and will allocate their resources accordingly.
- There is quite often a lot of administrative discontinuity in policy implementation in the agricultural sector. This causes investment uncertainties. When the government bans and after a while unbans the import of an agricultural commodity, it causes uncertainties.
- Policies and programs should integrate women. Gender-neutral policies have not been very efficient so far. They have tended to be male-biased. It is important to use women-targeted tools to integrate women's interests. Women make up over 60% of the small-scale farmers, but have hardly benefited from any policies or programs (Sikod 1990).

Policies should also focus on enhancing sustainable soil fertility by improving organic matter management through mixed farming, composting, and recycling and by increasing fertilizer use. It will be necessary to reestablish the stock of phosphorus, the lack of which is a key limiting factor in agricultural productivity in most countries. Fertilizers with phosphorus contents will have to be subsidized, as these are quite expensive. The sales will have to be in retail quantities that farmers can buy (Tham 1989).

2. Institutional factors

- The current extension system is quite weak. It is necessary to strengthen it.
- It is necessary to link research activities to the needs of the smallholder farmers; that is, research should be based on an interaction with the smallholders to determine their needs, and what they can adopt.
- Land tenure continues to be a problem. Governments have to develop tenure systems that will allow farmers to invest in the land they farm. This is important for soil conservation and sustainable farming.
- There are many ministries whose activities have an impact on the agricultural sector, and yet there is no coordination among them.
- A major handicap of smallholder farmers is lack of knowledge. It will be important to identify and support institutions that build capacity.
- An issue that appears difficult, but must be done is to make credit available to the farmers. This will require careful study of how to overcome the constraints that have made it difficult for farmers to have access to credit.

There should be an institutional setting to handle postharvest losses. Postharvest facilities that may be helpful to the smallholder farmer will include:

- storage facilities
- development of small capacity processing units for individual farmers
- development of small to medium capacity processing units for groups of farmers
- contractual (or cooperative) arrangements for small processing units

The above recommendations are not exhaustive; rather, they are indicative of some of the areas that need to be looked into, if there have to be effective incentives to smallholder farmers for sustainable production.

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Enabling policy and institutional changes for improving the impact of structural adjustment programs on small farm production in sub-Saharan Africa

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Abstract
An examination of the economic performance of sub-Saharan Africa (SSA), suggests that growth was slowing down even before the oil price shocks of the early 1970s. During the 1970s, many SSA economies experienced decline growth rates in their Gross Domestic Products (GDPs). This combined with high and accelerating growths in population to lower the growth rates of per capita GDP to about 0.2% per annum for the period 1970–1982 (Smith 1989). The development polices of most countries in SSA during the 1970s had focused on industrialization to replace imports, a high degree of protectionism vis-à-vis imports, and the neglect of the agricultural sector. Policy issues and necessary institutional changes are suggested in the present pages for the subsequent reduction of the negative impacts of the Structural Adjustment (SAP), on small-scale agricultural enterprises.

Introduction

Neglect of agricultural enterprises for non-agricultural industries with the introduction of SAP has caused negative effects. Industries produced at high costs and received producer prices, which were excessively high, compared with world market parity prices. Agriculture was the main source of taxes and domestic savings. High taxes on agricultural exports, excessively priced industrial goods, increasing over-valuation of the domestic currency shifted the inter-sectoral terms of trade to the disadvantage of rural production and consumption. Besides, a price policy supported by imports and subsidized food products operated to the detriment of agriculture. Inefficient governmental and parastatal service companies also subjected the agricultural sector to organizational and cost-related obstructions to its supply and marketing channels. The resultant effects were rural exodus, degradation of the capital stocks in the agricultural sector, stagnation of agricultural production for the domestic and export markets, higher food imports, lower macroeconomic savings ratio, increasing foreign debts, etc. (Brandt 1997).

These chronic economic and agricultural problems of the 1970s (Ghai and Smith 1987) were compounded in the 1980s by a further rapid decline in Africa's international terms of trade due to rising oil prices, the global recession with its adverse effects on tropical commodity prices, and the impact of high international interest rates which created serious problems of debt service provisioning for the funds borrowed in the 1970s to finance the trade gap and development expenditures. A marked decline in net capital flows into SSA as a reaction to the international debt crisis compounded the problem resulting in a serious balance of payments problem.

In their efforts at seeking lasting solutions to problems of structural imbalances, many SSA countries have adopted SAP anchored largely on deregulation of economic activities.

Targets/objectives and instruments of structural adjustment programs

SAP refers to a set of comprehensive economic reform measures to correct imbalances in the economy arising from unfavorable external factors as well as inappropriate domestic policies. Countries embark on SAP when their economies manifest imbalances or are in fundamental disequilibrium. An economy in such disequilibrium suffers from persistent current account deficits, rising external indebtedness, over-valued currency, and distortions in relative prices leading to loss of international competitiveness. It is also affected by the impact of recession and slow growth in the industrial countries, compounded by protectionist attitudes in those countries, leading to a deterioration in terms of trade. Too often, rising inflation, declining or reduced economic growth and inefficient allocation of resources feature prominently in such an economy in fundamental disequilibrium (Omoruyi 1990).

Policy targets/objectives of SAP

The broad objectives of SAP are to effectively alter and restructure the consumption and production pattern in the economy as well as eliminate price distortions and heavy dependence on the exports of a single product as the main foreign exchange earner and on imports of consumer and producer goods. More specifically, SAP is designed to:

- restructure and diversify the productive base of the economy in order to reduce dependence on a single major foreign exchange earner and imports
- achieve fiscal and balance of payments viability over the period
- lay the basis for a sustainable non-inflationary or minimal inflationary economic growth
- lessen the dominance of unproductive investments in the public sector, improve the sector's efficiency, and encourage the growth potentials of the private sector

Policy instruments of SAP

A set of basic policy tools or strategies has been put in place for all fund-assisted programs, although different emphasis is placed on the principal policy instruments in view of the diversity in the levels of economic development, social, political, and institutional characteristics of countries undertaking the programs. The instruments used in pursuit of the above policy objectives include:

(i) adoption of a realistic exchange rate policy
(ii) trade and payments liberalization
(iii) restructuring of tariffs to give effective protection to local industries
(iv) stimulating of domestic production in order to broaden the supply base of the economy
(v) strengthening of demand management policies i.e., fiscal and monetary policies
(vi) reduction of any complex administrative controls and greater reliance on market forces to direct economic activities
(vii) removal of elements of subsidy on goods and services provided by public cooperations and agencies

Thus, the major instruments of SAP are the expenditure reducing measures in the form of restrictive fiscal and monetary policies (demand management policies) including privatization, and expenditure-switching measures in the form of adjustments in relative prices through exchange rate adjustments (Omoruyi 1990). Expenditure-reducing policies are often targeted at the public sector, which is seen as the major source of excess demand. The reduction in budget deficits can reduce a major inflationary pressure but this frequently results in setbacks in productive services and welfare activities with adverse effects on output and income distributions. Expenditure switching policies are designed to make imports more expensive than domestic goods and so switch domestic expenditure from foreign to domestic goods. Such policies are also designed to make exports more competitive and profitable. The usual instruments are exchange rate devaluation and liberalization of price controls and trade restrictions that favor foreign over domestic goods.

It is important to point out that countries with or without the support of the international monetary fund (IMF) and the World Bank may undertake SAP. Countries usually resort to IMF/World Bank supported adjustment programs for greater access to foreign funds than would be possible otherwise. Since 1980, an increasing number of countries in SSA have adopted IMF/World Bank supported SAP.

The purpose of this paper is to highlight enabling policy and institutional changes for improving the impacts of SAP on small farm production in SSA. The paper is divided into four sections. The introductory section discusses the rational, policy targets/objectives and instruments of SAP. Section 2 makes a comparative analysis of the empirical results of the impacts of SAP in some countries of SSA. Section 3 discusses the enabling policy and institutional changes for improving the impacts of SAP on small farmers in SSA, while section 4 contains the summary and conclusion.

A comparative analysis of the impact of SAP in some sub-Saharan African countries

African Adjustment Study (AAS)

The World Bank (1994) carried out an African Adjustment Study (AAS) to compare the policies and performances of 29 SSA countries engaged in structural adjustment of their economies. The study covered two periods: 1981 to 1986 when these countries were in economic crisis and 1987 to 1991 when these countries adopted SAP. The study documented the extent to which six sets of policy reforms—macroeconomic, trade, agriculture, public enterprises, financial sector, and public sector management were implemented in the 29 SSA countries and the results of the policy reforms. The results of the study are summarized as follows (Husain 1995).

1. Extent of policy reforms

(i) Progress was found satisfactory in the areas of macroeconomic reforms, trade policy, and agricultural pricing and marketing.

(ii) Macroeconomic reforms spurred external competitiveness while keeping inflation low.

(iii) Trade reforms increased access to the imports needed for growth.

(iv) Reduced taxation of agriculture in many countries helped the poor while encouraging domestic production and exports.

(v) There were few policy changes with regard to public enterprises, the financial sector, and public sector management.

(vi) African governments have been able to sell off or to liquidate only a small share of their assets.

(vii) Financial flows to public enterprises were still high without any sustainable improvements in their efficiency.

(viii) The financial sector was still found to be heavily burdened by public sector demands for credit, crowding out the private sector.

(ix) There have not been any perceptible improvements in civil service efficiency and productivity.

(x) Finally, poor economic policies were found to be responsible for the poor performance of the economies of most of the 29 SSA countries. However, the task of adjustment was made more difficult by larger declines in terms of trade between 1986 and 1991.

Results of policy reforms

(i) Those countries which pursued SAP in a consistent and sustainable manner showed *positive results in terms of resurgence of growth.*

(ii) The group of countries which instituted the most extensive macroeconomic reform policies between 1981 and 1986 and 1987and 1991 enjoyed a medium growth rate of per capital GDP of about 2%. Conversely, countries, which did not improve their policies, had a 2.6% decline in their per capita GDP. A similar pattern was demonstrated by export and industrial growth.

(iii) As for agriculture, countries that taxed their major export crops less experienced a 2% rise in the growth of total agricultural value added while those countries which taxed their farmers more had 1.6% fall in their agricultural growth rate.

(iv) Countries, which significantly reduced the black market premium (by devaluation) and adopted realistic macroeconomic policies, enjoyed the biggest benefits e.g., Ghana, Nigeria, and Tanzania.

(v) Countries that brought about a real depreciation of 40% or more with flexible exchange rates had a 2.3% median increase in per capita GDP (e.g., Gambia, Mauritania, and Sierra Leone).

(vi) Countries, which had appreciations with fixed exchange rates, suffered a median decline of 1.7% in their per capita GDP (e.g., Cameroon, Côte d'Ivoire, and Gabon).

(vii) Countries which were assessed as having adequate or fair macroeconomic policies had a 0.4% annual growth rate in median GDP per capita while countries ranked as having poor or very poor macroeconomic policies have a 2.1% decline in their median GDP per capita per year.

(viii) Countries with limited government interventions in markets had a 2% growth in median GDP per capita per year in contrast to a decline of 1% for countries that intervened more extensively.

African adjustment case studies

Husain and Faruquee (1994) carried out a case study of seven SSA countries—Burundi, Côte d'Ivoire, Ghana, Kenya, Nigeria, Senegal, and Tanzania which embarked on SAP

during the mid 1980s, ending in 1991. The countries were selected to capture a variety of characteristics and initial conditions. Adjustment programs in the seven countries focused on such distortions as overvalued exchange rates, high current account, and fiscal deficits, low factor mobility, restrictions on domestic and foreign trade, distorted pricing for tradeable commodities, and inefficient public services. The results of the study are as follows (Husain 1995):

Higher economic growth

(i) All seven countries studied, except Côte d'Ivoire, experienced positive per capita GDP growth during the adjustment period, 1986–1991. The average growth rate of the six countries over the adjustment period was 4.5% a year. This is considered a strong improvement when compared with an average growth rate of 1% in the period preceding adjustment.

(ii) Burundi and Kenya, who had fairly good initial conditions, maintained their previous growth rates.

(iii) The biggest turnabout during 1986–1991 in annual growth rates was registered in Nigeria (16%), Ghana (6%), and Tanzania (4%).

(iv) Even Senegal registered a small turn around in growth despite the problem of an over valued exchange rate.

(v) Côte d'Ivoire, which once had an impressive growth rate, could not revert to its precrisis rate primarily because of its exchange rate problems.

Agricultural sector

(i) All the seven countries showed significant increases in agricultural output.

(ii) The index of per capita food production rose in all the countries except Tanzania.

(iii) In Burundi, per capita food production seemed to have stagnated but was able to keep pace with population growth rate during the 1980s.

(iv) Food prices in real terms declined in Nigeria.

(v) Average food imports declined by between 30 and 60% in Burundi, Kenya, Nigeria, and Tanzania and remained constant in Côte d'Ivoire, Ghana, and Senegal.

(vi) The volume of cash crop exports grew rapidly in Burundi, Ghana, Nigeria, Senegal, and Tanzania but declined in Côte d'Ivoire.

(vii) New non-traditional agricultural exports have emerged in almost every country in this group, though in modest amounts.

Export sector

(i) The growth of exports has been remarkably high despite decline in terms of trade. Exports have not only recovered from the crisis period but have surpassed their precrisis levels.

(ii) In terms of export diversification, oil was found to still dominate Nigerian exports but unlike the early 1980s, Nigerian goods are now competing with other imports in West African markets.

(iii) In spite of a sharp fall in cocoa prices in the world market, Ghana has more than doubled her exports in the past seven years with gold exports replacing cocoa as the number one export.

(iv) Today, at least 20% of Ghana's export earnings come from products other than cocoa, gold, and timber compared with 8% a decade ago.

(v) Tanzania had the highest rise in non-traditional exports; its unrecorded exports were estimated at about $400–500 million a year.

(vi) Côte d'Ivoire, Kenya, and Senegal have export bases, which are among the most diversified in Africa, but changes during adjustment have been minor and show no persistant trend.

(vii) Burundi is the only country among the seven to show continuing heavy reliance on coffee, her diversification efforts having being negligible.

Investment

(i) In spite of increased inflows of foreign savings, public investment has fallen in relation to GDP in the seven countries, recovering to precrisis levels only in Tanzania.

(ii) The conditions needed to encourage private investors have generally been lacking. The slow down in public investment in an attempt to reduce budget deficits and to cut uneconomic projects without a compensating rise in private investment would result in depressing overall investment ratio.

(iii) Domestic investors have been discouraged in the short run by the effects of restrictive monetary policies, high interest rates, and devaluations all of which increase the costs of imported inputs as well as trade liberalization.

