Project C

Supporting innovation processes (SINPRO) (assessing impact, formulating policy options, and systems analysis project)

Annual Report 2003

IITA

Research to Nourish Africa

International Institute of Tropical Agriculture | Institut international d'agriculture tropicale

Contents

Preface

IITA's research-for-development agenda is divided into six project themes, around which these project annual reports are prepared. These projects themes address different aspects of attaining sustainable increases in productivity of dominant farming systems and utilization practices in the various agroecologies of sub-Saharan Africa (SSA). Research and training activities carried out in the six projects are being implemented together with national program partners in order to increase the well-being of resource-poor people in SSA through higher levels of food production, better income, nutritional status, and reduced drudgery particularly for women.

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Project overview

IITA is committed to creating new knowledge and technologies that are relevant to the needs and livelihoods of rural Africans and widely applied by them. To raise the incomes of poor farmers, and conserve natural resources, technical innovations must fit the local, national, and global contexts including their social, political and especially economic dimensions. This project applies the analytical skills of economists, sociologists, information specialists, geographical information systems analysts, and other social scientists working in conjunction with biophysical colleagues to develop innovations that are appropriately suited to the various dynamics, domains, and pathways of rural development in sub-Saharan Africa such an intriguing challenge.

Intermediate project goal

The project goal is to generate and transfer knowledge leading to the development of improved food production systems and underlying food markets, supportive institutions, policies and infrastructure in the belief that doing so will result in accelerated sustainable development and reduced poverty in sub-Saharan Africa.

Project purposes

- Through collaboration with NARES, NGOs, advanced research institutes, and stakeholders, farmers develop the capacity for, and generation of, knowledge and innovations for agricultural systems in sub-Saharan Africa.
- Through collaboration with NARES, NGOs, and ARIs and dialogue with policymakers define appropriate recommendation domains for agricultural innovations, suggest supportive policies to facilitate their widespread adoption, and assess the impact of innovations developed by IITA.

Project outputs

Following recommendations of the center-commissioned external review in December 2003, the project has proposed reducing the number of outputs on which it is working from seven to five. The five currently proposed (to be finalized in November 2004 at IITA's annual work planning week) are:

- The development of innovations (both institutional and technical) to enhance the profitability, equity, and efficiency of production and marketing systems in the agricultural sector.
- Analysis and recommendations for policies and legal frameworks supportive of generated innovations and the innovation process itself.
- Scaling up and scaling out of IITA research innovations through the development and application of geospatial modeling and social science methods.
- Research priority setting and impact assessment of innovations.
- Strengthened NARES capacity for social science.

Project rationale and strategic background

The rational for the project lies in past experiences, which have shown the importance to the innovation process of integrating social science with other disciplines in an agricultural system approach. Innovation in the agricultural system, which is the analytical focus of the project, is affected by the interaction of macro-, meso-, and micro-level factors. Some of the more important categories of factors considered by the project include agroecological, political, economic, sociological, demographic, and cultural.

Taking a macro perspective, agriculture is one of numerous sectors in the macro-economy, all of which compete for government resources and public investment. In most countries of SSA, the public resources invested in agriculture are disproportionately small relative to its importance in terms of employment and share of gross domestic product. This reflects in part the low weight given to rural development in most political economies. Trade in agricultural commodities both within and outside the boundaries of SSA is vitally important for the generation of foreign exchange and regional food security. From a macroecological perspective, agriculture has resulted in wholesale changes in natural ecosystems, which have usually been accompanied by degraded environmental services.

At the meso-level, agricultural output markets link producers to consumers. Thirty-five years ago when IITA was founded, the large majority of the population was rural-based and markets had less significance than they do today. Today's reality finds many countries in West Africa now having urban majorities. The transformation of agriculture from semi-subsistence to commercial production systems is being driven by the rapid growth in urban markets, which have accompanied this demographic transformation. While most food markets are highly competitive with many sellers competing, marketing margins are often excessively high due to poor communications infrastructure especially roads, and underinvestment in market information systems.

Traditional export crop markets which in the past were tightly controlled by government marketing structures rationalized by the non-existence of an entrepreneurial class sufficiently well developed to participate in global markets, have recently been liberalized and in some cases dominated by multinational firms to the detriment of the smallholder. Inefficient marketing systems whether due to multinational manipulation or the high costs of marketing greatly reduce farmgate prices and producer revenues. Other market institutions needed to support a viable commercial agricultural system, such as credit, insurance, labor and agricultural input supply, are experiencing growing pains as they evolve with and adapt to new commercial demands. At the meso-level, the resources of agricultural research and extension services must be selectively allocated across a wide range of food and fiber commodities.

Prioritizing where limited resources should be allocated is one of the focuses of this project. Ecological impacts of the agricultural system often show differences at the regional meso-level depending on the characteristics of the predominant land use systems (e.g., a landscape consisting of 10 000 ha oil palm enterprises versus a mosaic of smallholder cocoa agroforestry and mixed food crop systems).

At the micro-level, producer and consumer behavior in the aggregate along with trade policies are major determinants of food market supply and demand. In the increasingly liberal markets of SSA, competitive markets and price signals have largely replaced government-marketing interventions in allocating scarce resources. The interactions between household endowments of land and labor combined with local institutions, social capital, and market

accessibility are important determinants of innovation adoption and as such are a potential focus of project investigation.

Given the breath and scope of the agricultural system, project scientists could work on nearly anything and still fall within its boundaries. Project focus is provided by IITA's mandate to genetically improve maize, cowpeas, soyabeans, yams, plantains and cassava as well as to develop sustainable rural enterprises founded on improved crop and natural resource management. Project scientists work with breeders to better understand consumer demands and market agents' requirements through demand studies. Pilot market development efforts such as the Rural Sector Enhancement Project (RUSEP) in Nigeria and FOODNET in Uganda have focused on improving farmer access to, and understanding of, input and output markets for IITA mandate commodities. In an increasingly liberal global economy, market and food consumption studies are important for developing strategies to increase the commercialization, diversification, and intensification of African agriculture. Social science research has taken similar approaches in the Sustainable Tree Crops Program (STCP), a private-public partnership focused mainly on the cocoa sector of West Africa.

Crop and resource management is conducted mainly in IITA's ecoregional benchmarks where social scientists work with biophysical scientists and farmers to understand the constraints and opportunities for improved management practices and then test and evaluate innovations deemed to be congruent with those constraints and opportunities. The scaling up and out of innovations, whether varietal improvements or crop and resource management improvements, is the focus of IITA's Geospatial Unit of the project. The scaling up of agricultural innovations depends as well on the engagement of policymakers, which is the intended target of the second output of the project. Priority setting for the Institute is another important function for the project, which is closely integrated with the assessment of IITA impact. Finally, all outputs seek to build capacity by engaging national research institutes and NGOs as collaborators.

Attaining the basic CGIAR goals of poverty reduction, food security, and environmental protection requires the development of suitable technology as well as good policies and supportive institutions and infrastructure. Better understanding of the interaction of these factors will contribute to increased technology diffusion and adoption in support of the rapidly evolving commercialization, diversification, and intensification processes that are needed to transform African agriculture.

1 Knowledge and innovations to enhance the profitability and efficiency of production and marketing systems

IITA is fundamentally involved in the design and development of improved germplasm, sustainable land use systems, affordable and environmentally sound methods of plant health management, and market innovations to meet the rapid growth in food demands which have been driven by high overall population growth and even higher rates of urbanization. Social science contributes to the development of these innovations through diagnostic analysis of production processes and consumer preferences, through the identification of important market failures and market opportunities, and through economic and social analysis of IITA innovations. One of the prominent research approaches applied especially by this output is benchmark areas in the savanna and humid forest zones for natural resource management research.

Resource-use efficiency among smallholders in southwestern Nigeria

by V.M. Manyong, A.S. Bamire (Obafemi Awolowo University, Nigeria), and P.S. Zuckerman (Zuckerman and Associates, UK)

The farm-level efficiency of smallholder resources has important implications for the agricultural development of a nation. Efficient farms make better use of existing resources and produce their output at the lowest cost. Thus, achieving the food security objective and ensuring sustainable agricultural production require an understanding of the structure of household farm resources.

This research examines the efficiency of smallholders' production in two communities representing the rain forest and derived savanna agroecological zones of southwestern Nigeria. Specifically, the objectives are to examine the structure of farm resources (land, labor, capital, and credit) in the two zones, and determine the productivity and efficiency of farm resources use in the study area. The hypotheses tested are that current farm resources such as land, labor, capital, and credit, can enhance the efficiency of farm production; and that households are highly efficient in their use of farm resources.

The study was conducted in two communities (Akinlalu and Ilero) located in two agroecological zones (rain forest and derived savanna) of southwestern Nigeria. The farming system in the forest zone is dominated by tree and root crops, with cereals playing a secondary role in cultivation. The major tree crops are cocoa, kolanut, orange, and oil palm. Cassava, maize, and vegetables are the main arable crops cultivated. A combination of cereals (maize), root crops (yam and cassava), and leguminous grains (cowpea and groundnut) characterize the farming system of the savanna zone.

Two rural communities that are noted for agricultural production activities were purposively selected in 2003 because they were surveyed by IITA in the 1970s. A list of household heads was generated for each community. A proportionate random sampling resulted in a sample of 123 households in forest and 129 respondents in the savanna zone. The household, which is the number of persons living under the same roof and eating from the same pot, is the primary sampling unit.