(iv) Foreign investors appeared yet to be convinced that African economies offer good investment prospects.

(v) The case study confirmed the importance of stability, continuity, and credibility of policies for providing the necessary signals to both domestic and foreign investors.

(iii) Out of the seven countries studied, Ghana and Kenya came closest to meeting these conditions.

External financial flows

External economic environments affect African countries in three main ways (a) the terms of trade, (b) the debt servicing burden, and (c) external resource transfers. The study showed that:

(i) Six of the seven countries had a decline in terms of trade during the adjustment period both in absolute and relative terms vis-à-vis the pre-adjustment period.

(ii) With regard to how far this decline in external income was affected by net external transfers—aids flow, debt-servicing relief and accumulation of arrears, Tanzania was by far the largest beneficiary of positive net external transfers which wiped out the terms of trade losses and resulted in a significant increase in net external flows.

(iii) Burundi, Ghana, and Kenya were able to neutralize the terms of trade losses and had some modest overall gains.

(iv) Nigeria suffered the most through terms of trade losses which were compounded by net negative transfers.

(v) Côte d'Ivoire and Senegal also incurred net declines in external flows.

External factors versus policy reforms as determinants of growth

In terms of determining how much of the renewed growth of the adjusting countries could be ascribed to external factors—aid and terms of trade changes, and how much to policy reforms the results were as follows:

(i) Nigeria performed better despite terms of trade losses and net negative flows of external resources. Nigeria's net resource transfers to her external creditors stood at 5% of her GDP each year. This implies that her growth could have been higher without heavy external debt burden.

(ii) Côte d'Ivoire has been hurt by terms of trade losses and a relative decline in external flows as well as by poor policies. Côte d'Ivoire is also heavily indebted but has avoided a cash flow crunch by not paying all her creditors and by accumulating arrears. It is anticipated that the 1994 devaluation of the CFA Franc and its accompanying measures will change the situation.

(iii) Burundi, Ghana, Kenya, and Senegal are among the group of countries that are fully servicing their debts and all of them have been hurt by terms of trade losses.

(iv) Kenya's growth record reflects some positive impact of adjustment while the turnaround in Ghana's growth was due more to better policies than to other changes.

(iv) Tanzania's growth was attributed to factors other than aid. The country is generally perceived to be highly dependent on external donors, and has received huge sums of aid historically, however, when debt-servicing and terms of trade losses are accounted for, the real external resource flows to Tanzania during her adjustment and pre-adjustment periods were not different in absolute terms.

SAP and the poor

(i) The study showed that adjustment has generally improved the welfare of the rural poor while most likely hurting the urban poor.

(ii) The growth attained so far due to adjustment policies was still not enough to reduce the incidence of poverty.

(a) Rural poor

(i) In all the seven countries, the majority of the poor who live in the rural areas are smallholders and self-employed who derive their income from the production and marketing of both food and export crops.

(ii) Since six of the countries (except Côte d' Ivoire) had an improvement in the rural terms of trade as a result of devaluation, liberalization marketing, higher producer prices and lower taxes, the rural poor appeared to have benefitted from real income gains over an extended period.

(iii) Export crops and particularly non-traditional export crop producers gained more than other agricultural producers.

(iv) Real food producer prices to farmers declined in many countries, but the marketed output increased, replacing food imports in many cases.

(v) The real income gains to food producers varied. Those in Ghana, Nigeria, and Tanzania seemed to have benefitted most.

(v) Burundi and Kenya had been self-sufficient in food therefore, the food crop farmers did not gain much, while the situation in Côte d' Ivoire and Senegal was unclear.

(b) Urban poor

(i) The impact of SAP on the urban poor was mixed.

(ii) In Ghana and Tanzania, the urban poor were better off after adjustment. This is because consumer goods became available, real food prices declined, and informal sector activities expanded.

(iii) In Côte d'Ivoire and Senegal the urban poor were worse off.

(iv) In Nigeria, the unemployed, fixed-income earners, and minimum wage earners were worse off.

(v) However, for both Burundi and Kenya, it was unclear whether the real incomes of the urban poor in these countries worsened or improved because of lack of data.

Enabling policy and institutional changes for improving the impact of structural adjustment on small farms in SSA

Why target small farmers?

In most economies of SSA, the overwhelming majority of agricultural producers and indeed the vast majority of the total population, can be classified as smallholders who reside in the rural areas. Agricultural performance in the region has been poor. The low or declining levels of agricultural productivity in the region is attributable to the economic and physical constraints imposed on smallholder agriculture. The environment is characterized by very limited access to the resources necessary to raise productivity coupled with inadequate transportation and marketing infrastructure. Smallholders often operate close to the margin for survival and under uncertain climatic and market conditions. Therefore, any change in the economic and social welfare of the rural sector will have a profound impact on the long-term performance of their national economies.

The need to focus attention on smallholders derives from the evidence that they constitute the bulk of the poor in SSA and because of the potential significance of their contribution to successful adjustment through a supply response.

Policies directed at improving the conditions of small-scale farmers are likely to play a vital role in helping the poor and vulnerable groups during adjustments and in promoting growth. Generally, improving farmers' incomes help to alleviate poverty and increase growth. Thus, raising the income of small-scale farmers has direct effects in poverty reduction among the rural poor.

Moreover, improved rural conditions reduce rural–urban migration and the extent of urban poverty. The success of small farmers also has important linkage effects on the rest of the rural economy in terms of expenditure by farming families on local goods and services and agricultural imputs as well as from the local processing of farm produce (Longhurst 1987).

In addition, a great deal of evidence indicates that small-scale farmers are more productive per unit of land than large-scale farmers, (Rudra and Sen 1980; Lipton 1985; Corina 1985). The agricultural sector as a whole often has a comparative advantage, which has been neglected by government policy in the region. Focusing on the small farmers will, therefore, promote growth, efficiency, and equity.

Improvements of the balance of payments and market efficiency are important objectives of SAP. A major way of improving the balance of payments is by reducing food

imports through increased domestic production. This can be possible through an increased flow of resources to small-scale farmers.

The impact of SAP varies according to the situation of small farmers. In macroeconomic adjustment, prices of tradeable goods and services rise relative to non-tradeable. Thus, the small-scale farmers who produce for subsistence are worse off than those who produce for export. Besides, in cases of foreign exchange constraints, the agricultural sector and the small-scale farmer suffer from acute shortages of production imputs—fertilizer, hoes, seeds, agrochemicals, and from a deficient transport system. Increased supplies of inputs in these areas are important for increasing production.

Straegies for improving the impact of sap on small farm production in SSA

Effective input supply and distribution

Evidence reveals astronomical increases in the costs of most agricultural inputs due to SAP with particular reference to hoes, cutlasses, agrochemicals, fertilizers, and tractors. In the livestock sector, the affected inputs are drugs, vaccines, and livestock feeds, while in the fishery sector prices of outboard engines, canoes, boats, nets, and floats have also increased astrononically leading to scarcities. These increases in input prices are due to exchange rate depreciations, high interest rates, and the withdrawal of subsidies accompanying SAP. All these have acted to reduce farm size and productivity especially of small-scale farmers. There is, therefore, the need for increased supply and distribution of agricultural inputs including credit to small-scale farmers. Food and inputs subsidies may have to be removed gradually rather than abruptly but need to be much more targeted towards non-tradeable food producers.

Development of rural infrastructure

Inadequate transportation and communication facilities, lack of social ameninities such as electricity, potable water, rural industries, education, and health facilities characterize most rural sectors of SSA. There is also inadequate marketing infrastructure in terms of transportation, processing and storage facilities, coupled with inadequate repair and maintenance of existing facilities. Improving the access of small-scale farmers to infrastructure can be as beneficial in many cases as increasing their productive assets. Infrastructural investments in many SSA countries bypass areas containing high concentrations of small-scale farmers. This raises their production costs and acts as a barrier to gains from greater specialization. For example, while adjustment programs in Ghana and Kenya sent out clear signals for the expansion of tradeable activities, many of the poorest farmers have faced difficulties in achieving this because of their location (Hellers et al. 1988). In making new infrastructural investments, there is the need to give priority to actions, which assist the small farmers, and open access to them. In many areas, transport infrastructure has broken down so that some local markets are poorly integrated with national markets, leading to large regional price differences (Ahmed and Rustagi 1987). This is further compounded by administrative restrictions on the flow of products. In designing a program of infrastructure, greater priority should be given to areas that are poorly served by the transport infrastructure but have high concentrations of small-scale farmers.

Where the failure of poor groups to benefit from adjustment arises from weak price signals due to weak marketing structures, the terms of trade facing poor farmers may be

raised through improving the efficiency of official marketing organizations (World Bank 1990). Ahmed and Rustagi (1987), found out that in Asia, 75–90% of the consumer prices of food grains is paid to farmers while in Africa, the proportion is 35–60%. Nearly 30% of the difference in margin is due to lower efficiency of African marketing organizations. In Tanzania and Zambia, that growth of marketing costs has been as important as currency over-valuation in causing low producer prices. By integrating the smallholders into the main stream, marketing reforms may now begin to benefit poor farmers. Restructuring of the marketing system in Mali shifted output and input prices in favor of farmers.

Export crop production

There has been excessive concentration of large farmers in the production of export crops in SSA although export crops can also play an important role in improving the incomes of small-scale farmers. Raising cash cropping by farmers offers an important way in which benefits from adjustment and growth can be increased. A number of studies have confirmed that export cropping can lead to significant gains by offsetting any unfavorable impacts in smallholder income and nutrition (Von Braun 1989, Von Braun and Webb 1989). Agricultural commercialization in Kenya has had a favorable impact on landless agricultural workers and has led to improved family nutrition and reduced hours of work for women owing to reductions in the food hectarage and increases in family income. In some cases, investments in infrastructure and improvements in marketing may be adequate enough for small-scale farmers to raise their income sufficiently. In such circumstances, policy interventions should be directed at the micro level. Other cases may require a more comprehensive package of measures in terms of infrastructural and marketing services.

Export crops are important in smallholder development as a means of diversifying sources of income and to provide cash for buying food during seasonal shortages. However, food production should not be neglected especially to provide for subsistence and minimize import requirements. What is needed is an increase in productivity in both sectors and improvements in marketing systems so as achieve an orderly transition from semi-subsistence to a more commercialized farming.

Research, technology development, and transfer

The level of technology employed by smallholder farmers in SSA is generally low. Most farmers still depend on the traditional techniques of production and processing; the rates of technology adoption are low; most smallholder farmers lack the technical know-how for efficient production and therefore rely heavily on traditional methods. There are also poor research-farmers-extension linkages, ineffective extension services and inadequate research facilities in terms of funding, research personnel, and equipment. These problems are exacerberated by SAP and need to be changed by providing the enabling environments. Moreover, agricultural research for smallholder farmers needs to be increased especially on food crops such as coarse grains, roots, and tubers. A research strategy needs to be developed for subsistence and secondary crops. Longhurst and Lipton (1985) revealed that income setbacks and the spread of poor people onto marginal lands have acted to make these secondary neglected crops more important. Many secondary crops are processed to provide food and oils while Fleuret (1979) found out that gathered food also generated cash income in Tanzania. Other desirable policies will include small-scale irrigation to extend the growing season, improved dryland farming methods, technology to reduce

labor peaks, intercropping, crop varieties with short maturation periods, and crop breeding for drought resistance.

Land access and security of tenure

In many parts of SSA, access to land and security of tenure are major problems confronting smallholder framers. Securing the claims to ownership which poor people have over their assets is an important first step to ensuring that poorer rural groups benefit from an adjustment program. Land rights are often tenuous in customary areas of SSA, thus hindering agricultural development. Policy reforms accompanied by measures to ensure poor households' rights to land will benefit the smallholder farmer. Extending property rights to smallholders and ensuring their subsistence have the effect of raising their incentives to maintain and improve those assets. In SSA, few women have secure and independent access to land. It is, therefore, important that land tenure interventions protect the traditional rights of women to cultivate land for food. Côte d'Ivoire, Ethiopia, Kenya, and Zimbabwe have now given women the right to inherit and own property (World Bank 1986).

Increased support for women

In spite of the predominance of women in agriculture in many parts of the world, women continue to be neglected in policies and strategies. It is estimated that about 85% of rural women in Africa are engaged in agriculture where they produce and process as much as 80% of family food consumption (Longhurst 1987). Reductions in male wage employment and increasing landlessness have led to increased dependence on women's earnings in poor rural households. Women must, therefore, be part and parcel of strategies designed to improve the balance of payments with regard to agricultural exports under SAP. There are also linkages between structural adjustment objectives to increase food supply, the economic and technical roles of rural women and the welfare of children. Women, representing the poorest households, head many households in both Asia and Africa. Also in Africa, there is an increasing number of households where the male is absent through out-migration.

Policies to strengthen women's land rights complemented by policies to improve their access to credit, agricultural extension, new technologies, more education, and quality health care can enhance their productivity and income and thus contribute to poverty alleviation.

Effective organization of smallholder farmers

There is the need for organizing the small-scale farmers in the region to enable them improve their productivity and efficiency under SAP. Most farmers operate on a small scale and are scattered and dispersed in settlements and hamlets within the region. These small-scale farmers engage largely in subsistence farming and thus have little turnover and income. The most common organization is the family unit made up of the man, his wife or wives, and children. Occasionally, the farmer draws from the extended family made up of two or more of the single family units.

Increased agricultural production both for export and domestic consumption, which is a major objective of SAP, requires a change in the above arrangement. It requires bringing smallholder farmers together which is not an easy task in view of the degree of geographical dispersion, social cohesion at the family level, the lack of integration beyond it with

inherent suspicion of strangers. Most government projects demand an organization for beyond what the family can offer. Irrigation agriculture, large-scale farming, and group farms are best carried out under consolidated agricultural holdings.

Only the cooperatives can satisfy the above requirements. However, there is a lack of effective organization of farmers into viable cooperative associations in many parts of the region. Since smallholder farmers are unable to provide individual security for loans, their organization into viable farmers' cooperative associations becomes vital to their success. This is to enable smallholder farmers to obtain government financial assistance and to purchase the needed inputs in bulk, thereby taking advantage of economies of scale.

Promotion of non-farm income

In addition to rural households involved in agricultural production, there are those who derive a large proportion of their income from non-agricultural wage labor activities. The great majority of these are involved in informal sector activities, such as artisan or trading skills. They produce consumption goods with little investment from locally produced or acquired raw materials to meet domestic demands. Examples include blacksmiths who produce and repair the modest capital equipment essential to the smallholder farmer's operations. Growth within this sector (induced by agricultural production growth) is of crucial importance if adjustment measures are to succeed in reducing rural urban migration and if they are to activate intersectoral growth linkages.