Primary data were collected from respondents with the aid of a pretested structured questionnaire. Data collected included demographic and socioeconomic characteristics of the respondents (age, household size, and education level) farm attributes (farm size, crop production, and farm expenditure), and market factors (price of output, and nonfarm income). Data collected were edited and analyzed with the aid of descriptive statistics while the Stochastic Frontier Production Function (SFPF) was used to determine the farm-level productivity and efficiency of resource use in the zones.

Estimates of predicted economic efficiency show a wide variation among the sampled respondents as the frequency of distribution ranges from a minimum of 0.34 to a maximum of 0.95, and a mean value of approximately 0.76 for the forest zone. The savanna zone recorded the lowest level of efficiency of 0.14 and a mean value of about 77%. There was, however, no statistically significant difference in the level of maximum economic efficiency recorded in the zones.

Within the limits of the production technologies used in the study area, 2% of the respondents' farms were within 40% level of efficiency, 58% were between 41 and 80% efficient, while 40% of the respondents were more than 80% efficient in the forest zone. Only about 18% of the farms out of the last category were more than 90% efficient, while none of the farms

was 100% efficient. The distribution shows that economic efficiency is skewed heavily in the 0.41–0.80% range, showing that the majority of the respondents do not use their productive resources efficiently as there are opportunities for improvement. About 33% of the farms recorded less than the average level of efficiency in the area.

Based on the values of the likelihood ratio, sigma-square ($\square^2$) and gamma ($\square$), the frontier model was found to have good fit, with observed stochastic inefficiency effects. The relatively high magnitude of the variance parameters ($\square^2$ and $\square$) in the model shows that economic inefficiencies abound in farms located in the study areas. The savanna recorded a higher figure of 98% for $\square^2$ and 70% for $\square$ while 84 and 55% were similarly obtained for the two zones.

Given the specification of the Cobb-Douglas frontier model, the results show that the elasticity of mean value of farm output is estimated to be an increasing function of farm size and net nonfarm income, and a decreasing function of family labor and agricultural expenditure in the forest zone. In the savanna, farm output is an increasing function of farm size, agricultural expenditure, and net nonfarm income, and a decreasing function of family labor. When the two zones (representing southwestern Nigeria) are considered, farm output showed a decreasing function of agricultural expenditure only. However, variables with a statistically significant level (1%) are net nonfarm income for the forest; farm size and agricultural expenditure for the savanna; and family labor, farm size, and net nonfarm income for the combined zones. This shows that a 10% increase in net no-farm income to the farm will increase returns to production by about 0.10% in the forest zone.

In the savanna zone, a 10% increase in farm size will result in about 5% increase in farm returns while similarly increasing agricultural expenditure will lead to an increase of about 2% in farm returns. Expanding arable land into cultivation gives the highest returns to the system compared to other variables in the production function. In the forest zone, an increase in 10% of net nonfarm income would improve the farm output by about 1%. The results obtained for the two zones combined reveal that a 10% increase in farm size, net nonfarm income, and family labor will result in increases in farm returns by 3, 0.3, and 0.3% respectively. Thus, land remains the most important determinant factor of production. Therefore, the whole issue of land availability and quality is important to improve farm productivity. Family labor supply was found to have a weak effect on farm outputs. Respondents ascribed this to the movement of youths to urban centers. The results also reveal that the amount spent on farm operations such as chemical application in cocoa fields, fertilizer application, or hired labor is not contributing much to farm output, especially in the forest zone. Changes in the management of these inputs are important to improve the efficiency of the system and increase the outputs. In general, any productivity growth strategy designed for the study area needs to take all these factors into consideration.

Parameter estimates of economic inefficiency showed that none of the demographic variables (age, household size, and education) significantly influence technical inefficiency in the rain forest and derived savanna zones when considered separately. However, when the two zones are taken together, household size and education were statistically significant in determining farm-level economic inefficiency at the 1% level of probability. Therefore, programs and projects to increase the level of education and to improve family planning would contribute to improving the economic efficiency of smallholders in southwestern Nigeria.

The computation of returns to scale is based on elasticity estimates. Given that the sum of the output elasticity of the inputs in the production function is significantly less than unity, the returns to scale value of 0.13 in the forest, 0.66 in savanna, and 0.36 in the two zones

together show a decreasing return to scale in farming operations in the study area. This can mainly be explained in terms of managerial limitations and inefficient resource use. Output can still be increased with current available resources.

In conclusion, estimates from the Stochastic Frontier Production Function showed that, based on the existing level of inputs and available technology in the study area, farmers in the forest and savanna zones are economically inefficient in the use of resources as there are opportunities for improving their current level of efficiency. Productivity growth can therefore be enhanced to a large extent by rearranging input combinations with current available resources. Hence, providing extensive extension education services might lead to substantial resource savings in the two zones. A wide-ranging extension education would enlighten farmers on modern farm management practices as well as to acquaint them with research results on the optimal combination of production resources.

Family labor, farm size, and net nonfarm income were statistically significant in explaining the efficiency of farm resource use in the study area. Thus, improving farm output under the prevailing circumstances in the study area requires that farmers are able to obtain funds from nonfarm sources. Development programs need to pay attention to issues of capital use in agriculture, such as viable microcredit schemes for small-scale farmers. The importance of land for farming does not need to be overemphasized. Land zoning programs are required to prevent encroachment into cultivable agricultural land in the area. In addition, the general global problem of land resource degradation calls for policies that will enhance the livelihood of people on marginal lands to address the problem of farmland shortage particularly in the savanna zone. There is also a need to facilitate the access of smallholder farmers to appropriate and adequate intensification technologies that could enhance farm productivity under the prevailing state of land degradation and declining man-land ratio in the area. Farmers require different skills to adequately manage their resources, given the state of the land resource potential. In order to address the problem of inadequate farm labor, necessary infrastructural facilities need be provided in the rural areas that will reduce or eliminate the shifting of farm labor to urban centers.

Implicit market values of fresh yam (*Dioscorea* species) tuber attributes in two urban centers in Togo

Koffi Amegbeto in collaboration with the University of Lomé, Togo

The diversity of yams across and within species provides a great deal of choice alternatives in terms of agronomic, morphological and end-use characteristics to producers and consumers alike. These characteristics provide flexibility to the timing of harvesting, tuber storage, and marketing. In the context of enhancing producers' food security, income generation capacity and at the same time reduce poverty, recent research efforts at IITA aimed at developing nutritious and highly marketable yam varieties. Information about the implicit market values of these characteristics would be critical in guiding decision-making by farmers as well as demand-oriented breeding programs. However, this information is not available in the literature on yams even though the framework for evaluating consumer demand as a function of the good and its characteristics is well-established in economic theory. It is deemed imperative to fill the knowledge gap by simultaneously taking into account varietal characteristics, spatial production, and seasonal marketing factors.

This study applied a flexible-form hedonic pricing model to derive the implicit market valuation of yam characteristics in two consumption centers in Togo. A yam retailer is assumed

to maximize profits (□) in a competitive market where he/she could not influence prices. The retailer incurs some costs that depend on the quantity offered on the market, the characteristics of the tubers, and other factors. It follows from the first order condition for profit maximization that the retailer's offer price for the i^{th} characteristic must equal the per unit marginal cost of that characteristic, which determines the offer function for fresh tubers with specific bundle of characteristics. In collaboration with the University of Lomé, Togo, data on yam tuber prices and physical characteristics were collected in two cities, Lomé and Sokodé that are major yam consumption centers.

Results of the price model for Lomé markets showed highly level of price differentiation based on the yam species and varieties. Compared to the *D. rotundata*, late-maturing varieties, estimated average premium for early-maturing varieties equaled approximately CFAF3 while *D. alata* species were discounted for about CFAF20.5. Price variations were significantly and positively explained by the size variables namely, tuber length and width as expected. The marginal value is about CFAF2 for tuber length, CFAF0.34 for the width at the head portion, and CFAF0.24 for the width at the middle section of the tuber. There is a marginal increase in tuber price as the size increases, implying that larger sizes of fresh tuber commanded higher unit values on the markets.

White and light yellow were two colors of tuber flesh identified during the market survey. The former carried a discount of CFAF11 over the latter. Yellow pigmentation of tuber flesh is due to the presence of carotenoids that have a nutritional value, as precursors of vitamin A. Tubers having this pigmentation are common but less popular than white yams in terms of volumes supplied in the markets. Thus, a combination of demand and supply factors explained the additional valuation of yellowish tuber flesh. Among tuber shape variables, cylindrical, conical and flat tubers were less valued on the market place compared to irregularly shaped or branched tubers. Estimated average discounts vary between CFAF2 and 10 depending on the shape. This finding is quite surprising as one would think that city dwellers would be more inclined towards nice and uniformly shaped tubers for convenience and ease of processing. However, irregular and branched shapes may be typical of some varieties that were preferred for specific reasons. In situations where consumers can make a link among physical attributes of tuber, specific varieties and end-use quality or where the marginal cost of processing is very low, then preferences and demand could be high for such characteristics as seen in the current study.

The real price of yam tuber decreases with the presence of necrotic spots and symptoms of rot, which contributed to an average discount of CFAF2–3 per unit. Among 25 supply sources identified for the three markets in Lomé, yam tubers that originated from Bassar, Kpalime, Atakpame, and Agbavi, in decreasing order of importance, were valued above those from other origins. Tubers from Bassar carried the highest premium of CFA F 11.2 per unit compared to CFAF3.2 per unit of those supplied from Agbavi. With respect to market location within the city, tuber prices were relatively lower in the Akodessewa market with an average of CFAF4 per unit. Compared to the base month (September), yam producers and retailers could derive a premium for storing yam toward sales in later months. The potential market window remained the period of April through July where the implicit value of time was high and varied between CFAF11 and 23 per unit (Fig. 1).

The existence of market premiums for short growth cycle, tuber size, shape, flesh color, and time factors shows opportunities for some farmers to use cultivar selection, planting, harvesting, and marketing decisions that can be controlled from supply side to tap into the market

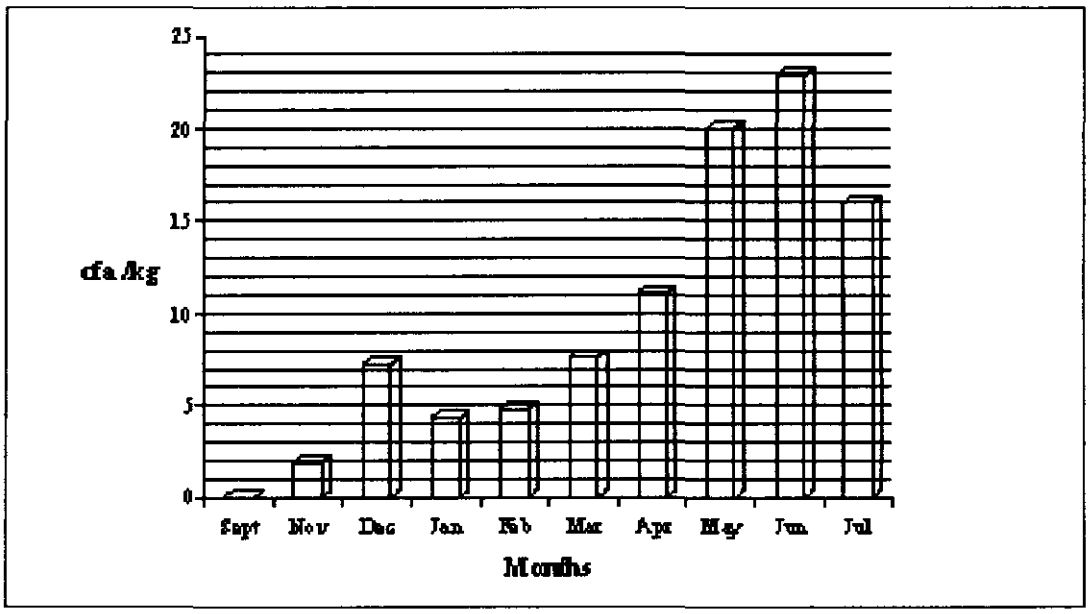

Figure 1. Implicit market value for time of fresh tuber sales.

and effectively increase farm benefits. Early harvest of varieties that have a short growth cycle gives flexibility to the producer to tap into high price markets for early harvests. The differential valuation for tuber shape observed suggests that market participants make an association between varieties that have typical shapes and their specific end-uses. The presence of premium on the yellow coloring of tuber flesh is a market opportunity for product differentiation.

These findings have implications for the development of new yam technologies. Tuber shape can be used effectively as a mean of product differentiation. Methods for producing distinctive and desired tuber shapes are well-known and practiced in some Asian countries. Similarly, genetic improvement of yams should consider the development of hybrids that combine the yellowish color with short growth cycle, in addition of criteria such as high yields, resistance to diseases, suitability to alternative end-uses that are already taken into consideration. Popularization of such varieties is likely to benefit both producers and consumers. The implicit market valuation for big tubers, which reflects consumers' preferences as well, could have detrimental impacts on natural resources if producers do not adopt intensification and better crop management technologies but resort to natural fallows to increase tuber size and yields. Therefore, yam producers should promote joint resource and crop management technologies to achieve sustainability in the production systems.

Rural household demand for roots and tubers in southwestern Nigeria: an almost ideal demand system analysis

by V.M. Manyong, A.S. Bamire (Obafemi Awolowo University, Nigeria), and P.S. Zuckerman (Zuckerman and Associates, UK)

Improving rural food security, income, and nutritional status requires an understanding of the food demand structure of the households. Food crop production remains the main source of income for a large majority of households in Nigeria.

However the rural households with their limited income and unlimited expenditure profile have to make choices from among alternatives in a manner that is consistent with the evaluation of their self-interest.

This choice is guided by the utility derived from the consumption of goods and services, and households allocate income among the various goods and services to be consumed in such a manner that the marginal utility per price of all goods and services consumed is equal. Thus, food crops are constantly evolving, not only in terms of genetic makeup but also with respect to the changing pattern of expenditure on the food items and the social, economic, and environmental relationships with the people who grow, sell, and consume them. This fact applies more emphatically to roots and tubers such as cassava (*Manihot esculenta*), potatoes (*Solanum* spp.), sweetpotato (*Ipomoea batatas*), and yams (*Dioscorea* spp.). These crops deserve particular attention because many of the poorest and most food-insecure households in the developing world look to these crops as the principal source of food, nutrition, and cash income.

In addition, farm households see the value of roots and tubers in their ability to produce more edible energy/ha/day than other commodities and in their capacity to generate yields under conditions where other crops may fail. Therefore, the importance of roots and tubers on consumption behavior and income pattern in any rural household budget cannot be overemphasized. This paper analyzes the income and expenditure patterns of rural households on root and tuber-based products in two agroecological zones of southwestern Nigeria with the aim of improving the food security and nutritional status of households as well to alleviating rural poverty.

The study was conducted in two communities in two ecological zones of southwestern Nigeria: Akinlalu (rain forest) and Ilero (derived savanna). A multistage sampling technique was used to select 252 respondents in the two communities. Primary data were collected over two weeks in each quarter for one year with the aid of a structured questionnaire. This frequency of data collection during the year was to take into consideration the seasonality in crop production that is the basis for food supply. During the course of the survey, daily data were collected on items of income and expenditure, types of food consumed, and their quantity/value in the household. Demographic and socioeconomic data on households were collected once a year and checked for any change during the quarter sessions. Data on income and expenditure patterns of households were edited and analyzed using the almost ideal demand system (AIDS) model. This model makes possible the empirical measurement of the standard relationship between food consumption, commodity prices, income, and household characteristics by a system of budget shares. It is expressed as follows:

$$W_i = \alpha_o + \sum_{c}^{C} \alpha_{ic} H_c + \sum_{j} \lambda_{ij} \ln(P_j) + \beta_i \ln\left(\frac{X}{P^*}\right) \quad \ldots\ldots (1)$$

Where W_i = Budget share of the ith commodity; X = Total expenditure on roots and tubers; P_j = Price of root and tubers; H_c = Household characteristics (e.g., age, gender, education); P^* = (Stone price index) defined as $\sum w_j \ln P_j$); α, β, and λ = Coefficients to be estimated (with α_o being the intercept; α_{ic} the coefficient of household characteristics, β is the income elasticity of demand which determines whether root and tuber-based products are luxuries or necessities). A commodity for which λ is negative (positive) has an own price elasticity greater (less) than 1 in absolute value.

When λ is positive (negative), the commodities are considered substitutes (complements). In the AIDS model, elasticity computed from cross-section data is generally interpreted as long-run parameters that reflect the adjustment of all variables causing households to be different.

Farm production accounted for about 71.3% of total household income in the forest and 66% in the savanna while secondary off-farm sources contributed 18% (forest) and 31% (savanna). There was a clear contrast between the two ecologies. In the forest zone, tree crops and vegetables accounted for more than half of the gross farm income, with a greater diversification in sources of farm income. In the savanna, the economy is dominated by maize (39.1% of farm income) and yam (30.5%). The household income corresponds to an average of N84/day (US$0.7/day) in the forest and only N66/day (US$0.55/day) in the savanna. These rates fall below the World Bank's poverty line of US$1/day.

About 79% of the budget is used for household expenditure on food and nonfood items such as housing, clothing, health, education, and infrastructure services, among others. Households in the forest zone recorded a higher spending profile on food items (double that found in the savanna), probably because the large share of income is from cash crops (tree crops and vegetables against food crops only in savannas) and they consume less of their own food production (35% against 88% in the savanna). The budget spent was small on root and tuber-based products because a large part of harvest for cassava and yam (the major root and tuber crops) is used for home consumption. Major root and tuber-based products were *gari/eba*, cassava flour, boiled yam, *amala*, boiled yam, pounded yam, and cocoyam.

Estimates of price elasticity indicated that the own (direct) price elasticity for *gari/eba*, *amala*, pounded yam, cocoyam, and *fufu* are large in absolute value (i.e., >1) in the forest. This shows that the demand for these commodities is price elastic, while the demand for boiled yam (-0.874) and cassava flour (-0.913) are price inelastic. In the savanna ecology, only the demand for *gari/eba* (-1.1962) and *amala* (-2.0455) were price elastic while the demand for other commodities was inelastic. Except for *fufu*, all other food commodities had the expected negative own price signs in the two zones.

The cross-price elasticities for some of the commodities in the zones are positive while others are negative. The positive cross-price elasticity of demand between *gari/eba* and *amala* (0.5434) in the forest and between *gari/eba* and boiled yam (0.8822) in the savanna, for example, suggest that these commodities are substitutes. This implies that an increase in the price of *amala* will lead to an increase in the demand for *gari/eba*. Similar relationships were recorded for *gari/eba* and *fufu*, *gari/eba* and cassava flour, and *gari/eba* and cocoyam. The degree of substitutability between most of the commodities was not strong (i.e., with coefficients < 1). Negative cross-price elasticities were obtained for products that are complements such as *gari/eba* and pounded yam (-0.2350) in the forest or *gari/eba* and *amala* (-0.3121) in the savanna. Thus, an increase in the price of pounded yam, for example, will lead to a decrease in the demand for *gari/eba* in the forest zone. The degree of complementarity was found strong between pounded yam and *fufu* (-3.47) in the forest and between *fufu* and boiled yam (-7.797) in the savanna.