Health and nutrition interventions

One objective of SAP is reduction of government expenditure through restrictive fiscal policy. In this process, social services, including health services, have experienced reductions in expenditure. These combined with other SAP policies have adverse effects on health and nutrition of the rural poor, and these exacerbate a further decline in productivity and income in the rural sector. Government can use selective measures to protect and even to improve the health and nutrition of the poor during SAP through (a) income-generating programs, (b) income transfer programs, (c) food price subsidies, (d) food supplementation schemes. (e) nutrition education programs, and (f) primary health care (Pinstrup Anderson 1987). Income generation, income transfer, and price subsidy programs are used to compensate for losses in household income. Food price subsidies are used to make food or certain food commodities cheaper relative to other goods. Food supplementation schemes may be viewed as income transfer programs since they add resources to the household. Nutrition education programs can assist in reducing the negative nutrition effects of income losses by influencing household acquisition and allocation behavior. Finally, primary health care programs may play a major role by increasing the physiological utilization of ingested food and by reducing the occurrence and frequency of anorexia (Pinstrup Anderson 1987).

Educating the small-scale farmers

As pointed out in the last section, SAP involves reductions in government spending. The resource-poor smallholder farmers are particularly affected by changes in government expenditure on basic health and education services and on food subsidies. Moreover, most smallholder farmers in SSA can neither read nor write. However, many studies show a positive relationship between education and productivity (Pudasaini 1983; Jamison and

Mock 1984; Azhar 1991; Pinckney 1997) or education and adoption of new technologies (Lin 1991, Onyenweaku 1991). These results call for higher investments in formal and non-formal education (agricultural extension and adult education) in rural areas to raise agricultural productivity and income of smallholder farmers.

Summary and conclusion

This study was designed to determine the enabling policy and institutional changes for improving the impact of SAP on small farm production in SSA. The poor economic performance of most countries in SSA was attributed to the development policies of the economies in this region during the 1970s. This policy had focused on industrialization to the neglect of the agricultural sector. In a bid to find lasting solutions to the economic problems, many SSA countries embarked upon SAP in the 1980s. Analysis of the impact of SAP on the economies of some countries of SSA show mixed results. The overall results of adjustment have been modest relative to the original expectations—despite some successes in agriculture and food production. Adjustment has not yet succeeded in raising the rate of growth to levels required for effective poverty alleviation. Region-wide economic recovery is still fragile, though with variations in outcome. Currency depreciation and inflation are yet to be subdued in many countries due to the persistence of expansionary fiscal and monetary policies. Many countries still rely heavily on external grants and concessional financing to close their fiscal gaps. Per capita consumption is still stagnant while private investment is yet to be revived. Unemployment rates especially in urban areas are still high while poverty is on the increase.

Agricultural development in most of these countries is biased towards large farmers who have been the main beneficiaries of technology, research, extension, credit, and marketing services. However, this bias has not resulted in increases in agricultural productivity needed in most of these countries where the bulk of agricultural production, including food, comes from smallholder farmers. Thus, focusing on these small-scale farmers is expected to promote growth, efficiency, and equity since there is abundant evidence that small-scale farmers are more productive per unit of land than large-scale farmers.

Therefore, policies for improving small farm production under SAP will include: (i) raising small farm income, (ii) promoting non-farm income opportunities in the rural sector, (iii) effective input supply and distribution, (iv) provision of rural infrastructure, (v) export crop production, (vi) research, technology development, and transfer, (vii) land access and security of tenure, (viii) increased support for women, (ix) effective organization of small farmers into viable cooperative associations, (x) health and nutrition policy interventions, and (xi) providing education (formal and non-formal) to small-scale farmers.

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Application of farm-level data and GIS for ecoregional policy and planning in the tropics

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Abstract

The value of data in policy formulation and planning among regions of the tropics, and across West Africa was reviewed. The majority of these were based on farm-level data obtained through field and farm surveys (formal and informal). This technique of data acquisition was found to be cumbersome, tedious, and time-consuming, making its revalidation expensive for most developing countries.

The use of satellite-based data and information is promising and the potentials are great for developing countries. Data obtained through this system are readily available and can be verified on the ground, while the updates are less expensive and easily executed.

The acquisition and use of such data by developing tropical countries would enhance their formulation of reliable and sustainable agricultural plans and policies.

Introduction

The decision to follow a course of action, individually or collectively, rests largely on interest and available avenues at achieving these ideals or aims (Ikpi 1995). Documented plan of action, statement of aims and ideals by corporate bodies, government and individuals thus constitute the policy adopted by such party.

Interests are known to rarely change, however, the course of attaining such aims and ideals may change with time and situation. The need for planning to arrive at achieving ideals stated policy is crucial to their success. This is governed by several factors and inputs into such decisions; based on available data (primary and/or secondary) and the projection of the data to forecast the future trend of events and sustainability of the policy.

Decision making for ecoregional policy and planning requires the use of authentic facts and figures. These quantitative and qualitative requirements are essential for arriving at reliable and predictive results of such actions. This step involves every sector of human endeavour; including agriculture, economy, international relations, mineral prospecting and exploration, etc. Arriving at and proclaiming a policy statement involve several steps and the use of facts; particularly in the agricultural sector, the use of data is an important guide at making policy statement by all the stakeholders. The government, on a large scale, uses data generated by its field staff and other secondary information in formulating its policy on each sector and subsector.

This paper updates the uses of ground-truth data and those generated through the Geographic Information System (GIS), particularly in the formulation of ecoregional policy and planning in agriculture. It also reviews the potentials and limitations of the applicability of each source of data.

Policy issues in agriculture

The pride of every nation primarily lies in its ability to feed its people with little importation of food from outside. Therefore, the need for the provision of a conducive environment for food production, storage, marketing and improvement is crucial. These aforementioned stages of agriculture involve several inputs that are determined by others, particularly non-farming professionals. Thus, in order to harmonize these inputs into the production chain of agriculture with the aim of increasing and improving agricultural yields, the atmosphere for their use must be conducive.

Nations the world over have realized the important role being played by governments in checking the excesses and promoting the use of all factors (aggressive and weak) of production, particularly as they relate to agricultural crops. The various issues in agriculture (Olayemi 1995) that need the intervention of the state in order to ensure their synchronized performance and encourage their utilization by practicing farmers include:

- Land tenure/pattern of ownership
- Food security
- Research and development
- Production, that is commodity driven
- Credit facilities
- Subsidy systems/facilities
- Biodiversity conservation, and
- Land sustainability

In order for the state to make a proclamation on its stand on these sectors and profer guidelines to stakeholders in their operations, it requires accurate data and information. Many questions will be asked and answers to them should be based on available facts before projections could be made. Some of the production factors are briefly highlighted as follows:

Land tenure/ownership

Ownership of land and its transfer protocol largely determine the size of land available to individuals as well as what could be planted on the farmland, including the duration of tenancy, even when the land is rented/leased. For example, in Nigeria and several other parts of Africa where land is communally owned, how much land an individual can get is limited by communal norms. Similarly, where land is heritable among offspring and probably relatives, the size becomes smaller with successive generations. The Nigerian Land Use Decree of 1978, that vested the ownership of land in the state, has not been effective especially with respect to interpersonal transactions in spite of the good intent of its letter.

Government too acquires lands and pays compensation to their owners before the transfer could be completed. Tradition, custom, culture, and other factors need to be seriously considered in formulating an acceptable and functional land-use policy in most developing tropical countries.

Food security

Production of food crops (unlike animal production) is seasonal and follows a particular trend, with each plant type having its own season. It is common to have the peak production among these crops, each with few off-season varieties. During the off season, some of these crops command high prices, while during the peak production period, a glut is often experienced as a result of the supply exceeding the demand.

The year-round supply of these food commodities cannot be guaranteed. While grain crops (cereals and pulses) can be partially preserved over time, several others such as tubers (yam, cassava, cocoyam) and fruits (citrus, plantain/banana, etc.) cannot be treated equally. It is obvious that government cannot provide the wherewithal for postharvest processing and storage of all classes of food. However, government should provide the enabling environment that would encourage individuals or corporate entities that have the capacity and provide the requisite technology for adequate postharvest storage so as to enhance sustainable food security.

Commodity-driven production

There are several large developing tropical countries (e.g., Burkina-Faso, Mali, and Nigeria) with diverse soil and vegetation formations. Thus, certain food crops are more suited to particular areas of the country than others. In order to tap the yield potentials of these crops, it is instructive that their intensive production should be encouraged in the appropriate ecozones. Owing to the overall implications, the government should provide the appropriate and enabling environment to encourage small- and large-scale farmers to utilize this for increased production.

Credit facilities

Agricultural production is capital intensive, yet the majority of our farmers are resource-poor, and unable to afford most of the essential inputs. The need for assistance to acquire some of these inputs to increase their crop yield is patent. The government should determine the modalities for acquisition and repayment of such assistance especially in the form of credit facilities. Such assistance must, however, be based on several production factors including: the total farming population requiring assistance, the types of crops and normal gestation periods, the relevant inputs and average production costs, etc.

Subsidy

Experience has shown that in some developing tropical countries, cash loans granted to farmers by the government for food production were sometimes diverted to other non agricultural uses. In this circumstance, it is advisable that the majority of the production inputs to be given to farmers should be subsidized, whereby the farmers pay only part of the cost. Such inputs therefore look cheap and affordable to the farmers. However, the level of subsidy will be determined by several factors including the strength of the national economy as well as the disposition of the farmers to agricultural production and government offers.

Land sustainability

Abuse and misuse of land resources have resulted in a decline in land fertility and subsequent productivity. Land is a renewable resource that should be properly managed to ensure

sustainable productivity from one generation to another. Therefore, the general attitude of the people to land and its common use should be appraised and monitored. Furthermore, only sustainable farming practices, which enhance crop yield and reduce site degradation should be promoted by government agricultural extension agents.

Research and development

Innovation and development are dynamic in all human endeavors including agriculture. Innovations often result from improvements on the old methods or ideas of activities, through a series of experimentations. What need to be improved are many, while the resources to carry out the improvements are limited and sometime scarce. Government should therefore set research priorities and production targets with a clear mandate for particular national agricultural research centers in respect of specific crops (Okoro 1995). The introduction of improved and high yielding crop varieties into the production system should be officially guided. A total of 244 crop varieties have been registered and released for farmers use (Anon 1999). Among these, some were retroactively registered because they had been released into the system before the official registration. While breeding should be encouraged to continue for envisaged future use, the development and release of bred lines/varieties should follow the national needs. Hence through the National Committee on Registration and Release of Crop Varieties, with the secretariat at the National Center for Genetic Resources and Biotechnology (NACGRAB), national requirements in terms of each crop should be obtained and the information/data will be a useful guide to the formulation of national policy and guidelines for planning release of bred varieties. This will have a long lasting consequence on the amount of active genetic resources available in the system. Similarly, the expected or desired goals in the overall development of the system should be clearly spelt out in the official document by the state.

In addition, some externalities that affect agricultural production should be given due consideration, and be clearly spelt out in official policy statements of the government. For instance, details of importation of food items, the categories as well as the conditions for their acceptance, should be reviewed in the general interest of the people.

Farm-level data generation and utilization

On the spot assessment and evaluation generate data for factual decision making in every sector. However, the generation of these data could be cumbersome, tedious, and often time consuming. The techniques of obtaining these vary with the type of studies and its application such as social, biological, or physical disciplines.

For socioeconomic policy and planning in developing countries, data generally come from two sources (Babu et al. 1996):

- primary data collected directly through sample and field (formal and informal) surveys
- secondary data published in numerous government documents that either partly or fully depend on the sample or field surveys

Field enumerators under the leadership of a field officer often collect data.

Generation of data useful for decision making on food and nutrition policy and planning at both the national and regional levels in Malawi was organized through the initiation of Food Security and Nutrition Monitoring (FSNM) system. The operations of the system were based on farm-level surveys involving the collection of periodic information with

four different modules: (i) household food security, (ii) household income and expenditure, (iii) market and price, and (iv) nutrition monitoring (Babu et al. 1996). The application of farm survey data (farm and non farm growth linkages) from the Eastern province of Zambia shows that the promotion of policies and investments in the supply response and local marketing of non-tradable foods could greatly enhance the income and employment impacts of agricultural growth (Hazell and Hojjati 1995).

Farm-level data have been obtained for use in the western Brazilian Amazon, on why agroforestry systems were not being adopted (Vosti et al. 1998). The application of these findings to policy formulation in the region has equally being suggested (Vosti et al. 1998). Similarly, the use of farm-level (plot-level agronomic) data from Burkina Faso, for the provision of better policy guidance for agriculture in sub-Saharan Africa has been demonstrated by Udry et al. (1995).

Facts and figures have been used for a long time in planning a schedule of activities, particularly those that involve sustainability and long-term activities. In the forestry subsector, management plans have been used for the sustainable management of both natural and plantation forests. Hitherto, these management plans were based on reconnaissance and inventory data obtained from exercises carried out across the forest estate and projections made on the growth rate and sustainability of the estate. In this forestry subsector, the use of inventory (field measurements and surveys) data to obtain complete information on the quantity and quality of resources in an ecosystem as well as the value in a plantation, have been used to arrive at policy decisions in many African countries. For instance, the indicative inventory of the reserved high forests of southern Nigeria carried out by the Federal Department of Forestry during 1973 to 1977 and repeated by FORMECU from 1996 to 1998 served as a useful guide for policy decisions at national, regional, and state levels on timber production, conversion of natural forests to forest plantations, and in selecting areas of priority for intensive management surveys. This was also used to draw up and formulate forest management plans for all the states affected by the exercise (FORMECU 1996). Similarly, the results of the household surveys carried out by Ladipo (1998) and Karimu (1998) on Omo Forest Reserve, Ogun State, Nigeria, had far reaching implications on the forest reserve management policy of the government.

Data generation and utilization through GIS

The cumbersome, tedious, and time-consuming nature of farm-level data generation necessitated the need for advancement in the methods of obtaining data for decision making. The use of remote sensing to obtain information on an object from a distance without physical contact was a breakthrough in this direction. Various advances have been made in this technology over time, improving its applications and versatility. Over the years, this technology has proven a veritable source of information about the earth's surface and this advantage has been exploited for ecoregional policy and planning in the advanced world. However, the developing countries still lag behind in the multiple usage of remote sensing (Adeniyi 1985).