Expenditure elasticity estimates in the forest show that when income increases, households will consume relatively more cassava flour (1.9149), *amala* (1.8676) and boiled yam (1.68). On the other hand, households will consume relatively less *gari/eba* (0.4489) and cocoyam (0.6534). This implies that when income increases by 10%, expenditure on *gari/eba* increases by 4.49%. So, *gari/eba* is an income-inelastic food item and a necessity for the households. The negative expenditure elasticity estimate for pounded yam (-2.196) and *fufu* (-0.1781) imply that increases in household income will lead to decreases in the consumption of these commodities. In the savanna zone, cassava flour, *amala* and cocoyam recorded positive esti-

mates. Thus, households in the savanna will consume relatively more of these commodities as income increases. All the other products recorded negative expenditure elasticity.

In conclusion, roots and tubers represent an important component of a food security strategy. In the study area, they are processed into many products and consumed in different forms: *gari/eba*, cassava flour, *fufu*, boiled yam, *amala*, pounded yam, and raw cocoyam. These products were already identified 30 years ago in the 1970s. Therefore, no progress seems to have been made on linking farmers to markets despite increases observed for the study villages in community assets such the building of new roads, banks, daily market places, churches, light street, etc.

The availability of market infrastructure alone is not a sufficient condition of igniting a commercial farming. Infrastructure needs to be complemented with clear market development oriented strategies for subsistence farmers to fully enter into commercial farming. The concept of development domains should be used in developing and targeting research-for-development strategies for root and tuber crops since ecological differences were obvious in the sources of income and food basket between the two communities under analysis.

Factors affecting farm-specific economic efficiency in the savanna zones of West Africa

by I. Okike and M.A. Jabbar (ILRI-Ethiopia), V.M. Manyong, J.W. Smith, and S.K. Ehui (ILRI-Ethiopia)

Africa is often cited as the only developing region where agricultural output and yield growth is lagging seriously behind population growth. One way of solving the problem of food shortage being created by the widening gap between food output growth and population growth is through increasing agricultural productivity via technical change and/or improving the efficiency of farmers in utilizing available resources. However, the technical change could only be considered a more appropriate option when efficiency in utilizing existing resources is very high among users thus limiting the scope for increasing productivity through reallocation of current resources.

It has been shown that ecology, population pressure and market access induce agricultural intensification and crop–livestock interactions in the savanna zones of West Africa. The next question is: do these forces also induce higher efficiency in resource use leading to higher output per unit of resources applied?

This report presents the results of a study in the northern Guinea savanna (NGS) and Sudan savanna (SS) zones of Nigeria—representative of those of West Africa. The study tested three hypotheses: efficiency of farms is higher in the SS than in the NGS; within each agroecological zone, efficiency is higher where high human population density interacts with high market access than in areas where the interaction is between low human population density and low market access; and efficiency is also higher in mixed farms than in crop and livestock farms.

Data were collected from a sample of 559 households in the NGS and SS zones of Nigeria. From each agroecological zone, four villages were purposively selected representing:

- low population density and low market access (LPLM)
- low population density and high market access (LPHM)
- high population density and low market access (HPLM)
- high population density and high market access (HPHM) situations.

This design was adopted to enable an understanding of the various farming practices that occur along the biophysical gradient involved in moving from the NGS to the SS and in moving from low resource use situations as in the LPLM domains to high resource use situations as in HPHM domains. From the eight villages, 559 households were selected using a stratified random procedure. The stochastic frontier production function was applied in measuring the farm-specific economic efficiency. The estimated production function was of the form:

$$ln(Y_i) = \Sigma\phi_j D_j + \Sigma\beta_j ln(X_{ji}) + v_i - u_i$$

where D are intercept dummies; the subscript i refers to the i^{th} farmer, j refers to the j^{th} stratum i.e., socioeconomic domain; ln is the natural logarithm and Y_i is the total value of farm output of the i^{th} farmer in Naira; X_{ij} are input variables made of the age of farmer (years), land use intensity (number of years of continuously cropping a farm plot), livestock owned (TLU), obtaining credit for farming (1 = yes, 0 = no), belonging to farmers' cooperative society (1 = yes, 0 = no), farm size in hectares, labor in person-days, chemical fertilizers used in kilograms, and other costs to cover expenditure on seeds, crop residue, animal traction implements and other miscellaneous costs. Intercept dummies have been used to measure technical efficiency differences across eight domains, three farm types, users and non-users of fertilizers and animal traction. The eight domains were arranged as follows: LPLM, LPHM, HPLM and HPHM domains of the NGS; LPLM, LPHM, HPLM, and HPHM domains of the SS.

The mean economic efficiency for the sample was 63%. Two farms were less than 20% efficient while seven farms were more than 90% efficient. There was only one frontier (100% efficient) farm. Major characteristics of the most efficient farms (10% of the top performing farms) that differentiate them in a statistically significant manner from the least efficient farms (10% lowest performing farms) are:

- higher gross revenue per hectare
- smaller farm size
- higher land use intensity (longer years of continuous cropping)
- higher quantity of manure applied per hectare
- younger age of farmers
- higher number of livestock (TLU) owned
- higher cash expenditure on crop residue.

The t-test of equality of means further shows that the NGS had a proportionately higher number of least efficient farms (33 out of 56) but a lower proportion of most efficient farms. These results point consistently to farms in the SS being operated at comparatively higher levels of economic efficiency than those in the NGS.

The results show highly significant differences in the parameters across the socioeconomic domains and also between users and non-users of animal traction and users and non-users of manure. For the socioeconomic domains, economic efficiency varied and increased substantially from the NGS LPHM and a sequence of increasing economic efficiency can be traced from SS LPLM domain–the lowest–to SS HPHM domain–the highest.

Therefore, within each agroecological zone, these results show higher economic efficiency with increased population pressure and market access. The users of animal traction or/and animal manure have reached a significantly higher production frontier over non-users. This is an expected outcome and is in line with the evolutionary pathway for agricultural energy intensification.

The estimated coefficients of all the input variables in the production function show decreasing returns to scale in farm operations in the sample areas, given that the sum of the gross revenue elasticity of the inputs in the production function is significantly less than unity.

The results also indicate that inefficiency exists among farms in the sample and is high among aging farmers and those that received credit. On the other hand, owning more livestock and higher land use intensity reduce inefficiency. Farmers who belonged to cooperative societies were more efficient. The reduction of inefficiency effects through farmers belonging to cooperative societies is linked to cooperatives being a source of good quality inputs, information and organized marketing of products–especially dairy products. Higher land use intensity also reduced economic inefficiency effects as should be expected with more complete utilization of resources.

In conclusion, differences in economic efficiency of farms, in the northern Guinea and Sudan savannas of West Africa occur in a pattern related to their biophysical and socioeconomic circumstances. This gradient of economic efficiency is particularly vivid in the analysis by the socioeconomic domains and could be traced from the low-population low-market domains to the high-population high-market domains of each of the agroecological zones, in an increasing order—using the NGS LPLM as base domain. Overall, farms in the Sudan savanna also operated at a higher level of economic efficiency than those in the northern Guinea savanna. It can be concluded from the above that intensification leads to higher economic efficiency especially when an increase in the use of one input interacts synergistically with improved quality or increased quantity of other inputs and that greater crop–livestock interactions and integration in farms lead to higher economic efficiency.

Following the hierarchy of efficiency levels revealed by the results of this study, it could be speculated that low-population low-market domains need to acquire better skills to improve their farming efficiency than they do need new technologies. By contrast, the high-population high-market domains, especially in the Sudan savanna would need new technologies to increase their agricultural productivity because they are already operating efficiently, both technical and economically.

The characteristics of the top performing farms point to smaller farms, the use of more manure and chemical fertilizers, ownership of more livestock per hectare, increased number of years of continuous cropping and the involvement of youths in farming as the pathways for increasing economic efficiency of farms in savanna West Africa.

Adoption of storage technologies in the Guinea savanna of Benin

by K. Hell in collaboration with B. Azoma, O. Gbati, and H. Skovgaard

In the continuity of storage technologies adoption studies, pesticide use has been investigated in 2003–2004. One of the principal constraints to the valorization of maize production relates to its conservation. The appearance of new pests induced behavior on food products storage. The treatment of stored food products with synthesis insecticides is one of these new practices acquired by the producers.

In this way, the Sofagrain® has been using for several decades now to treat maize. This study, led in the central and northern Benin, tries to assess factors affecting the use of this pesticide among farmers. The results obtained indicate that availability of the insecticide; its effectiveness against pest and its work requirement are determinant in sofagrain use. The

part of stored maize to be sell is positively correlated to the use of sofagrain while the nearest of market place to farmers house is negatively linked to the probability of sofagrain use.