In Nigeria, the Side Looking Airborne Radar (SLAR) imageries of the country acquired by the Federal Department of Forestry (FDF) between 1976 and 1977 were subsequently interpreted to produce the vegetation and land-use maps of the country. These have provided the all important information for scholars, industries, and governments for planning and policy purposes. The tremendous success of the earlier use of SLAR encouraged

the repetition of the exercise between 1993 and 1995, using a combination of satellite imageries.

Developing countries from other regions of the world have also benefited from this scientific achievement. During 1994, the results obtained from a small number of Landsat and Spot imageries on Togo showed that intensified clearing of vegetation from the beginning of the 1990s, after 25 years of a strictly enforced protection policy, would lead to accelerating land degradation over the next ten years (Anon 1997). In an ambitious project to monitor crop production and predict harvests throughout the Sahel, pictures obtained from NOAA weather satellite and processed in Niamey, Niger, and complemented with ground observations were used to forecast likely harvest times. This has been very useful for planning humanitarian aid as well as supplies from regions of surplus to areas that are likely to be in deficit (Anon 1997).

Cape Verde has also developed a GIS database with the intention to optimize the development of the island of Santiago and improve agricultural productivity from its resources. This has been used to collate inventories of the island's natural resources: climate and rainfall; topography; morphology; and plant biodiversity. It is also envisaged that new layers of information (demography and urbanization) will be superimposed on the thematic map which will be highly useful for planning distribution networks for electricity and water throughout the island (Anon 1997).

The Forest Management, Evaluation, and Coordinating Unit (FORMECU) of the Federal Department of Forestry, Nigeria, was able to assess the changes in land use and vegetation in Nigeria between 1978 and 1995, using GIS techniques (FORMECU 1996). This result has provided a reliable platform for planning and policy formulation for the various facets of the Nigerian economy. Similarly, the Center for Arid Zone Studies, University of Maiduguri, Nigeria, reported a remarkable success in the use of GIS for computing the changes that have taken place in the ecology of the northeastern parts of Nigeria. This has enabled the center to design appropriate and sustainable farming techniques for the area.

Land-use characterization of the inland valley systems of West Africa has being carried out using GIS, remote sensing, geographic positioning system and ground-truth data, for policy formulation among the different countries covered by the system (Thenkabail and Nolte 1995a, b, and c).

Comparative analysis of farm-level data and GIS economy

Farm-level data are obtained through tedious, cumbersome, and time-consuming exercises, that often or sometimes combine camping on site, with a series of measurements, tabulation, and calculations. While the monetary implications in terms of allowances given to the field officers and the expenses on the vehicles and other consumables can be easily computed and valued, the risks and other hazards that are associated with such exercises cannot be quantified, as long as the team returned safely to base. The use of remote sensing and other GIS techniques have attempted to overcome these shortcomings of the farm-level system. The Landsat and Spot imageries used for the Togo GIS exercise were obtained for 150 000FF and confirmed by ground surveys which required a travelling of over 35 000 km in the different regions of the country. Systematic ground level verification of satellite image interpretation is an essential part of any program and the cost of this groundwork could be more than the cost of purchasing the corresponding satellite imageries. However,

GIS makes it easy to correlate the biophysical characteristics of a region with its socio-economic variables. Similarly, quantitative data could be obtained using GIS.

Farm-level data require frequent repetition to update and monitor the progress. And this also requires appreciable funding to put the team on the road. The permanent position of the satellites in the orbit makes the acquisition of its data readily available and constantly updated, almost on a daily basis. Data collected through the GIS cover wider areas than farm-level data and could be extrapolated for wider objects and subjects.

Conclusion

The diversity of farming systems, cropping systems and resource constraints, even within a country as well as the inability of the few policies designed at the national level to have similar effects on the rural households have be recognized.

The use of data collected through the application of GIS for sustainable policy and planning should be made available to all nations. Each country should be able to acquire this information relatively cheaply and supplement this with ground-truth verification of selected sites. These are then used to make general proclamation on such resources. Monitoring of changes in such exercise is already made easy with constant update of information from the satellite imageries.

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Agribusiness and marketing information systems development to support smallholder and medium-scale farmers in sub-Saharan Africa

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Abstract
Sub-Saharan Africa is characterized by widely dispersed small- to medium-scale agriculture-related processing eneterprises. There are activities of mainly micro-enterprises or very small-scale generators and they are very widely distributed all over the region. These as a whole contribute on the average, about 55% of the 40–70% contribution made by all microenterprises; the United Nations Industrial Development Organization (UNIDO) has earlier said that about 95% of all agri-business firms are owned and operated by individually distinct and unrelated local proprietorships. Only the remaining 5% are operated by conglomerets.
Recently, moves by some export-oriented agroindustrialists have, however, helped forge a new direction for the development of certain microenterprise operations in the agribusiness sector. It is this new development that has made it possible for some form of modular marketing information system (MIS) to emerge. This paper discusses this fully in the light of the needs and the sustainable development of small enterprises in sub-Saharan Africa.

Introduction

With the exception of a few agriculture-related processing enterprises, agribusiness establishments in the EPHTA study area of West and Central Africa are generally observed to be limited to and controlled by millions of small-scale operators/microentrepreneurs who are widely dispersed within rural and urban centers of sub-Saharan Africa. Where they are large, these businesses are more often located in suburban districts where the type and volume of final output produced usually requires an expanse of land that can accommodate the necessary infrastructure. Individually, agribusiness microenterprises have output capacities that are small and often limited. In spite of this, however, agribusiness enterprises contribute, on the average, over 55% of the 40–70% contribution made by all microenterprises to the gross domestic product of countries in sub-Saharan Africa (Ikpi 1998a).

Furthermore, a recent UNIDO (1997) study reveals that, in sub-Saharan Africa, about 95% of all agribusiness firms are owned and operated by individually distinct and unrelated local proprietorships, while the remaining 5% are operated by large conglomerates that may be domestically or internationally owned. Consequently, a large number of the agribusiness microenterprises belong to the informal sector of the countries in which they are established. This particular characteristic imbues a unique attribute of general

difficulty in organizing these enterprises into definable and systemic cooperative units that could combine their resources for synergistic gains. This marketing information system is discussed later in this paper. In order for us to appreciate the intricate relationships that exist between these agribusiness firms as a system, it is necessary that we classify them into definable categories.

Classification of agribusiness enterprises in the EPHTA region

Agribusiness enterprises in the EPHTA study area may be classified at three levels. Structurally, they may be grouped into three *operational areas* (agriculture, forestry, and fisheries/wildlife) under each of which are then identified four *functional categories* (production, processing, marketing, and service provision). Different *specific types* of these firms are then placed within each category such that a general typology of agribusiness operations may be presented as follows:

(1) Agriculture-based

production agribusiness concerns

- fertilizer and other agrochemicals providers
- livestock producers
- crop producers

processing agribusiness firms

- meat processors and packers
- fruit, vegetable and other crop processors and packers

marketing agribusiness companies

- meat distributors
- fruit, vegetables, and other crop distributors

service-providing agribusiness operations

- food wholesale and retail outlets
- food-production and processing-equipment repair centers
- restaurants/cooked food outlets

(2) Forestry-based

production agribusiness firms

- forestry-seedling providers
- lumber and other forest product providers
- non-timber forest product providers

processing agribusiness companies

- wood processors
- furniture makers

marketing agribusiness concerns
- wood and furniture distributors

service-providing agribusiness operations
- wood and furniture wholesale and retail outlets

(3) Fisheries- and wildlife-based

production agribusiness concerns
- fish net makers and suppliers
- fingerling suppliers
- fish and wildlife farms

processing agribusiness firms
- fish processors and packers

marketing agribusiness companies
- fish distributors

service-providing agribusiness operations
- fish wholesale and retail outlets
- restaurants

The number of agribusiness types in each category depends on factors such as intensity of the agricultural/forestry/fishery practice in a given country, the location of the enterprises (rural/peri-urban/urban), the size of population served, the income levels of the target consumers, the consumers' tastes and preferences, etc. Generally, however, the domestic demand placed on these enterprises is small. It is the new export markets being developed today that provide the needed leverage to increase their size of operation.

Background of the agribusiness sector in the EPHTA study area

A general background of the agribusiness sector in the EPHTA study area is best provided through a discussion of the sector's productivity, government attitude and existing public policy environment, and linkages currently established between its various components and/or subsectors. It is this background picture which defines the system's development that supports the microenterprise (small- and medium-scale) farm operations in the region.

Agribusiness enterprise productivity

The productivity of a given enterprise or business sector is usually defined by its resource-deployment capacity and the general level of output derived from the use of those resources. In other words, the productivity level of an enterprise or sector is illustrated by comparing the rate at which input requirements are converted into outputs within that enterprise or sector. Under the enterprise or sector definition, productivity may also be given by a *concentration index* (measured by the total quantity of some selected final product in the sector that is contributed by a specified number of the firms producing that output), and the *scale of organization* of the firms concerned.

Productivity may sometimes be measured in relation to either the factor(s) of production or the final output. In either case, productivity is a good indicator of efficiency in resource use. When considered on the former basis, productivity estimates for labor and capital invested in agribusiness operations show high returns, indicating that factor-marginal productivity is not yet optimal and that factors of production are not yet being sufficiently and effectively used in the region.

At the total enterprise level, however, productivity estimates are low. For example, with respect to the entire agribusiness sector/enterprise performance in 1996, UNIDO estimates for the EPHTA study area show that the resource-deployment capacity in the agribusiness sector is poor, covering less than 35% of the level that is needed for desirable food-security and food self-sufficiency impacting. In other words, although productive agricultural resources are abundant in sub-Saharan Africa, their use rate is below desirable and economic levels. This is partially attributable to the fact that it takes, for instance, more than 95% of the firms in the subsector to provide about 50% of the output needs of the sector. This percentage is equivalent to millions of farmers being needed to provide less than 50% of the required food output as compared to a few farmers (usually 5 to 15%) in developed countries. Such a concentration index is too high, indicating either a low productive base or a low capacity utilization of resources by existing firms (Ikpi 1998b).

As an example, cassava is used here to provide a classical confirmation of this low-level agribusiness productivity within the EPHTA study area. Table 1 summarizes cassava plantings, total production, and yield per hectare in four selected EPHTA study countries (Ghana, Nigeria, Tanzania, and Zaire) for 1980–1995.

Table 1. Cassava planted area and productivity in four selected EPHTA study countries, 1980–1995.

Country	Year	Planted area ('000 hectares)	Total production ('000 metric tonnes)	Yield/ha (metric tonnes)
Ghana	1980	380	2,896.3	7.6
	1981	345	2,720.6	7.9
	1982	280	1,985.5	7.1
	1983	210	1,375.2	6.6
	1984	495	4,065.0	8.2
	1985	370	3,075.0	8.3
	1986	365	2,876.2	7.9
	1987	390	2,725.8	7.0
	1988	354	3,300.0	9.3
	1989	415	3,320.0	8.0
	1990	323	2,717.0	8.4
	1991	525	5,701.5	10.8
	1992	518	5,662.0	10.9
	1993	545	5,972.6	10.9
	1994	550	6,025.0	10.9
	1995	555	6,611.4	11.8
Nigeria	1980	105	942.0	9.0
	1981	69	620.0	9.0
	1982	65	592.0	9.1
	1983	55	513.0	9.3
	1984	1,255	11,800.0	9.4
	1985	1,195	13,500.0	11.3

Table 1. Cassava planted area and productivity in four selected EPHTA study countries, 1980–1995 (Continued).

Country	Year	Planted area ('000 hectares)	Total production ('000 metric tonnes)	Yield/ha (metric tonnes)
	1986	1,096	12,388.0	11.3
	1987	1,285	13,876.0	10.8
	1988	1,243	15,540.0	12.5
	1989	1,851	17,404.0	9.4
	1990	1,705	19,943.0	11.7
	1991	2,204	26,004.0	11.8
	1992	2,727	29,184.0	10.7
	1993	2,869	30,128.0	10.5
	1994	2,953	31,005.0	10.5
	1995	2,935	31,404.0	10.7
Tanzania	1980	302	1,207.0	5.6
	1981	310	1,456.0	7.4
	1982	331	1,658.0	7.4
	1983	372	1,967.0	7.4
	1984	401	1,894.0	7.4
	1985	300	2,087.0	7.4
	1986	362	2,031.0	8.3
	1987	345	1,709.0	8.3
	1988	361	1,272.0	8.3
	1989	392	1,731.0	8.3
	1990	371	1,566.0	8.3
	1991	198	1,778.0	9.0
	1992	200	1,802.0	9.0
	1993	200	1,802.0	9.0
Zaire	1980	1,897	13,090.0	6.9
	1981	1,880	13,170.0	7.0
	1982	1,707	11,780.0	6.9
	1983	2,180	11,840.0	6.9
	1984	2,005	15,040.0	7.5
	1985	2,065	15,490.0	7.5
	1986	2,220	16,440.0	7.4
	1987	2,275	16,500.0	7.3
	1988	2,270	17,000.0	7.5
	1989	2,320	17,400.0	7.5
	1990	2,330	17,400.0	7.7
	1991	2,370	18,500.0	7.6
	1992	2,460	18,700.0	7.6
	1993	2,470	19,00.0	7.7

Sources: Compiled by Ikpi from various publications: (1) For the Ghana figures: Ghana Ministry of Agriculture. 1997. *Agriculture in Ghana—Facts and Figures*. Accra.
(2) For the Nigeria figures: Central Bank of Nigeria. 1995. *Annual Report*, Lagos.
(3) For the Tanzania figures: (a) Ferguson, T.U. 1991. *An FAO Report on Cassava Consulting Mission to Tanzania and Uganda; and (b) Kiriwaggulu, J.A.B. 1994. Industry Review of Sorghum, Millet, and Cassava in Tanzania.*
(4) For the Zaire figures: (a) Shapiro and Tokens. 1992. *Cassava Production in Zaire;* and (b) Department of Agriculture, Zaire. 1994. *Regional Cassava Production Estimates.*

From Table 1, one can deduce that the average yield per hectare of cassava harvested during the period covered ranged from 5.6 tonnes in Tanzania to 11.8 in Ghana and Nigeria. Compared to the achievable yield of between 24.5 and 30.95 tonnes/ha (depending on the soil type), this low average yield recorded for each of these countries is an indication that much still needs to be done in terms of disseminating improved cassava varieties for adoption. In fact, field visits to Tanzania and some parts of Ghana and Nigeria confirm that scientists in the National Agricultural Research Systems collaborating with IITA in these countries still have some serious sensitization work to do in order to effectively disseminate the improved cassava technology presently wasting on the shelves.