Development of strategies to promote farmer utilization of herbaceous legumes for natural resource management

by N. de Haan

The overall objective of the GTZ-BMZ project was to determine opportunities for targeting the introduction of herbaceous legumes into crop–livestock systems in two agroecologies, the NGS (northern Guinea savanna) in Nigeria and DS (derived savanna) in Benin in order to increase farmer income and food security in an environmentally sustainable manner. The focus was on a participatory "learning-by-doing" approach, which was re-iterative and interactive throughout the three years. The project was a first attempt at practical, on-the-ground implementation of a combination of socioeconomic and biophysical parameters in villages selected to represent a diversity of resource-use intensities in the two agroecologies. Following village level constraint assessments, farmer evaluation of herbaceous legumes involved a range of aspects. In each village an introductory workshop was conducted to explain to farmers the legumes that would be offered and some of the expected benefits.

In each of the eight villages, demonstration trials were then established which were largely managed by the research team, but farmers also had the opportunity, throughout the three-year project to request for seed of any material they were interested in testing themselves. In these instances, no specific "rules" about management or utilization of the legumes were enforced. Farmers' individual rationales for experimenting with and adoption of herbaceous legumes were also evaluated as part of the group and individual discussions.

A considerable database including both biophysical and socioeconomic information from both group and individual levels was compiled. In addition to identifying some key issues with respect to herbaceous legume targeting, being among the first projects to attempt on-the-ground combination of hard and soft science, there are also some generic lessons about appropriate strategies and future directions that may be applicable to other interventions. In the NGS, groundnut was popular in all villages, requiring no additional inputs, little processing and being suitable for home consumption. In general, dual-purpose legumes, were most appropriate at the more intensive end of the spectrum, with good market access, and whilst the focus was on grain, forage was used for livestock.

Although the single variety of cowpea did not seem well accepted by farmers, new systems involving dual-purpose cowpea may be more appropriate here. Forages were of most interest to farmers with poor market access, or richer farmers in areas with better market access. In the DS, soil fertility was the paramount problem and *Mucuna* was accepted as a solution to this as well as contributing to weed reduction. In the DS again, groundnut was popular, but only for grain production. For villages with highly degraded soils, familiar with legumes for both soil fertility and food both *Mucuna* and soybean are appropriate.

In villages with intensifying systems where confinement of livestock begins to be necessary, forage species are beginning to be of interest. Although to some extent the major findings of the research undertaken are straightforward and almost intuitive, the methodology developed and utilized represents an important new tool (albeit needing further refinement) that can be modified and subsequently used to bring together biophysicial and socioeconomic factors to improve targeting of other technologies.

Key approaches taken and lessons learned by the present project centered on integration. Thus, for example, integrated crop–livestock farming systems, integrated socioeconomic and biophysical research, and integrated livestock-soil-crop studies have been addressed. Whilst these strategies strive to address issues that are relevant and close to real-life farmer situations, there are also an inevitable number of challenges. These include developing institutional mechanisms between the various partners to ensure appropriate equity and attribution issues are addressed. For such structures to work effectively, communication was a key issue, it was also realized that face-to-face communication as often as possible was an essential part of keeping all stakeholders informed and working together. In line with this, the diversity of scientists who worked together in the context of the present project demanded considerable time and effort towards developing a common understanding and vision of project aims and strategies. Scientists who focused on non-biophysical issues were at times reluctant to impose any methodologies or recommendations at village level, whilst biophysical scientists recognized the need for a certain level of input and management to ensure successful plant growth and therefore give the farmers the best impression of the potential of the introduced options.

Conversely, there were times when the biophysical knowledge was inappropriately interpreted to be superior to rather than equal to that of farmers. It was relatively easy to assess plant growth in the field, but determining the potential of the species, for example, as forage and their likely benefits to ruminants was more challenging. In retrospect, such issues might have been better addressed by developing specific strategies to interact with Fulani cattle keepers in the NGS, but that would have precluded the self-selection of farmers. Balancing these kinds of issues was essential to ensure the smooth progression of the project.

Socioeconomic analysis of promising balanced nutrient management systems in northern Nigeria

by K. Wallys (MSc Student, KU-Leuven), E. Tollens (KU-Leuven), and V.M. Manyong

Poor soil fertility is one of the major constraints for agricultural production in the cereal-based systems of the northern Nigeria. Technological solutions based on the use of chemical fertilizers are available and have been applied in some areas. In general, however, their use remains limited all over Africa because of high costs and inefficient marketing systems.

An alternative to the use of N fertilizer has been to grow legumes in rotation or in mixed cropping with cereals, as a source of N. The capability of legumes to fix atmospheric N allows them to grow in N-impoverished soils. However, the amount of soil nutrients supplied in those systems might not be enough to solve crop productivity problems in the African savannas. Therefore, sustainable crop production in most of these soils requires continuous addition of judicious applications of inorganic fertilizers and organic inputs for acceptable levels of production.

Three improved maize-based cropping systems are being tested since 2000 in a series of farmer-managed trials. The first practice is a continuous maize treatment mainly characterized by high fertilizer rates (SG2000). In the second technology, part of the fertilizer quantity is replaced by animal manure (BNMS-manure). Thirdly, a soybean–maize rotation treatment is included, again with reduced fertilizer rates to maize (BNMS-soybean/maize). An economic analysis was carried out by means of a partial budget analysis. The results highlighted the economic beneficial effects for each of the improved treatments over the farmers' practice.

The BNMS-soybean/maize rotation had the highest net benefit (because of high market price of soybean) and the BNMS-manure treatment was the least profitable when manure was evaluated at full cost. This treatment out-performed the SG 2000 when manure was considered free. The sensitivity analysis on both the fertilizer prices and manure price showed that the BNMS-manure treatment was very sensitive to changes on these two key parameters. Therefore the manure market is a key for the future of the BNMS-manure system. Also, increases in crop yield or output prices would be more profitable to the BNMS-manure. Thus, there is a need for continuous breeding of high yielding varieties for the BNMS-based systems to become even highly profitable.

Both the midseason and the end-of-season evaluation of farmers showed a clear preference of the BNMS-Manure, followed by BNMS-soybean/maize and SG 2000 in that decreasing order of importance. There were indications of auto-diffusion of the new technologies to other fields within the same farm by participating farmers and outside the farm by non-participating farmers into the experiment. It was also found that the rate of adoption of components of the improved systems varied widely among participating farmers. In particular, the adoption of a high plant density of maize was consistently low in all the three systems.

In conclusion, the availability of manure and its market was a key to the profitability and sustainable adoption of the BNMS-manure treatment. The price evolution of soybean (i.e., the market for the new product) is critical for the future of the BNMS-soybean/maize rotation system. There is a need for better information to farmers. Therefore the development of extension materials and training in technical messages are important.

In the short run, there was no clear-cut choice for any of the three improved systems as far as their profitability is concerned. Therefore, it is suggested that they would be promoted as a basket of best-bet options where farmers could choose from depending on their resources and situations.

Socioeconomic determinants of households' food insecurity across agroecological zones and sectors in Nigeria

by K. Amegbeto and B. Maziya-Dixon

Food security is defined as "access by all people at all times to enough food for an active and healthy life". How to measure it is the subject of debate within the development community. There is no simple formula for constructing valid measures because of the difficulties in defining the concept, which include quantitative, qualitative, cognitive and affective components of certainty, acceptability, and sustainability. Methods such as ethnography, rapid rural appraisal, coping strategies, food economy approach, expert systems, and livelihood security have been used in developing countries to gain an understanding of food insecurity and to develop measures. Matching various demographic characteristics of households with food consumption data is vital to policymakers and program designers who plan to reduce food insecurity. Household food consumption surveys are a source of multiple, policy-relevant and valid measures of food security. They allow multilevel monitoring and targeting, and can be used to identify the food insecure people for appropriate interventions. The objective of this section is to identify the socioeconomic and demographic factors that determine households' food insecurity level in Nigeria. A quantitative measure of food availability and its access by households was defined and compared across three sectors (rural, medium, and urban), three agroecological zones (dry savanna, moist savanna, and humid forest) and with respect to households' socioeconomic characteristics in Nigeria.

A detailed food consumption and nutrition survey was conducted in 2002 in Nigeria. Information was collected on, among other variables, food availability and affordability from 6000 households. A measure of food insecurity at the household level was defined based on the availability and affordability of food items over a period of 12 months. The constructed food insecurity index (FSI_h) is comprised within the interval [0,1], and the closer the index is to zero for a given household, the better is the household's food security level in terms of joint availability and affordability. Tobit model provides a good framework and was used in the analysis to identify the socioeconomic determinants of the variability in the index across households because its formulation is based on a censored distribution of the dependent variable. The model measures both the probability and the extent of food insecurity across the households, and has been extensively applied in economic analysis of consumer demand for food.

Empirically, the food insecurity index was regressed against a set of variables that described the socioeconomic characteristics of households. Depending on households' primary source of energy, drinking water, methods of refuse disposal, and toilet systems, households were also classified into low, medium, and high standard of living categories. The low standard corresponds to an environment without electricity and where pond, lake, spring, river, or harvesting rain water was the main source of drinking water, bush was used for toilet or refuse disposal. The medium standard refers to access to rural electrification, well or bore hole for drinking water, and refuse dump and VIP latrine for waste disposal. The high level includes households that possess their own electricity generator or have access to the NEPA (National Electrical Power Authority), to organized refuse disposal services, and having water-flushing toilets. The regression model was run on Limdep 7.0.

Across the sectors, households in the rural sector in Nigeria were relatively more food insecure than those in the medium and urban sectors. Similarly, households in the moist savanna agroecological zone were more food insecure compared to those in the dry savanna and the humid forest respectively.