The generally low overall productivity of this crop in each of these producing countries (in spite of the fact that it is less land and labor demanding than other crops) confirms that there is currently not enough investment to bring out its commercialization potential. The total land area devoted to this crop in each of these major cassava-producing countries has not reached the point of economic optimum that will yield attractive profits to growers.

Government attitude and existing public policy environment

Government influence on entrepreneurs is of paramount importance in the development and expansion of indigenous agribusiness enterprises in sub-Saharan Africa. This influence is discernible in three ways. First, government's general attitude toward private enterprise determines whether or not the business climate is favorable. Secondly, government policies usually indicate the economic sectors in which private enterprise is encouraged to operate, set rules and regulations with which businesses must conform, and affect the market incentives and pressures that guide its day-to-day operations. Thirdly, government programs usually provide the means for financial help, technical assistance, and other types of aid which private entrepeneurs need for establishing, expanding, and improving their activities. In the EPHTA study area, these various components of government influence have tended to be negative towards agriculture and agribusiness microenterprise development. In fact, the general government attitude and public policy on agribusiness growth and expansion in the region have been downright inimical. They have actually tended to discourage agribusiness practice, especially as it relates to small- and medium-scale operators.

Interestingly, despite this non-supportive role of government attitude and public policy on indigenous private enterprise, virtually all countries in the EPHTA region have been seeking to encourage private foreign investment as a major source of the capital and of the technical and managerial skills required for their development. Thus, even in the socialistically inclined African countries, whatever objection there is to private economic activity on ideological grounds is outweighed by realistic recognition of the need to take advantage of all possible sources of capital and initiative. As a better understanding of the nature and potential benefits of indigenous private enterprise spreads among African leaders and the disadvantages of excessive dependence on public enterprise become increasingly recognized, the willingness of many African governments to modify doctrinaire convictions about indigenous private enterprise will increase and be encouraged. This broader understanding and consequent willingness to rely upon various types of economic activity are also likely to be fostered as experience is gained in the process of development planning which, in one form or another, is being practiced by most African countries.

Linkages between agribusiness sector components and/or subsectors

As indicated above, the agribusiness sector in sub-Saharan Africa is made up of different components and/or subsectors that operate mostly independently. However, because of economic dynamism and the existence of the law of natural relations and dependence of related parts, a system of linkages has developed within the agribusiness sector. These linkages are normally encouraged by the formation of trade associations and chambers of commerce in industry and agriculture that national business regulations usually impose on even small proprietorships as are dominant in agribusiness. Furthermore, the need to add value to agricultural raw materials before they are sold to final consumers or manufacturers has necessitated the formation of local groups or associations that promote the interests of members. Hence, business linkages have developed among and between agribusiness enterprises in both rural and urban areas of the EPHTA region. These linkages are maintained and fostered by a drive/desire for survival by these enterprises; and it is from their existence that a marketing information system has developed to support the small- and medium-scale agribusiness operators.

Marketing information systems development in African agribusiness

Generally, the level of marketing information collection, processing and dissemination in relation to and for the use of agribusiness operations is a serious handicap that effectively slows down the rate of development of this sector. Consequently, existing domestic markets are simple, scattered, and uncoordinated; export markets for most of agricultural and agribusiness products are just beginning to develop for most of the EPHTA study area. Recent UNIDO studies of the agro-industrial sector of sub-Saharan Africa in 1996 show that external demands imposed on the sector have led to the creation and existence of rudimentary and informal but partially effective marketing information systems for and among agribusiness micro-enterprise operators in the region.

These information systems operate at three levels, the commodity producer level at the farmgate centers, the processor level at collection points, and the exporter level at the few specified ports. The success of the system at each level is inversely related to the number of operators at that level such that the operators at the farmgate level have a weaker system than those involved at the exporting level.

At each of these levels, the marketing system generates and collects data on the:

- number and concentration of producers/processors/distributors in each geographical location
- total quantity of each commodity produced/processed/distributed within the defined domain
- proportion of this quantity that is available for domestic consumption and sale
- price per measure of the commodity or processed form
- number and form of associations that exist for the various operators in that level of the market
- periodicity/frequency of meetings of the market

A collection of centers at each level constitutes a *business cell* whose members are bound by invisible rules and regulations that govern its survival. Information generated and collected at this level is usually digested and disseminated with dispatch among operators.

Women's issues in agribusiness development in the EPHTA region

Generally, women play a crucial role in agribusiness enterprise development. Available statistics from the ILO (1995) indicate that about 60% of all agribusiness firms are established and operated by women. Unfortunately, however, in their efforts to promote gainful self-employment and operate agribusiness micro-enterprises, these women face certain constraints. According to Ikpi (1998a) and the ILO African Employment Report 1995, most of these constraints are gender-specific. They include:

- *behavioral barriers* which make women operators have little self-confidence and a negative self-image
- *educational barriers* which make women attain relatively lower education levels, receive a biased education, and usually have limited access to vocational training opportunities
- *infrastructure barriers* which deny them access to credit, technology, support services, land, and information
- *legal barriers* which make independent legal action limited for women
- *occupational barriers* which cause women to have fewer opportunities in the formal sector for skill development
- *role-related barriers* which arise because of conflicting role demands and time constraints on women
- *social and cultural barriers* which promote negative attitudes towards women in business, demand that women must fulfill other roles, restrict them as to the choice of sector, and increase their lack of family support and mobility

Most of these constraints have sociocultural origins, and so require deep-rooted attitudinal changes in the sociocultural environment. Despite these observed constraints, many women still become self-employed by setting up agribusiness microenterprises. Thus, for a proper development of the agribusiness sector, women-headed enterprises should not be viewed in isolation from the economic and sociocultural context in which they evolve. The establishment, survival and growth of women-headed enterprises are all crucially affected by societal values such as undervaluation of women's economic role, sex-role stereotyping, women's limited access to certain types of vocational training, industrial policies, and legislation.

Conclusion and recommendations

The way forward for agribusiness enterprise development in sub-Saharan Africa demands that, in recognition of the potential contribution to economic growth, economic resilience, savings accumulation/capital formation, employment creation, etc., governments in the EPHTA region should start implementing programs that generally encourage entrepreneurial capacity building for all investors, but especially for female agribusiness investors. Such programs should incorporate the following elements:

- provision of credit
- technical training for improving productivity and quality of output
- managerial training
- action to facilitate more women's involvement in economic activities through the organization and funding of various supporting social activities such as child care and group discussions to develop better social awareness of women's economic roles in society

- marketing assistance
- actions to facilitate the establishment of women's groups including an early start to improve girls' access to education and to training in modern technical skills as well as in leadership
- assisting in setting up new agribusiness enterprises or upgrading existing ones

In order to effectively implement the above suggested elements, it is necessary to train officials in many public departments, banks, and other lending institutions that have anything to do with agribusiness development to recognize the economic potential of their entrepreneurs, especially women. Furthermore, there is a need to build up networks and ensure appropriate coordination between all relevant government and nongovernment departments and institutions in the field of business promotion and development (credit, technical and managerial training, choice of technology, input procurement, legal counseling, marketing, and management).

There is a need to establish, within the EPHTA study area, agribusiness industrial parks whose principal focus should be to promote agricultural-input industries and commercial crops, ensure food security, enhance agricultural productivity, increase competitiveness, and attract needed resource flows into agricultural industries. Such parks should be able to unveil viable avenues for enhancing value-added products while increasing the degree of local processing. They should also demonstrate how the region's industrial complementation could be achieved.

Finally, experience shows that past development efforts at assisting African nations have centered on large projects. These efforts have summarily failed to meet desired goals or objectives. For instance, social funds budgeted for and spent in countries of the region have failed to work because of nontransparency of handlers and improper application of such funds. In the last 25 years alone, development banks have spent over a trillion US dollars in sub-Saharan Africa funding large projects that have proved irrelevant to the intended beneficiaries. There is a need, therefore, for such banks to refocus by reassessing their planned contribution to development in future. They should develop new workable strategies that invest in people (human capital) instead of in macro projects such as buildings, roads, etc. They should support only those strategies that intermediate with nongovernmental organizations working with microenterprise owners and operators in the agribusiness sector.

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Gender roles in the development of sustainable food systems in sub-Saharan Africa

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Abstract
Efficient and sustainable strategies for the production of food to serve the needs of the rapidly rising population of sub-Saharan Africa are presently a factor worth considering. Women are directly involved in food production and the attainment of its sustainability and the continued role of women in food processing and distribution is also a worthwhile factor in the development of sub-Saharan Africa. Unfortunately, despite their laudable contribution, tradition engendered norms in the distribution of entitlements is skewed in favor of men, but at least there is an exeption as in the care of the Chewa in Southern Malawi.
Women continue to be active in the provision of food for the family even as they take up alternative or additional jobs, thus making women sustainer of the home in sub-Saharan Africa. Poverty and food insecurity continues to grow as in Nigeria and Ghana where crops such as cassava, yam, maize, and others continue to fall for one reason or another. Male-dominated patriarchal norms of resource allocation, distribution, and decision making in traditional farming economy, the persistence for urban bias in infrastructural allocation including an urban-driven lowering of prices, etc., contribute to the present crisis in food production in SSA. The need for more attention in addressing these issues is vital in order to sustain food production and to reduce gender bias.

Introduction

A major challenge facing sub-Saharan Africa (SSA) is finding efficient and sustainable strategies to produce enough food, reduce postharvest losses, and distribute the produce to the continent's rapidly rising population. Several studies on food production in SSA have confirmed that in small-scale agriculture, women are directly involved in this struggle for food security at all levels. Unlike men, the contribution of women goes beyond production to include processing as well as distribution in many countries. The evidence, however, is that in the region, as has been found elsewhere, gendered norms in the distribution of entitlements in the household and family seriously influence the allocation and ownership of productive assets. Except under extreme forms of matriliny as has been found among the Chewa in southern Malawi, resource distribution practices have typically favored men at the expense of women's activities in agriculture (Henn 1984; Boserup 1970).

Women's involvement in promoting food security in SSA is important for other reasons besides their heavy presence in the farming sector. A rigid gender segregated division of labor in agriculture, compounded by the drift of men during colonialism into commercial production compelled women producers to expand their farming activities to feed the family. Today, most women farmers continue to concentrate on food production, while men have more varied choices between food production and export or other cash crop production such as commercial staples. Indeed this landscape underlies Boserup's description of SSA as the region of female farming par excellence (Boserup 1970).

In the last two decades, living standards in SSA have been facing a general decline manifested in increased levels of poverty and food insecurity. Per capita food production has been inadequate in the region and declining steadily (Abalu 1997). Production growth rates for selected food crops in Ghana and of general food production in Nigeria, as presented in Table 1 and Table 2 are indications of this fact.

The situation of women producers can be understood from two directions. First, male-dominated patriarchal norms of resource distribution and decision making in the traditional farming economy have had constraining effects on the growth of women's production activities. Secondly, the persistence of urban bias in infrastructure development and urban-driven low pricing mechanisms, together with a neglect of general incentives for rural producers have had disproportionate effects on women producers. Policies supporting lower prices of food that are common in Africa are criticized for being urban biased (Timmer et al. 1993) and are identified as being the fundamental causes of the food production crises because they do not provide adequate incentives to the producers, most of whom are women. These policies tend to overlook the links between urban food prices, producers' incomes, and their capacity to ensure national food security.

In the past, policymakers had been comforted by a general expectation that policies which improve the access of smallholders to land, improved technology, fertilizers, credit and market information, can both raise aggregate food supply and minimize scarcity pressure on food prices (Pinstrip-Anderson 1989). But development analysts using gender-sensitive field techniques are beginning to acknowledge the fact that this general principle is subject to local discriminatory pressures in resource-distribution practices. Koopman (1992) has argued, for example, that to achieve a sustainable food system in

Table 1. Production growth rates for selected food crops in Ghana (%).

Crop	Growth Rate (%)	
	1988–1991	1991–1995
Cassava	9.7	8.8
Yam	3.9	1.1
Plantain	13.2	12.7
Maize	9.8	7.7
Rice	14.2	13.3
Millet	21.5	15.3
Sorghum	15.3	12.9

Table 2. Growth rate of food production in Nigeria.

Period	Growth rate (%)
1976–1980	4.41
1981–1985	9.31
1986–1990	14.55
1991–1993	5.71

Source: Akanji (1997).

Africa, policymakers need to understand intra-household separation and inter-relation of men's and women's enterprises and incomes, in addition to directing resources to a great majority of resource-poor farmers.

Additional reasons why development practitioners are turning their attention to the gender dimensions of food production can be traced to the problem of natural resource management. By virtue of their sheer numbers in food production, women directly influence the management of soil fertility and erosion, water infiltration and retention, waste and by-products (Cleaver and Schreiber 1994).

Gender analysis of food production further draws attention to the key issues of time and labor availability. At stake is the extent to which men and women, as separate producers, are able to devote the time and effort it takes to intensify food production. Studies on time use at the smallholder level already point to the fact that women experience severe time deficit problems, because they are burdened with multiple roles of child bearing, housekeeping, and economic production. Further, there is evidence that even in production systems that are male designated, such as export crops, women provide vital labor. It has been found in Zambia, for example, that women put in about 8.5 hours daily on men's farms compared to 7.4 hours by men during the peak farming periods. Altogether these commitments put disproportionate pressure on women's energies with negative consequences on their productivity.

To be able to address the issues of gender imbalance in men and women's production strategies, one needs to acknowledge that their operations differ in many respects. Cleaver and Schreiber (1994) have summed up the major differences that require the attention of policymakers as follows:

- Men and women often have different objectives in farming.
- They have different and uneven resource endowments.
- They are faced with different incentive systems.
- The constraints they encounter are different.
- They perceive different risks and adopt different risk management strategies.
- They experience differing access to factor and product markets.
- Their access to information, technology and other support services differ, and
- The pattern of resource flow between men and women's farming activities is uneven and often in favor of men (e.g., labor).

The general aim of this paper is to highlight women's contribution to agriculture, and common gender-related issues in food production in SSA. Special reference is made to the peculiar male-biased intra-household resource flow patterns and how they impact on women's agricultural activities. The paper also looks beyond the households and families to external institutions of development, to see how gender-neutral development frameworks have had differential impact on men and women producers. In the final analysis an attempt is made to identify ways in which SSA countries can proceed to remove the constraints on men and women's contribution to food security. The rest of the paper is divided into the following sections:

- Gender and resource allocation in agriculture
- Existing gender roles in food production, postharvest handling and marketing
- Technology development and transfer
- Gender considerations in agricultural resource management
- Conclusion and recommendations

In preparing this overview we have relied heavily on past reports and publications on women and agriculture in sub-Saharan Africa. Special attention has been given to Ghana, Nigeria, and Kenya to illustrate the issues being discussed.

Gender and resource allocation in agriculture

While a majority of women in food production can be described as disadvantaged relative to men in access to resources, women are nevertheless not a homogeneous group. There are important inter-generation and cultural differences between different groups of women. Some women are fortunate to have more opportunities for mobilizing resources to promote their enterprises. Throughout this paper, it is the situation of the more deprived women that receives attention.

The background of African farmers

Except in one or two respects, there is a general impression that the background of both male and female farmers in Africa has changed little in the last 40 years, a period during which most African countries had obtained their independence. Data to verify this impression are however, often sparse due to irregular censuses and other data gaps. Prior to the introduction of surveys on living standards with the Structural Adjustment Programme (SAP) in many African countries, there were no regular nationwide socioeconomic studies on households.

Recent evidence, however, confirms that the majority of African farmers remain without formal education. They continue to depend on age-old traditions and skills in farming handed down to them by their forefathers and mothers. They rely largely on local knowledge for natural resource management, although these methods may no longer satisfy the needs of a rapidly degrading environment. Marketing practices continue to be dominated by poor information flow between buyers and sellers concerning prices. The lack of formal education and access to other information channels means that farmers still suffer from limited access to innovative information and technologies (Cleaver and Schreiber 1994).

A study by Garba (1997) revealed that about 43% of Nigeria's *gari* processors are uneducated while another 43% possess primary education; 77% of the uneducated did not keep records. The situation is common among women producers and processors in sub-Saharan Africa. Apart from making effective planning quite impossible, lack of proper record keeping makes the estimation of returns very difficult.

In many countries, there is also a growing concern that the age profile of farmers is rising, due to high migration of youths from rural to urban areas. In the past this was a phenomenon associated with young men, but adolescent girls are increasingly joining this exodus. Old men and women and female household heads are left to manage with the help of children, with negative consequences on children's education. Young girls who are the preferred helpers in most cultures suffer most from these arrangements.

Gender and land allocation in agriculture

In spite of the impressive contribution women make to the food system, their productivity is generally lower than the already too low levels that characterize smallholder agriculture. This is because most have relatively lower access to various factors of production,

education, and market information. Even women's own labor input in the food system is reduced as a result of their multiple roles (Due 1991).

In Ghana, for instance, land is predominantly regulated by customary rather than statutory laws. On the surface, customary laws appear to have clearly stated codes for controlling land use, but it has been noted that pressures on land allocation have opened land laws to wide interpretation and have affected decisions related to access and ownership of land. Channels of access to land in Ghana and other West African countries include the family, spouses, share cropping, lease, purchase, or gift transfers. Though women have extensive land-use rights, their access to the resource depends largely on their relationship with men, its availability, and the goodwill of those who control it. Similarly in Nigeria, while the 1978 land-use decree vested all land rights in the states, traditional laws still prevail in practice. Women have to channel their access to land through the rights of their husbands and male relatives. Furthermore, the plots women own are subject to more fragmentation (Akanji 1997).

Studies have revealed that women form a large proportion of farmers who do not own land in Ghana (GGDP 1991). The situation limits women's sense of security and motivation in agricultural production. In cases of divorce, death, or changes in land-use decisions by men, women often risk losing the land they depend on for their livelihood. With the rehabilitation of export crops such as cocoa and coffee under SAP, in many African countries, the expansion of tree crop farming, for example, has taken more fertile lands out of women's food production activities.

The evidence that different forms of kinship structures have differential impact on women's access and control of land is mixed. In places such as Ghana, matriliny has surprisingly no major ameliorating effects on women's land problems, because it is men in the matrilineal family who still practically control land (Bortei-Doku 1990). On the other hand, as noted earlier that in the matrilineal-matrilocal district of Zomba in Malawi, it is said that women enjoy high tenurial security because they continue to stay in their communities, farming land controlled by their mothers and grandmothers. Land scarcity here, however, creates practical problems even for women (Hirschmann and Vaughan 1983).

Land reforms in sub-Saharan Africa do not seem to improve the position of women in land rights and tenurial patterns. In East, Central, and Southern Africa where this occurred, no serious attempts have been made to confront the gender asymmetry in the ownership of land by traditional leaders who control land, or policymakers. Consequently, reforms have not touched on the necessary legal codes that will guarantee both women and men equal legal rights to full use, control, and ownership of land (Horenstein 1989).

With increasing awareness of the importance of gender analysis for sustainable development, the trend in research is to examine inter-household resource mobilization and distribution flows, as well as the dynamics of social interaction within the household. The latter governs the access to, and control of resources among men and women and how they influence productivity, output, and incomes.

Access to credit

It has been established that African women's productivity is low for various reasons and hence, their returns from the productive activities are low. With low incomes, amounts reinvested are invariably low. A majority of the women cannot afford modern technology that will increase their productivity. The recurrence of this phenomenon must be broken to

enable women play a meaningful role in developing a sustainable food system. Access to credit is perceived to play a significant supporting role in the development process and provide a means for individuals and groups to acquire and mobilize productive resources.

Historically, farmers' access to formal agricultural credit has lagged behind credit for commerce and other formalized sectors where quick returns can be anticipated and provide more security. Undoubtedly, women's lack of access to credit is part of the larger problem of inadequate credit to small-scale farmers. Formal credit to the agricultural sector in Ghana, for instance, has declined consistently over the years, mainly due to chronic and high default rates among farmers. Formal financial institutions have argued that the administrative costs of small loan borrowers have been high (Table 2). The situation is no different in other sub-Saharan African countries.

But African women are faced with a complex range of legal, social, and practical constraints. For example, collateral required by most banks in Africa are traditionally not owned by women in the region.

Where businesses have been accepted as collateral, women, often engaged in small-scale enterprises with no documentation of formally registered business, have not been considered. In some communities, attitudes and beliefs lead to underestimation of women's potential agricultural productivity and their ability to repay loans. Generally, high levels of illiteracy, lack of guarantors, lack of access (especially of married women) to bank accounts, long distances to credit institutions, and complex banking procedures, have continued to limit rural women's access to credit. Loans extended in the Kwahu Praso Rural Bank, Ghana, to rural women as presented in Table 4 depict the situation clearly. Information on sources of credit for male and female farmers and produce traders in Nigeria, as presented in Table 5 reinforces this fact.

Table 3. Percentage of loans and advances to the agricultural sector by commercial and secondary banks.

End of period	Commercial banks	Secondary banks
1988	16.6	13.2
1989	15.5	13.4
1990	15.8	16.1
1991	13.6	13.0
1992	11.1	8.7
1993	9.6	7.5
1994	6.6	9.3
1995	4.8	9.0

Table 4. Percentage of loans granted to women by the Kwahu Praso Rural Bank, Ghana.

Year	% of total loans to women
1984	23
1985	37
1987	10
1988	12

Source: UNECA (1996).

Table 5. Sources of credit to male and female farmers and produce traders in Nigeria (percentage from given sources).

	Farmers		Traders	
	Male	Female	Male	Female
Moneylenders	15.8	12.5	1.2	23.6
Licensed buying agents	23.7	12.5	–	1.6
Banks/govt. credit institutions	10.5	3.1	17.9	–
Cooperative union	42.0	40.9	3.6	17.6
Spouse/friends/relations	–	–	57.3	46.0
Personal savings	–	–	12.8	–

Source: Akanji (1997).

Several studies have, however, shown that lack of credit does significantly limit adoption of improved technologies even when fixed costs are not large (Feder et al. 1985; Lipton 1976; Bhalla 1979). A large proportion of rural producers including women farmers tends to rely on the informal financial market for their credit (Akanji 1997). These include middlemen, friends, relations, moneylenders, and in some cases, spouses (Table 5). From these sources neither collateral nor interest is usually demanded. Loan transactions are conducted verbally and records are often undocumented. In addition, repayment terms can be quite flexible. It is not unusual for borrowers in some communities to repay cash loans with labor assistance as occurs in the northern part of Ghana.

Some farmers obtain credit from prospective buyers to pre-finance their farming activities. Other rural women form groups to engage in rotating credit schemes popularly known as *susu*. Cash mobilized from these sources is generally not very large, though it plays a critical role in financing business (Bortei-Doku and Aryeetey 1995). Borrowers seeking larger sums on the financial market turn to local moneylenders. Despite the bad publicity they receive for their exorbitant rates of interest, their facilities are patronized because they are accessible to ordinary people.

In recent years, considerable effort has been made in sub-Saharan Africa to eliminate some of the factors that impede female access to credit. Special programs have been created to increase women's access to credit, using innovative approaches, such as improving traditional group savings schemes, savings/credit associations and cooperatives, or special rural credit lines. These approaches have been noted for attempting to simplify credit procedures, relaxing guarantee requirements, and bringing credit facilities down to the village level (UNECA 1996).

Various agricultural projects in Ghana stepped in to link up poor farmers with formal credit institutions by lodging funds with banks to provide revolving credit funds to both men and women producers. Although attempts by development agencies to link farmers up with banking institutions have increased, the coverage remains quite low.

The literature shows that when state and donor resources are targeted at households rather than at particular categories of farmers, they become subjected to male control and rarely enable women to gain access to the inputs they require to improve their productivity and that of their plots (Koopman 1992). It is, therefore, important to target credit specifically at rural women for their on-farm and off-farm income generating activities to enable them to break through the poverty cycle that they face and ensure their household food security.

Encouraging traditional savings systems modeled on the Grameen Bank has been proved to be an effective way of channeling credit to women. This group approach helps to target credit specifically at groups of women, relying on group guarantees as well as peer group pressure for repayments. It makes provision for women who might only want smaller amounts than the Bank's minimum lending requirements. It also reduces the administrative cost of lending. The approach has gained wide acceptance in Africa (UNECA 1996) because it is a sustainable means of using credit to raise household incomes. It is, therefore, necessary to intensify efforts toward the formation of women's groups and building up the capacity of existing ones to enable more rural women to have access to credit facilities.

Reports from one of the projects in Ghana, UER LACOSREP, which adopted the group approach for its credit scheme, indicates its success in the African environment. In the UER LACOSREP project, about 64.35% of the loans were extended to women. Reports from the project further suggest that women's production levels have gone up and their savings deposits are growing faster than in the men's groups. Women also had better repayment rates. In Nigeria, while the repayment rate for loans extended to women for cocoa production was 85% that of men was 53% (Akanji 1997).

Another way to enhance rural women's access to credit is by formulating and enforcing policies that reserve acceptable proportions of agricultural credit to women. Rural women could also be reached with credit by linking village-based savings and loan groups with larger government credit programs and/or with the banking sector (UNECA 1996). Non-governmental organizations (NGOs) could also be commissioned to act as intermediaries between the governments and commercial banks to provide credit for rural women.

Women's nutrition status and its implication for agricultural productivity

Women decide how much food can be available for the family and the kind of food the family eats. They prepare the food to conserve its nutrients and apportion it among family members. In most rural communities, men and women eat separately; the women serving the food feel obliged to give the more nutritious sources (fish and meat) to the men while they have the bulky low calorie staples. The typical pattern of eating (adult male first, followed by boys, girls, and last, women) suggests that when food is scarce, women are likely to go hungry. In addition, with increased monitization, women farmers have been observed to sell more and consume less of their produce to raise funds for farm inputs that go with improved production methods (Akanji 1997). These factors contribute to the poor nutritional status of women. About 40% of women in sub-Saharan Africa are affected by anemia (Yambi 1996).

Another factor that has negative implications for rural women's nutrition status is the lopsided gender distribution of labor for agricultural production. Even when recent trends in development have led to changes in gender roles, the changes have been unidirectional, with women always assuming men's role and not vice versa (Lado 1992). Women in food production continue to have a heavy workload. This, together with gathering fuelwood, child care, and food preparation leave women overburdened and has important implications for their nutrition and health status.

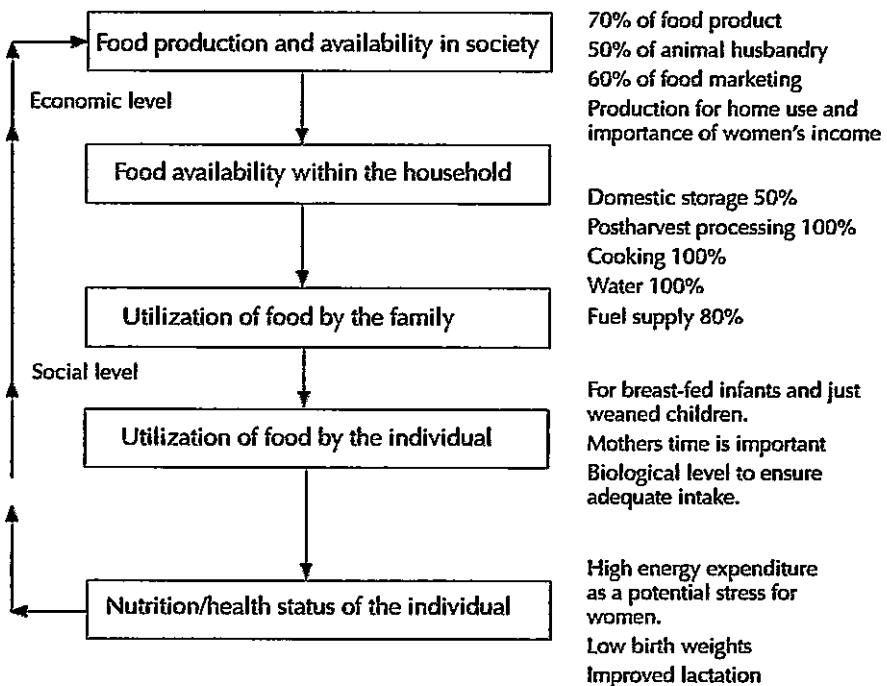
The general inferior position of women in traditional African societies affects their health and has serious implications for their agricultural productivity. In addition, maternal malnutrition limits neonatal immunity and predisposes infants to contracting communicable

diseases and thereby increasing health care bills, which is often borne by the mothers. It places additional burden on the already low funds available for purchasing inputs for women's productive activities. About 39% of all Ghanaian 2-year olds are moderately or severely stunted (GSS 1994). Stunted children grow to be stunted adults. About 25% of Nigerian women of child-bearing age are stunted from malnutrition (Yambi 1996). One most significant consequence of adult stunting is reduced physical capability and productivity. Research in the Philippines shows that productivity of physical labor declines by 1.4% for every 1% reduction in adult height. Effects of malnutrition, such as mental impairment due to iodine deficiency, stunting due to protein energy malnutrition and iron deficiency anemia have a profound impact on work productivity.