On the basis of the primary occupation of household heads, families headed by farmers are the most severely affected by food insecurity. The level of insecurity decreases as one moves from households headed by farmers to those of traders, artisans, civil servants, and fishermen. At the same time, male-headed households show higher food insecurity compared to female-headed ones.There was a negative relationship between household incomes and the food insecurity index, as one would expect. Food insecurity is relatively more severe within households in the low living standard category, followed by those in the medium and high categories respectively. This suggests positive correlation between food security and living standards as measured in this study.This work is in progress to refine model specification. Full report and policy implications will be provided thereafter.

Market power and structural adjustment: the case of West African cocoa market liberalization

Michael D. Wilcox Jr. and Philip C. Abbott, Purdue University, in collaboration with Yapo Assamoi, Jonas Mva, Chris Okafor, and Jim Gockowski, IITA

Liberalization of the cocoa market in West Africa, due to structural adjustment reforms, has resulted in the elimination of parastatal marketing boards and initiated the creation of new institutions to replace the marketing services of those agencies. Concerns have been raised as to the effects of these reforms on prices of cocoa received by farmers, welfare measures and

competitiveness of marketing channels. Of particular importance is backward integration of multinational processing firms, who take over exporting activities and may collect rents previously captured as export taxes. This paper uses a conjectural variations approach to estimate the degree of market power present in the post-liberalized cocoa bean markets of Côte d'Ivoire and Nigeria. Evidence of market power is found in the Côte d'Ivoire markets between the farmgate and US/EU15 imports. The market power, exercised by multinational exporter/processors, must be considered in concert with the Ivorian government who is still collecting export taxes. In contrast, no evidence of market power is found in the Nigerian markets or domestic (farmer to trader) markets of Côted'Ivoire. A similar study is underway in Cameroon.

New and ongoing output 1 activities

Cost-benefit analysis of various on-station cassava trials in Uganda and Kenya

Anneke Fermont (PhD/APO project), NARO and KARI

Background/justification. The recent releases of high-yielding cassava varieties in eastern Africa have raised concerns about soil fertility depletion when these varieties are introduced on-farm. In addition, IITA is actively involved in developing cassava as a cash crop. These two issues have resulted in the development of diagnostic on-station trials in Kenya and Uganda with the main objective to determine:

- Soil fertility depletion under monocropped and intercropped cassava systems.
- Nutrient response curves for the main macronutrients (N, P, and K).

Results of these diagnostic trials will be used as base line information to develop improved soil and crop management practices for cassavas based cropping systems (both commercial and low-medium input).

Location and target beneficiary group. Namulonge Research Station in central Uganda and Alupe Research Station in Western Kenya. Direct beneficiaries of the diagnostic trials are researchers of IITA, KARI and NARO. Target beneficiaries on the long term are cassava farmers of Uganda and Kenya.

Methodology/implementation strategy. The following three cassava trials have been installed on station using a RCB design with 4 repetitions:

- variety x fertilizer trial using 3 local and 3 improved varieties under standard fertilized and non-fertilized conditions,
- nutrient response curve trial using 4 levels of N, P or K while keeping the other 2 macro nutrients at a constant, moderate level
- intercropping trial using 2 local and 2 improved varieties intercropped with beans or a grain crop (maize or millet).

Detailed soil and plant samples are taken to evaluate impact on soil nutrient pools and calculate nutrient balances for all trials. Input, yield and farm gate price data are collected to carry out a cost-benefit analysis for all treatments.

Expected results/deliverables in 2004. Cost-benefit analysis of all trials.

Milestones for coming year. Harvest finished by April 2004. New trials installed by May 2004. Cost-benefit analysis finished by July 2004.

Starting date and projected ending date. April 2003–April 2006.

Characterization of pilot sites in Uganda and Kenya

Anneke Fermont (PhD/APO project), NARO and KARI

Background/justification. The introduction of improved cassava varieties which have been developed in response to the cassava mosaic virus epidemic in eastern Africa is an excellent entry point to develop improved crop and soil practices for cassava based systems to increase the (economic) performance of these systems while sustaining or improving their soil fertility level. To develop appropriate management practices, a characterization of the pilot sites in Kenya and Uganda is needed. This will include information on existing cropping systems and the major biophysical and socioeconomic factors that are likely to influence the choice of management practices.

Location and target beneficiary group. The final choice on locations of the pilot sites has not yet been made. Most probably they will include the Luwero triangle in central Uganda and Busia and Siaya district in western Kenya. Direct beneficiaries are researchers of IITA, KARI, and NARO and the farmers of the pilot areas. Beneficiaries on the long term include cassava farmers of Uganda and Kenya.

Methodology/implementation strategy. One to two pilot sites will be selected in Uganda and Kenya. A rapid characterization of these sites will be done to describe the major biophysical and socioeconomic factors influencing cassava-based cropping systems. Data will be obtained from meteorological stations, soil maps, literature, and by interviewing key informants in the pilot areas (extension workers and staff of NARS and NGOs). Informal discussions will be held with farmer groups to gather general information on their farming systems. Thirty farms in each pilot site will be selected at random. Formal surveys will be held with each farmer to obtain specific farm data with emphasis on soil fertility management and possible management options to improve the performance of the cassava-based cropping systems. In each pilot site, cassava fields in 2–3 toposequences will be sampled to identify possible limiting nutrients.

Expected results/deliverables in 2004. Characterization of pilot sites.

Milestones for coming year. Pilot sites selected by February 2004. General characterization of biophysical and socioeconomic factors by June 2004. Farming system characterization by July 2004.

Starting date and projected ending date. January–July 2004.

Improving banana marketing and utilization in Uganda

Steffen Abele (IITA), NARO Uganda (National Banana Research Program), R. Kalyebara (Economist), D. Ngambeki (Agricultural Economist), K. Nowakunda (Postharvest Technologist), M. Pekke (Postharvest Technologist), W.K. Tushemereirwe (Program Leader/Pathologist), C.S. Gold (IITA Banana Entomology Project Leader) Makerere University, F. Muranga (Food Scientist), B. Bashasha (Economist), B. Kiiza (Economist), J. Kawongolo (Agric. Engineer)

Theme. Improving market-oriented banana production, adding value, and diversifying the product range to enhance food security, balanced nutrition, and income levels of grassroots communities in banana cropping systems.

Primary objective. Contribute to food security and household income through improved marketing and value addition to bananas.

Duration. One year with possible renewal for additional two years.

Starting date. September 2003

Background. This project focuses on establishing baseline information on characteristics and dynamics of banana production, marketing systems, needs and priorities. Gender constraints are identified and solutions sought through community participatory discussions. Also, the capacity of communities to produce for markets is enhanced and linkages between banana producers and agribusiness' promoted. A range of market quality banana value-added products and technologies to produce them were to be packaged and disseminated to processors. Under this project, network of marketing centers linking farmers, traders, processors and consumers in domestic and regional markets was set-up in selected sites to facilitate information flow.

Location and target beneficiary group. The location of the project is western Uganda. The beneficiary groups are small-scale farmers, rural processors, as well as rural and urban consumers.

Milestones for 2004. Baseline survey on banana production and marketing systems in Uganda:

- start up small-scale production and marketing of value-added banana products and technologies at community level;
- facilitate communities and marketing agents to form viable economic associations;
- facilitate and promote linkages among farmers, processors, traders, consumers, and service providers;
- analyze quality attributes and acceptability of banana products;
- develop and test on-farm low cost dryers;
- evaluate socioeconomic processing of technologies and products;
- supply and demand studies to determine producer/consumer preferences and potential to compete in domestic and international markets.

Identifying market opportunities in southern Sudan

Shaun Ferris FOODNET/IITA (CIAT ex-IITA), Steffen Abele (IITA), Catholic Relief Services, Southern Sudan Agricultural Revitalization Project

Expected result. Identification of potential market opportunities in primary agricultural products or processed products in order to invest capital and human capital in these market opportunities, given that southern Sudan has a peaceful and efficient institutional and political environment.

Duration. Six months from September 2003 to February 2004.

Starting date. September 2003.

Location and target beneficiary group. Southern Sudan, small-scale farmers, development agents, and policymakers.

Background. CRS Sudan leads a four-member consortium implementing the USAID-supported Southern Sudan Agricultural Revitalization Program (SSARP). In partnership with the authorities in southern Sudan, this five-year program aims to establish agricultural training centers within southern Sudan covering six topic areas—livestock, crop production, agricultural technology, wildlife, forestry, and fisheries. The training centers will emphasize support for the development of agricultural business opportunities serving both the local,

regional, and international markets. As part of the start-up phase of the program, CRS is commissioning a market-opportunities-identification (MOI) study that will be used to develop the training curricula for the centers, as well as to guide the subsequent technical support and training that will be provided to communities and individuals for the development of their various agricultural businesses.

Aim. The aim of the study is to identify and describe the current and expected market potential for the complete range of commodities and items covered by each of the training centers. Across this wide portfolio of products and services (covering both raw and processed items, and ancillary business activities such as input supplies, packaging needs, etc.), there will be a subsequent evaluation to determine their comparative market, competitiveness, and economic feasibilities. The focus is on the identification and support for income and employment generating opportunities for southern Sudan.