Women's role in the food system is not limited to production, processing, and marketing but extends to food utilization, nutrition, and health (Fig. 1). Women's role in food production is central to nutrition for three reasons. First, they produce most of the food in sub-Saharan Africa (about 70%) and thus, their productivity, to a large extent, determines how much food is available for consumption. Secondly, women have the responsibility for their families' health issues and rely on their incomes to respond to their family's health needs. Finally, childcare that includes ensuring an adequate food intake, is solely the responsibility of women in most African societies. The three factors—food, health, and care provided by women—together determine the nutritional status of an individual (Yambi 1996).

Besides producing food for the household, women spend their income from on-farm and off-farm activities on daily family needs. In fact, their income is more significant

Figure 1. Women's role in the food system.



Source: Adopted from UNECA (1974).

than men's for household nutrition requirements, not only because they are traditionally responsible for their own children's food but also because, though small, women's income is more regular than that of men (Lado 1992). Quite often, rural men's earnings are from the sale of cash crops and/or wages earned from working on other farms.

In so far as women's income is important for the nutrition of their families, women have to balance the costs and benefit of devoting their time to children with those of earning extra income. Certainly adequate access to labor saving production technologies can help women to devote reasonable time to their families without compromising their productive roles and/or lowering incomes. Perhaps the real issue is whether there is a trade off between "child care time" and "productive work time". More often, the actual reduction is in women's leisure time, with possible implications for their health (Lado 1992).

Nutrition programs in Africa have often been oriented towards increased food production without the realization that availability of food in itself does not guarantee access to food by all. In Nigeria, for instance, even when available food meets 95% of the national calorie requirement, as much as 36% of the population are malnourished (Yambi 1996). Similarly, while the available calorie level in Ghana is 93% of the required, about 27% of the population remains malnourished (Yambi 1996).

Lado (1992) rightly points out that: "Opportunities for incorporating women's interest in rural development schemes have been missed due to the contribution of ideological bias, lack of information and the desire for expediency among planners and policy makers".

Efforts to improve African women's nutritional status require an inclusion of nutrition objectives in rural and agricultural development programs. For this purpose, it is necessary to monitor changes in the nutritional status of women and children in particular (because of the reasons discussed earlier), work patterns, resource allocation, and household responsibilities. Because of the multisectorial nature of the nutrition problem, there is also a need for a collaborative effort by all relevant sectors ministries in planning for reduction in malnutrition.

Interestingly, sub-Saharan African women themselves are not aware of their poor nutritional status and how it affects their health and productivity. It calls for an intensification of nutrition education that take into consideration the types of locally available food, the income levels of the target families, and the sociocultural environment. This is necessary because social beliefs and traditions, many of which are still relatively strong (e.g., food taboos, most often related to protein foods) do influence the level of acceptance. Extension services and training programs could make effective contribution by: emphasising the role of women in food production, extension and farm management in the curriculum of agricultural training institutions; developing effective teaching aids that will be used at field demonstrations; training home economics extension agents in the cultivation of new and existing crops that may be of secondary economic value but contribute to family income and nutrition; and strengthening links between research and extension to make both more acutely focused on women food producers' needs.

It is important to note, however, that the educational campaigns may not yield the expected impact unless they are pursued simultaneously with efforts to improve the efficiency and workload of women.

Existing gender roles in food production and postharvest handling and management

Gender and division of labor in food production

The International Labor Organization (ILO) has estimated that about three-quarters of African women are actively engaged in agriculture, compared to two-thirds of African men. Equally important is the fact that these women in most countries are responsible for more than half of the total food produced. For a long time these facts eluded planners because of the tendency to overlook unpaid and non-economic production, especially women's production, in the preparation of national statistics, and in research in general.

In many countries in the region a fairly rigid division of labor in the rural economy leads to separate spheres of household and market production activities for men and women. The general pattern that has emerged from this is one of gender-specific farming systems with men and women farming separate plots and often growing different crops. It is, however, common to find that in spite of gender segregation, the replacement of male labor by female labor is quite common, unlike the reverse. Consequently, as men have historically switched from food to export crop production, or migrated to seek non-farm employment, women have been forced to take up the tasks that they previously did not perform (Cleaver and Schreiber 1994). Where they cannot fill the labor vacuum themselves, as in land clearing and other heavy-duty jobs, women have to find additional resources to hire male labor. Failure to do so usually means a scaling down in the size of farm operations or changing crop mixes. It is not surprising, therefore, that though women's role in farm management has increased, in most places they continue to farm smaller holdings than men.

Accompanying the movement of men from food production and farming in general, is the growing incidence of female-headed households in many parts of SSA. It is estimated that in East, Central, and Southern Africa where men have long been associated with high out-migration to the mines, 50% of rural households are headed by women (Cleaver and Schreiber 1994). The absence of adult male labor in this type of household has direct implications for the size of farming operations that the female head can carry. Until recently, however, the direct production needs of this group were not recognized.

Another aspect of the division of labor in smallholder agriculture is the expectation that women's produce will be used largely to support daily subsistence, rather than for sale. In the northern parts of Ghana, women's crops, mainly vegetables, are referred to as "soup ingredients". For this reason they do not receive priority attention in the allocation of household resources. Yet it is widely known in many parts of SSA that a significant proportion of the "soup ingredients" enter the market to raise funds for other household items such as salt, meat, fish, oil, and detergents. Such earnings also finance non-food consumption expenses such as medicines, clothing, school expenses, travel, etc, which are traditionally regarded as men's expenses in the household. Ironically, when men produce food as indeed the majority of men farmers do, they tend to produce staples with high market values, particularly cereals and selected vegetables, the bulk of which is sold for income (Henn 1984). It is important to remember however, that the nature of division of labor in agriculture across the continent varies widely between cultures. Cleaver and Schreiber (1994) point out, for example, that household characteristics, farming systems, natural resource base, community structures, and national economic policies influence it. Similarly gender roles are subject to seasonal pressures and life-cycle changes of men and women, and general development trends.

In Ghana, the agricultural sector employs roughly 62% of the female labor force. It is estimated that 70% of the women in agriculture are in food production. It is also estimated that at least 40% of smallholdings in Kenya are managed by women. Though gender differentiation in SSA agriculture is often task- rather than farming systems-specific, there are several instances in which production activities of men and women differ by the types of crops they grow, size of their holdings, or the livestock they keep, as well as by their access to production resources. Work profiles of men and women in farming communities reveal a high incidence of multiple farm-related occupations or work cycles, in which both sexes are engaged in production, processing, and marketing at the same time or at different times of the year.

Postharvest handling and management

One issue that is of great importance in ensuring food security and yet has received very little attention is postharvest management and, in particular storage and packaging. This factor among others has resulted in high levels of postharvest losses. The Ghanaian Ministry of Food and Agriculture has estimated that over 30% of all foods produced locally are lost for one reason or another, after harvesting. It reduces household food security in addition to rural women's incomes and, above all, it is a disincentive to production.

Agroprocessing in sub-Saharan Africa

The biggest contribution women make to the food system in sub-Saharan Africa is in the area of agroprocessing. About 90% of labor for food processing in the region is contributed by women and their children (Akanji 1997). The activities span vegetable oil extraction; drying, frying, and smoking of fish and meat products, preserving some staples and vegetables, preparation of alcoholic and non-alcoholic beverages, and the preparation of herbs and traditional medicines.

Women's production activities often supply the raw materials they use for their processing activities, as is the case of cassava producers involved in processing *gari*. However, some of their production activities are quite unrelated to their processing activities as is true of food producers who are also vegetable oil processors. It is also common to find that women in fishing communities where there are agricultural lands divide their time between fish processing and farming.

For many years the technology needs for women were taken for granted. Interventions in processing and preservation techniques had led to the application of fairly improved technologies for some activities/commodities such as cassava processing, vegetable oil extraction, sheabutter extraction, grain preservation, weaning food processing, and fish smoking, among others. The introduction of improved processing and preservation technologies since the late 1980s has started yielding positive results manifested in reduced drudgery and time spent on processing. Ghanaian women, who adopted mechanized technologies under ILO/Netherlands Support Technologies for Rural Women Project, reported considerable improvement in productivity, particularly in coconut and palm oil extraction.

While more women experiment with improved processing and preservation technologies, their rates of adoption appear to fall below expectation. Several factors account for this, including awareness and costs of adoption, but perhaps also low involvement of the small-scale farmer in the identification and development of research and extension

agenda. In situations when researchers have consulted processors in their bid for improved technology they hardly gave any feedback to the processors (Garba 1997). Hence, there is no link between research and processing operations.

Seasonality and the associated resource availability force men and women to stagger their production/processing cycles in order to be economically active throughout the year. In the production/processing nexus, non-tree forest products (ntfps) form an important source of supplementing foods and incomes in both dry and wet seasons. Women undertake a wide range of collection and processing activities based on ntfps, such as gathering sheanuts from the wild to be processed into sheabutter. Some men take up basket making and woodcrafts to supplement their farming incomes, while a few still hunt for the home or the market.

The dependence on traditional methods that have been passed down through the generations has its strengths and obvious weaknesses in a rapidly changing world. This contributes not only to low output but also to reduced labor productivity and high rates of postharvest losses. There are also problems of lack of uniformity in quality and in some cases low shelf life as well as poor packaging. These problems are partly a result of lack of education, monitoring and standardisation in processing, equipment and techniques, and too limited research and innovation in existing technologies. Thus, returns to labor and other inputs have not improved over the years (Garba 1997).

Food marketing in sub-Saharan Africa

The extent of women's involvement in the marketing of foodstuff varies considerably from low involvement in parts of East and Southern Africa to active involvement in most parts of West Africa. It is estimated that women make up about 80% of people involved in commerce and trading in Ghana and they are concentrated in the highly perishable and low profit goods of mostly agricultural products. UNECA (1996) estimated the proportion of crop marketing done by women in Africa to be 60%. Through a long chain of intermediaries and retailers, women distribute between 80 and 90% of locally produced food (Akanji 1997). Although a majority are involved in what is known as "petty trading" (involving low volumes of merchandise), there are also the wholesalers popularly known as "middlemen".

Food marketing generally takes place under quite hazardous and arduous conditions in some places as a result of poor storage and poor pricing information. Significant proportions of women (especially the wholesalers) market their produce in open spaces and are subjected to the vagaries of the weather. Very often, market structures provided for retailing of food in Ghana, for example, lack basic facilities for potable water, places of convenience, storage, waste disposal, and health posts. Various communities are, however, making efforts to improve the situation. For example, in Ghana, the Agricultural Sector Investment Project (ASIP) in collaboration with various district assemblies is making modest improvements to market facilities.

Though men are hardly mentioned in food marketing, they are very prominent in the wholesale of grains, legumes, and onions in West Africa. Women, however, market a wider variety of foods and over a wider geographical area. Even in the Brong-Ahafo Region of Ghana, where men are very active in marketing, an association of market women/men with a membership of over 500 has only six male members.

Technology development and transfer

Technology development

Despite the large amounts of money that have been spent on national and international research to improve agricultural technologies in sub-Saharan Africa, their use in food production and processing remains negligible. There had been instances where rural women were reluctant to accept improved maize seed for the reasons that the crop had an unpleasant taste, was hard to prepare, was less resistant to drought and insects, and depended on chemical fertilization (Ahmed 1985). These are objections that require consideration by researchers and development agencies. For women farmers, the situation has been worse due to their limited access to information, cash, capital and/or credit. In addition, there appear to be a certain amount of risk aversion among women farmers in particular, understandably to protect themselves against disaster if new technologies should fail. They use little or no fertilizer on fertilizer-responsive crops such as maize, beans, millet, and sorghum.

The recognition of the importance of gender in planning for agricultural development in Africa has remained rhetoric. Often no concrete actions are taken for establishing communication with women producers. Some efforts have, however, been initiated by some research institutions to establish direct links with women farmers. The Crops Research Institute in Ghana has, over the past decade, designed research that directly focuses on developing grain and legume varieties through on-station and on-farm trials involving men and women farmers. In this direction, farmers have been involved in workshops to review new technologies and to discuss issues of technology transfer. Such research initiatives are more likely to result in the development of technologies that reduce women's workload. Innovations that make female-designated activities more attractive to men are more likely to help reduce women's workload.

Women producers must be targeted not only because they produce most of the food SSA, but more importantly for the following reasons:

1. Given access to production inputs, women could be just as productive as men. The evidence indicates that gender differences do not explain productivity differences between men and women farmers, but rather gender disparities and women's lack of access to the basic yield-increasing inputs of production results in their lower yields (Udry 1994; Alderman et al. 1995).
2. Sociocultural norms and practices negatively affect women's activities in agriculture. Research on crops such as roots and tubers to which women devote a lot of their time and resources is limited.
3. Technology development aimed at reducing postharvest losses has not received the required attention. A few technologies that have been developed in this area have not been applied by a majority of rural people, either because they are not exposed to the technologies or tthey cannot afford them. One way to make postharvest storage and management cost-effective is to encourage group formation and build their capacity to pool resources that will give them access to improved postharvest facilities and practices.

Research and development for roots and tubers

Roots and tubers make good storage in carbohydrates. They contribute about 10% of human food (Okigbo 1987) and are a major source of energy for a significant population in Africa (Coursey 1983). However, investments in root crop research and production is low (9.4% or US$15 million globally) compared with cereals (68.7% or US$ 100 million). One root crop that has received most attention from researchers is cassava.

There are indications that not enough care is being taken about the efficiency of innovative technology. A study by Nigeria's Root Crops Research Institute indicated that the cassava peeler developed locally was not efficient and the sieving machine used far more water than manual methods (Oti et al. 1992). The problem with such an innovation is that while reducing labor input for sieving, it required more labor input for fetching water. Thus, it ceases to be a labor-saving device.

The common view is that technologies stand a better chance of succeeding when they take into account indigenous technologies developed by farmers themselves, particularly in areas such as postharvest root and tuber management and intercropping.

Technology transfer and extension services for women in agriculture

All over Africa, women farmers have very little contact with extension agents. This is principally because most extension programs have been male-biased in outreach and message. Consequently, it is export crops and local commercial crops that have received the most attention. Women's crops were often neglected. Extension agents have also reported difficulties in relating to women farmers, due to sociocultural constraints on women interacting with strangers. This is compounded by the difficulty of recruiting and retaining female extension officers. Once women who have been trained qualify, they are often torn between professional duties outside home and family obligations.

Extension coverage in Ghana is very low; most small-scale farmers do not see an extension officer in an entire year. Out of the 2184 agricultural households interviewed in the Ghana Living Standard Survey of 1988/1989, only 135 households or 6% reported extension contacts in the 12 months prior to the interview. Female-headed households reported just about 8% of these contacts. The bias towards men in extension services delivery goes back to age-old conceptions of the household as a unified decision-making entity, in which the male head controlled all resources and presumably shared information with other members of the household. Very often, both the sex composition of the extension structure and the scope of extension services have traditionally been geared towards serving the needs of male household heads. Thus, women are sidelined in extension services delivery.

Right from the beginning of agricultural staff training, men grossly outnumber women as agricultural science students at secondary and tertiary schools. The result is the male dominance in staffing at the Departments of Agricultural Extension Services. In Ghana, for example, the ratio of women extension agent to women farmers was 1 : 11 000 in 1987. During the same period, the rate of extension coverage of women farmers was below 10% in most of the regions (Panuccio 1989). Attempts at redressing the bias towards men in extension services delivery led to major reforms in the conception of extension for women and the creation of a Women in Agricultural Development (WIAD) component of the National Extension Program. The current trend is broadening extension programs to ensure that those on WIAD do not just cover home management and nutrition, but

also production and processing information and technologies, as well as broad issues of food security.

With the gradually improving enrollment of women in extension training programs, WIAD in Ghana reports that women's access to agricultural extension services is improving. Various agricultural support programs have collaborated with WIAD to improve extension services delivery to women. An important strategy that was adopted by one of the National Agricultural Projects—Smallholder Rehabilitation and Development Program (SRDP), was the recruitment and training of women extension volunteers to operate at the community level. The project completion report indicates that women farmers who participated in the SRDP were able to contribute substantially to their household incomes and thereby gained some level of respect in their households and communities. The possibility of replicating this strategy as a means for improving women's access to extension services should be investigated. Perhaps African agricultural research should explore avenues for effective technology transfer to women with emphasis on women's participation in technology transfer programs.

Similarly, Women in Development (WID) programs initiated in Nigeria in 1986 were to develop programs that would promote and enhance the well being of women and children in rural areas. A feature of the WID program in Nigeria is that it is limited only to some National Agricultural Development Projects (Akpoko et al. 1997). Even though there are no separate extension agents for WID, there is an understanding that at least 30% of all extension agents should be females who should ensure that at least 60% of their contact farmers are women. Nigeria has since reported some modest achievements in extension delivery to women (Akpoko et al. 1997).

Extension staff argue that apart from their own biases which tend to favor men and selected crops, it is also difficult to deal with the attitudinal problems of women farmers. In some cases, women farmers have apparently shown a lack of interest in extension programs. While this may be due to their ignorance of the benefits of extension, it could also be linked to the lack of relevance of extension messages and the extra workload involved in new practices. Extension agents have observed that women respond quickly to training programs when they are demonstrated to have a high and immediate potential for increasing their income-generating potential.

Factors that block women's access to and utilization of extension services include constraints faced by all extension officers, namely, lack of transport, poor ratios of staff to women, poor demonstration aids, lack of incentives, and lack of institutional or infrastructural linkages for follow-up work after the dissemination of innovation. These are in addition to sociocultural institutions that act to inhibit women farmers from accepting productivity-improving ideas (e.g., lack of security over land). Local norms may also inhibit them from deciding on their own to accept new ideas, or from interacting with male extension agents.

Though considerable efforts have been invested into extension reforms since the 1980s, agricultural production levels in recent years, as noted earlier, indicate that the reforms in extension have not yielded the expected impact. Some of the contributory factors have been documented as follows:

- thinly spread extension services
- low infusion of productive research information into technical staff training and operations

- high cost of improved technologies
- non-concentration of technologies which are suited and/or adopted to local conditions
- poor input distribution to small-scale farmers
- marketing bottlenecks
- lack of support services and facilities to back extension services

Gender considerations in agricultural resource management

The dilemma of sub-Saharan African agriculture is to meet the challenge of food production for the increasing population without depleting the natural resource base. In the face of physical and economic obstacles to the use of most high-input responsive technologies (e.g., fertilizer and insecticides), farmers in the region seek to increase crop production mainly through expansion in farmlands where possible. The traditional bush fallow system has also been practiced to rejuvenate the soil through nutrient cycling and litter. This system has worked so far as population pressures have been low and there has been abundant land.

With rapidly rising population and more land going under permanent rather than perennial cropping, fallow periods have reduced. Not only are millions of hectares of new land brought under cultivation each year, but the land already under cultivation has been used intensively without replacing soil nutrients. In addition, the traditional practices of separate crop and animal husbandry coupled with poor management has led to overgrazing. Further, rural people and especially women have depended on non-tree forest products (ntfps) as sources for inputs used in their processing activities and for supplementing household food incomes. Very often these activities take place without efforts to replace the resources. All of these practices have contributed to the degradation of the natural resource base, which supports productive and sustainable food production. According to Kumwenda et al. (1995), the decline in soil fertility plays a dominant role both in limiting yield improvement and the sustainability of cereal-based cropping systems of Africa.

The destruction of land is not deliberate; rural people are merely striving to feed themselves and their families using the only available means. Undoubtedly, sustainable food systems depend on reversing the degradation and making existing resources (i.e., land, water, plants, and animals) more productive. It demands wise use of the resources with moderate exploitation by the community they support. An effective resource conservation and management must necessarily involve strong local participation.

Because women play a major role in the food system, an analysis of land resources must include an appreciation of their central role. Many of the effects of degradation are experienced by women because of the gender-specific division of labor in rural societies. Yet, women's apparent low adoption of soil-improving technologies attributed to cash constraints and lack of information has not received adequate attention. Studies at the Crop Research Institute, Ghana Grain Development Project, showed that chemical fertilizer use among maize farmers fell from 50% in 1989 to 26% in 1990. The drop was attributed to the depreciation of the cedi, the removal of subsidy on fertilizer, and late rains. Most farmers who did not use fertilizer confirmed this by attributing their non-use to high cost (GGDP 1991).

Scientists on the continent, nevertheless, caution against the wholesale adoption of new technologies. Some analysts are of the view that the Green Revolution technologies

have led to an accelerated use of non-renewable resources and contributed to air pollution, contamination of ground water, and loss of biological diversity. Indeed, the appropriateness of the Green Revolution technologies in SSA is being debated. It is further argued that poor soil fertility, erratic rainfall, high cost of external inputs, among others in SSA do not provide the ecological and economic conditions required for the Green Revolution agriculture to make significant impact in food production. Certainly, the peculiar condition of resource-poor farmers suggest that priority should be given to expanding their use of organic sources of soil nutrients such as legumes that fix atmospheric nitrogen. Under the circumstances, intensification of food production should be achieved by diversification rather than by using increased amounts of fertilizer and other external inputs.

While women have relatively limited access to chemical fertilizer, they are often quite familiar with organic fertilizer, especially in areas where livestock rearing is popular. In northern Ghana, for example, animal manure is a traditional source of soil replenishment for compound farms. For a majority of African women farmers, this may be the best strategy for increasing soil fertility. Moreover, the efficiency of fertilizer use has often been low and declining as a result of declining levels of soil organic matter. Though organic fertilizer is seen by many to be preferred and a cheaper source of soil nutrients, serious problems exists with the supply and application of organic materials. There is usually not enough manure to meet the amounts required.

For decades, the approach to soil conservation has tended to be top down with engineers making plans for farmers to follow. It is difficult for the approach to deal with the causes of misuse. Researchers and development planners must adopt a bottom-up approach that understands farmers' methods and reasons for developing farming practices that safeguard the soil and in which farmers themselves become the conservationists. It certainly requires an extensive study and understanding of the interactions and interdependence of households and their resources.

Recent technology development has resulted in the formulation of several forms of integrated agriculture (e.g., integrated pest management and integrated plant nutrient systems). These integrated systems combine knowledge of traditional and modern agriculture and enhance biological and economic complementarity in the production of crops, animals, and trees. It, however, does not exclude the use of relevant external inputs but rather minimizes their level of use.

Options identified as appropriate for sustainable agricultural production in SSA are broadly categorized as those for enhancing soil organic matter content through cereal/legume rotation, use of crop residues, animal manure and rock sulphate compost; soil/water conservation and management; and crop–livestock integration. Women's access to these improved systems of farming can be enhanced through information diffusion via extension workshops and field days for women, gender training of trainers aimed at extension agents, and small loans for organic inputs.

Conclusion

While it is widely acknowledged that women make up about half the work force in agriculture and produce about 70% of food in SSA, development agencies including government machineries have been slow to find effective strategies for supporting women producers. Such omissions in agricultural policies and programs and inefficiencies in production are noted to be responsible for significant welfare losses. By all indications, rural women producers in SSA contribute significantly to household food security, income, and welfare.

It is clear that their potential to maintain a sustainable food system in the region remains largely untapped due to constraints in their access to productive resources. Some of these constraints (e.g., access to land, labor, and to some extent, credit) have received considerable attention. But judging from their outcome, it is clear that such a piecemeal approach is not likely to be successful. What is required is a more holistic approach that incorporates women's interests in development programs not just as beneficiaries, but as participants in the development process. This does not suggest that men should be neglected in the transfer of productive resources. It, however, points to the need to identify women for direct support. Recognizing that resources meant for women are likely to be appropriated by men, assistance programs should make provision for both men and women, wherever possible.

Recommendations

The key issues that are addressed in the process of identifying strategies for improving women's productivity to develop sustainable food systems are as follows:

1. Conduct studies into intrahousehold resource allocation for food production.
2. Develop and carry through policies and programs to incorporate women's issues in the food system.
3. Identify and support institutions to build capacity among women to improve performance in food security.
4. Increase and support women's access to improved technology and extension services.
5. Strengthen farmer associations to mobilize resources to promote women's involvement in the food system.

Conduct studies into intra-household resource allocation for food production

It is often assumed that traditional institutions operate according to their customary principles. Policymakers and development practitioners should seek to build a consensus on prevailing gender systems as a basis for understanding the situation of women farmers. A better understanding of the peculiarities of matrilineal and patrilineal kinship systems is necessary, especially in terms of pressures that are leading to changes in their customary provisions for women. Rather than focusing on aggregate household statistics, it will be beneficial to examine intrahousehold resource mobilization and distribution flows, as well as the dynamics of social interactions within the household which govern the access to, and control of resources among men and women. Findings from such studies should guide the process of allocating production resources to members of rural households.

Develop and carry through policies and programs to incorporate women's issues in the food system

The evidence indicates that programs meant to benefit women tend to be more effective when the women are involved with the design and implementation. Gender-sensitive or women-targeted tools should be used to incorporate women's interest in development programs since gender-neutral policies have been inefficient. Proper targeting will depend on collecting and reporting gender disaggregated statistics and conducting gender-sensitive socioeconomic analysis. In this regard, farming systems research that focuses on individuals within the household is required.

Institutions that collect periodic data on production, distribution of services, and consumption of goods and services, among others, should review their data collection instrument regularly to ensure that issues pertaining to women's activities are incorporated as they arise.

Identify and support institutions to build capacity among women to improve performance in food security

Countries in SSA recognize that their governments cannot provide all the needs of rural producers with their limited resources. They have, therefore, welcomed the involvement of nongovernmental organizations (NGOs) in this process. NGOs have generally made impressive contributions to the process of reaching women farmers with new technologies and other resources. They, however, possess uneven technical competence and have different conceptions of how to proceed to help resource-poor farmers. There is the need to coordinate the activities of NGOs to meet the needs of different producers. This should be done in collaboration with the NGOs and beneficiary groups, in order to avoid conflict with, and frustrate the valuable efforts of the agencies.

Government machinery at community levels can play an important role in creating more gender sensitivity in support institutions and communities. They can collaborate with development agencies and interested parties in their communities to build the capacity of farmer organizations including women's groups to enable them to take advantage of innovations.

Poor coordination among all the sectors that control agricultural production input, services, and infrastructure reduces the potential for the adoption of innovative technologies. This should be overcome through direct attempts to create a functional, enabling environment, in which farmers are seen as partners, and in which they can respond more promptly to new ideas.

There is also the need for an enabling environment and incentives for private sector involvement in the provision of support services (e.g., locating commercial food processing plants in rural communities that will purchase their home-processed produce for more refined processing).

Increase and support women's access to improved technology and extension services

There is the need to improve and sustain women's access to productive resources especially labor, credit, seeds, soil improving technologies and agrochemicals, as well as improving storage and marketing facilities. Some of the strategies that enhance women's access to improved technologies are:

- Making fertilizer inputs available in small packages in order to make them affordable and easier for women to carry to their farms.
- Improving women's access to farm implements.

Efforts to improve technology transfer to both men and women should address the following issues:

- National extension services units should collaborate with NGOs and donor agencies on extension methods to gain the benefit of cross-fertilization of ideas and to maximize the use of available resources.

- Extension messages need to be complemented with support services required by farmers to yield optimum returns on adoption of innovations
- Appropriate and affordable technology should be demonstrated effectively according to the needs of farmers in different ecological zones
- Collaboration between researchers, extension agents and women farmers is essential for developing sustainable food production
- Extension agents require regular training for sharing research findings, extension methods, and to discuss feedback
- The idea of adopting extension volunteers, where necessary, is worth considering to improve the ratio of staff to women producers
- Provision of incentives for extension staff
- Improved technologies that are labor- and time-saving should aggressively be introduced to women to expand their income-earning activities

For women farmers' special emphasis should be placed on soil fertility management.

Another equally important strategy that requires consideration in efforts to improve women's productivity includes intensified nutrition education. The provision of improved market facilities and information should also be given serious attention.

Strengthen farmer associations to mobilize resources to promote women's involvement in the food system

Since governments in SSA are unable to manage and finance all rural development activities, due to their limited resources, much of the task of managing and financing agricultural services will have to be done by farmer groups. Development projects and members of farmers associations should, however, avoid treating the associations as vehicles for the provision of services rather than as dynamic organizations that can mobilize resources on their own and provide the necessary services to members. In this regard, the following strategies could be adopted for building the capacity of the associations:

- Conduct functional literacy and business skills training for executives and members of farmer associations, to enable them to manage and operate the associations in business-like manner and operate more commercially viable enterprises.
- Provide credit facilities through revolving loan funds for members of groups to finance improved methods of production, processing and postharvest management.
- Provide strategies to link women's groups up to enterprising individuals and agencies whose work can serve as good demonstration for others around them.
- Encourage horizontal and vertical linkages between farmer and related associations to maximize cooperative benefits in information flow, resource mobilization, and marketing.
- Reorient farmers' organizations to make them more demand-driven, as well as receptive to program intervention.
- Nurture the idea of bulking produce for sale to middlemen to overcome the tendency of the latter dictating lower prices to individual producers.

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