Study structure. The study was divided into two separate but interlinked phases:

- *Initial perspective MOI.* This involved the rapid collection and assessment of existing information. While this was not aimed at providing a comprehensive document-review, it was to identify and evaluate previous similar work to avoid the repetition of recent studies. A limited amount of fresh information collection was to be carried out in key geographical areas (yet to be identified), and which would be implemented in conjunction with the consortium members of staff and the New Sudan Center for Statistics and Evaluation. The work was also to establish and describe the major agricultural products that are produced within southern Sudan and marketed both internally and to external markets, and to identify the market opportunities currently available and those expected over a 10-year horizon. The perspective MOI was to capture the dynamics of the changing market situation based upon a number of different scenarios, and their respective assumptions, regarding the ongoing peace process and its impact on population shifts, communications improvements, the reorientation of trade route, and a positive change in the investment climate.
- *Subsector MOIs.* Individual subsector MOIs was to deal further in depth with the products and services in each of the six topic areas covered by the training centers. These were drawn from the material researched and presented in the perspective MOI and its broadly described scenarios, and used the same indicators of how the flow of products and services being demanded is affected by these scenarios. They were to include participatory assessments of respective market opportunities involving center and consortium staff and other stakeholder organizations. A full analysis of the constraints and risks associated with the realization of these opportunities, and the formulation of measures that are needed to minimize these factors, was also to be presented. A 5-year phased program of recommended actions by the respective subsector actors to exploit the identified opportunities, with detailed market contacts, local and regional resources, training needs, etc, was formulated. Linkages between the different topic areas were identified.

Key findings so far. The initial perspective MOI has been completed. It combined an "inside southern Sudan" review of data and literature, as well as a field survey in the above-mentioned subsectors with an "outside southern Sudan" screening of seven adjacent countries in eastern Africa, as well as world markets. The inside screening was to determine present production and trade and hence comparative advantages of southern Sudan, whereas the outside screening aimed at determining future high potentials on agricultural commodity markets in eastern Africa and the world.

The findings showed that at present, southern Sudan has a number of comparative advantages and hence trade, especially in oilcrops (sesame, groundnut), cereals (maize), livestock (live cattle, hides and skins), and forest products like honey. The most important factors hampering trade are high transport costs and insecurity. The outside screening shows that promising markets in eastern Africa are processed product markets such as vegetable oils (groundnut, sesame, palm oil), and sugar, promising cereals are maize and rice, animal products with a future seem to be fish. All of these products have high-income elasticity, positive future price prospects, and are at the moment deficitary in the region.

Milestones for 2004

- Based on the findings of the first study, a shortlist was to be decided upon together with the stakeholder
- On these shortlisted items, there was to be an in depth analysis conducted with respect to production, marketing, and processing.

Saving the unique banana-coffee production system of Uganda: integrating farmers' and scientists' knowledge

Steffen Abele (IITA); IITA-ESARC in collaboration with National Agricultural Research Organization (NARO), Uganda

Location and target beneficiary group. Uganda (southwestern and central regions), target group is small-scale banana and coffee growers.

Background. Banana and coffee form the economic base for a large population of eastern Africa. A participatory rural appraisal (PRA) conducted at seven sites in western and central Uganda showed that the two crops are grown in various cropping patterns ranging from complete mixtures to intercrops dominated by one crop to adjacent monocultures. In some cases, banana may be phased out as a coffee crop matures. East African Highland cooking banana (AAA-EA), which covers the largest area (about 70%), doubles as a major food at all sites and also as the leading daily cash income crop at five sites. Other banana types used for brewing (AAA-EA and ABB) and as dessert (AB and AAA) formed 10–20%. Coffee is regarded as providing a long-term seasonal cash boom. The yield trends of the two crops over the last 20 years suggest that the systems were declining. The major production constraints are land scarcity, pests and diseases, declining soil fertility, and socioeconomic factors (poor marketing options and liquidity to hire labor and other inputs).

Key pests affecting banana include banana weevil (recognized by farmers at all sites), nematodes (noted by scientists at all sites but recognized by farmers at two sites only), *Fusarium* wilt in the exotic dessert type (AAA, AB) and brewing types (ABB). Key coffee pests and diseases included coffee wilt, coffee mealybug, scales, coffee berry borer, and coffee stemborer (reported at one site only). Robusta coffee is the predominant coffee cultivar at all sites and is very susceptible to coffee wilt. Arabica coffee (resistant to coffee wilt) was grown at one site only in Mbarara district. Currently, cultural control is the main IPM option adopted for all the above pest constraints. These include:

- Crop sanitation and clean planting material for banana weevil and nematodes and (ii) roguing for *Fusarium* wilt and coffee wilt.
- There are no clearly defined management options for other pests.

Banana and coffee mutually benefit each other but also compete with each other for resources. Banana provides shade and mulch for young coffee (moisture, nutrients) while coffee provides

husks for banana (nutrients) at sites closer to the coffee factories. Farmers using coffee husks also reported low incidence of banana weevil in their plantations and hence an additional option for weevil management. The effect of coffee intercrops on pests and disease incidence in banana was not clearly understood. Farmers at four sites (central Uganda) reported low weevil incidence in banana–coffee intercrop while farmers at other sites in Masaka and Mbarara did not notice any difference. Future studies to understand the effects of a coffee intercrop and use of coffee husks on banana weevil incidence and management have been planned. The antagonistic aspects of the system are that: coffee depletes soils while banana throws shade on older coffee plants. This is currently overcome by adjusting spacing. Both the economic and agronomic potential, especially of intercropping systems, is not yet fully exploited. Whether they are grown intercropped with each other or cultivated on pure stands, banana and coffee have many economic and agronomic relationships, both positive and negative. These relationships have to be further developed and improved. With regard to the economics of the system and its relationship to IPM, it was noted that liquidity and food security play an important role in economic decision-making. Lack of liquidity among farmers leads to poor crop management, including pest management. More attention was given to banana because of food security.

In the economic field, research will focus on analyzing the system with special respect to investments (in perennial cropping system), as well as production and marketing risk.

Hypotheses. Optimizing banana-coffee intercropping management (e.g., proper spacing and adoption of improved technologies), will improve soil fertility, minimize pest problem, increase longevity of the plantations and result in higher yields of both banana and coffee under the current key constraint of land and labor shortage.

In particular, application of coffee husk as mulch and soil fertility amendment in banana plantation reduces banana weevil constraint and increases banana yield. Improved marketing organization, by establishing better market information, by taking over marketing functions through the farmer (replacing middlemen with farmers' organizations) will increase farmers' cash income through: reduced marketing margins. Increasing the negotiation power of farmers versus traders and thus increase farmgate prices and thus remove the bottleneck of lack of cash and financial liquidity and add resources (especially labor and nutrient imports) to optimize management and input utilization.

Methodology and implementation strategies. Yet to be determined.

Milestones for 2004. Submit the full proposal and continue preliminary surveys on biophysical and economic factors determining the system.

Economic analysis of the best-bet balanced nutrient management systems (BNMS) in northern Nigeria (northern Guinea savanna benchmark area)

M.O. Ugbabe (MSc Student at Ahmadu Bello University), V.M. Manyong, and G. Dercon(IITA), and J.O. Olukosi and Ben Ahmed (Ahmadu Bello University)

Background. Different best-bet BNMS systems are being introduced to small-scale farmers in the northern Guinea savanna benchmark area through the Belgium-funded BNMS project. In 2003, a MSc student from KU-Leuven conducted a socioeconomic evaluation of three technologies on the basis of partial data from two years observations. This research activity is a continuation of the 2003 research. The current study is justified by the following reasons: the completion of the second BNMS treatment (BNMS-soybean–maize rotation)

this year (season) to enable data to be collected for global analysis is very necessary, in-dept analysis of the manure constraints to determine its availability to the farmers at the recommended BNMS usage rates of 6t/ha, a third year data is very much needed for comparative analysis, and this third year trials are very necessary for adaptation of the project by farmers. Reasons must also be deduced from this study as to why some farmers withdrew after some of the trials.

Location/target beneficiary group. The study was conducted in the northern Guinea savanna of Nigeria. The study involved 33 farmers located in nine villages. However, the target beneficiary group is made up with farmers located in the Guinea savannas of West Africa and elsewhere in Africa.

Hypotheses/research objectives. The objective is to recommend profitable technologies for sustaining farming in the savannas of West Africa. The specific objectives of this study are to conduct an economic evaluation of the best-bet BNMS technologies tested in demonstration trials, to assess farmers' appreciation of best-bet BNMS technologies tested in previous years in demonstration fields, to optimize the allocation of resources within the farm including the use of manure, and to draw the implications for research and extension service,

Methodology/implementation strategy. Four technologies are being evaluated. Intensive cost-ratio data will be collected in order to conduct a partial budget analysis. A typical farmer of each group will be intensively monitored to collect data to run a linear programing model.

Expected results/deliverables in 2004. The MSc thesis will be completed in 2004 and recommendations will be made on the most profitable best-bet technology for the farmers.

Milestones for coming year. To complete data collection, processing, and analysis. Drafting of one journal/conference paper out of the research.

Key findings to date. None.

Optimum management strategies under differential risk attitudes among maize farmers in the dry savanna zone of Nigeria (northern Guinea savanna benchmark area)

L.O. Olarinde (PhD student at the University of Ibadan), V.M. Manyong, A. Menkir, and J.O. Akintola (University of Ibadan)

Background. The importance of maize in Nigeria cannot be overemphasized, with the country producing 43 % of maize grown in West Africa. It is especially important in the northern Guinea savanna where it is one of the two major crops in about 40% of the area under agricultural production. Maize production has steadily increased in Nigeria between 1984 and 1994. This rapid growth occurred mainly through expansion of areas under cultivation, the introduction of better performing improved varieties, availability of fertilizer at highly subsidized prices, improved extension services, and better infrastructures such as provision of good roads.

However, maize yields of about 1.2 tonnes ha^{-1} and 0.99 tonnes ha^{-1} in 2000 for West and Central Africa respectively remain low as compared to countries in eastern Africa, such as Kenya (1.4 tonnes ha^{-1}), and southern Africa e.g., Zimbabwe (1.5 tonnes ha^{-1}). In addition to low yields, the overall trend has been declining for maize production from 1995 to 2002. There are many factors associated with that decline in maize production, including risk to adopt new improved varieties.

Location/target beneficiary group. The study is conducted in northern Guinea savanna benchmark area of Kaduna State, Nigeria, a major maize growing area. Maize production affects about 60% of households in the Guinea savannas of Nigeria.

Hypotheses/research objectives. The overall objective is to analyze the effect of farmers' risk attitudes towards the utilization of improved maize varieties and its effects on optimal cropping patterns in the dry savanna of Nigeria. The specific objectives are to measure farmers' risk attitudes towards the new maize technology, to make a typology of farmers based on their risk attitudes, to identify maize farmers' risk management strategies, and to evaluate the effects of risks on maize production and other economic enterprises within the farm. The hypotheses to be tested are double: (i) There is no relationship between attitudes towards risk and the adoption of improved maize varieties. (ii) There is no difference in the risk management strategies among low and high-risk averse farmers.

Methodology/implementation strategy. A three-stage stratified sampling technique with probabilities proportional to sizes was adopted to choose a final sample of about 350 farmers. Data were collected on factors that are assumed to affect maize yields, socioeconomic and demographic factors, and "risk variables". These data were analyzed with descriptive statistics, ridge regressions, discriminant analysis, and mathematical programing model.

Expected results/deliverables in 2004. The PhD report will be completed in 2004. A database is already available.

Milestones for coming year. Two journal papers are currently under development.

Key findings to date. Three groups of maize farmers were constituted on the basis of a risk factor. This factor was calculated using the econometric models. Different risk-mitigating strategies were identified for each group of risk-averse farmers.

Adoption pathways for fodder innovations

N.C. de Haan (IITA), Olusoji Olufajo (ILRI), Shirley Tarawali (ILRI), Jean Hanson (ILRI), Peter Bezkorowanjyj (ILRI), and various collaborators

Objective. Using different technology transfer approaches and partners to determine and facilitate successful adoption pathways of fodder legumes in Nigeria.

Background. The overall aim of the project is to increase use and adoption of fodder plants for improving livestock productivity, soil fertility and ground cover, and generating higher incomes as a means to enhance the livelihoods of rural resource-poor livestock keepers and the sustainability of their production systems. The background to this is that there are an estimated 555 million poor livestock keepers, mostly residing in rural areas in the developing world.

The inability of producers to feed their livestock adequately throughout the year remains the most widespread technical constraint to increased livestock productivity. Removing this constraint would enable smallholder livestock producers to improve their livelihoods by taking advantage of market opportunities and building assets. The project started in 2002, and is being implemented in Nigeria and India.

Location. 26 sites across Nigeria.

Methodology. Using a combination of sociological research methodologies (action research, actor linkage mapping and more structured questionnaires) while simultaneously working directly with farmers to develop and test varieties.

Expected results. To gain a better understanding of adoption pathways and of the specific roles forages can play in the farming systems across Nigeria, and to develop mechanisms for scaling up and out of forage technologies.

A Tobit analysis of agrochemical intensification in Côte d'Ivoire

Blaise Nkamleu (IITA)

Expected results. Recommendation on more effective strategies to promote use of agrochemicals in the cocoa sector and boost productivity.

Objective. Quantitatively examine the factors that are associated with farmers' decision to adopt and apply agrochemicals in their cocoa farms.

Background. Growth in this sector will continue to be the cornerstone of economic development and poverty reduction in West and Central Africa region. To be able to boost cocoa productivity towards more than the one tonne typically obtained in southeast Asia, it is urgent to spread the use of agrochemicals. Attaining the goals of economic development and poverty alleviation in the region, require an intensification of the cocoa production system by promoting the use of agrochemicals by farmers. The design of such strategies requires information on current use of chemical inputs by farmers and on factors affecting the adoption and the intensity of utilization of those inputs. A wide range of variables influences adoption of such input. It is important to understand the role of these factors to ensure the development and implementation of more effective programs to promote the use of chemical inputs. This activity will identify level of utilization and factors that affect the intensity of use of such inputs in the cocoa production.

Location. Desk analysis, Yaoundé.

Methodology. We will make use of baseline survey data conducted in all four countries. Limited dependent variable regression (Tobit regression models), will be used to quantify the impact of socioeconomic factors on investment in agrochemicals.

Milestones

- Draft report completed (30 August 2004)
- Final technical report 18 September 2004
- Article submitted to peer review by December 2004.

Update on milestones. Regression analysis on the adoption of agrochemicals by cocoa farmers in Côte d'Ivoire is completed. Computed is done. A draft paper focusing the determinants of investment in agrochemicals by cocoa farmers in Côte d'Ivoire is ready.

Scale, pure, and technical efficiency: the cocoa sector of WA

Blaise Nkamleu (IITA)

Expected results. Recommendation regarding where, when and how cocoa production could be increased without requiring additional conventional inputs and without the need for new technologies.

Objective. Measure the technical efficiency of cocoa farmers and investigate the factors affecting the efficiency level.

Background. In light of the general objective of economic development, cocoa producers' countries are seeking strategies that could lead to higher levels of cocoa production.

A key factor for a sustained increase of cocoa production is improving productivity, which is carried out through technical change and/or efficiency change. Intensification of agricultural production in Africa, i.e., more frequent use of agricultural land and increased input use associated with introducing high-yielding varieties, remains a complex process. As such, a relevant question for agricultural policymakers is whether the cocoa sector can be made more efficient, by achieving more output with the current input level, or by achieving the current output with less input usage than what is currently observed. It is therefore important to have measures of the technical efficiency of cocoa farmers and to investigate the factors affecting the efficiency level.

Location. Desktop analysis in Cameroon.

Methodology. We will use baseline survey data conducted in 2001. Parametric (stochastic frontiers) and nonparametric (DEA) methods will be used to derive efficiency scores. Regression analysis will then be use to search for determinants of efficiencies scores.

Milestones

- Draft report completed (30 August 2005)
- Final technical report 18 Sept ember
- Article submitted to peer review by December 2004 (GBK, JJG).

Update on milestones. Interesting results on technical efficiency among cocoa producers in Côte d'Ivoire computed. A draft paper on efficiency in Côte d'Ivoire is ready.

2 Analysis and recommendations for supportive policies and legal frameworks

Distorted world market prices: disincentives to increasing agricultural productivity, intensification, and food production in West Africa

by Koffi Amegbeto (ICARDA, ex-IITA)

Declining trends in world food prices may undermine the stimulus to domestic food production if commodity prices fall below production costs in developing countries. Factors such as rapid technological change, increased international competition in a global market, and large producer supports, and farm subsidies in developed countries are driving down commodity prices. As a result of low food prices, political crisis, and/or natural disasters, many African countries are increasingly dependent on food imports, either on a commercial basis or in the form of food aid in order to meet their deficits. However, the compounding effects of declining export revenues, rising external debts as well as the burden of food import bills call for corrections in the structure of food demand. Massive food imports jeopardize the implementation of prices that are sufficiently high to reward the farmers' efforts, which is the most critical driver of agricultural intensification. The aim of this study is to illustrate the extent to which excessive subsidies in developed countries undermine domestic urban markets for locally produced commodities such as yams, cassava, maize, rice, etc. It provides evidence that distorted world market prices cannot be used as signal for domestic producers and realignment of policies in the north will not only improve the price competitiveness of locally produced commodities but also lead to substantial foreign exchange savings from food imports.

Own-price elasticities were estimated and used in comparative static analysis to make projections of changes in import demand. Country trade data were obtained from FAO online

statistical database. Food imports include all crop and animal products in Benin, Ghana, Mali, Nigeria, and Senegal. Only rice and wheat that account for more than 20% of total food import values in these countries were considered. The aggregate import elasticity was measured by the average arc elasticity between two consecutive years over the 1995–2001 period using the average of prices and quantities imported, provided a negative price and quantity demand relationship is observed. Simulations were based on the 2001 imports levels using projected increase in world price of 10.1% for rice, and 18.1% for wheat as a result of the elimination of all policy distortions namely, tariffs, domestic, and export subsidies.

The magnitude of projected changes in food import following discrete policy measures greatly depends on the country. In the rice sector the value of imports compared to their 2001 levels will decline by 2–42% following a 10.1% increase in world prices. Similarly, wheat imports will decline by 8–44% as a result of 18.1% increase in its world price. These changes are relatively high when one assumes a larger trade substitution elasticity that reflects greater ease of import substitution between domestic and foreign goods. Contrarily to the ERS/USDA's projection of only 2% decline in agricultural imports in all less developed countries following a change in developed countries support policies, the current analysis of two commodities shows that import reduction could be higher in parts of sub-Saharan Africa that face a completely different set of development challenges.

The relatively low impact in Mali is explained by the country's limited dependence on rice importation compounded with its policy reforms to improve the competitiveness of the rice sector. Mali engaged in reforms and liberalized its rice sector since 1987. The reforms forced traders to pass virtually all of the increase in consumer prices to farmers. As a result, producers responded rapidly, rice production grew by an average of 9% per year, and national production more than tripled since 1985. In contrast, aggregate food imports increased steadily in Senegal since 1988. The country also implemented similar reforms and actually introduced new rice varieties to farmers. Improvements in grain yields have kept up with the population growth rate but not closed the gap between demand and supply. The private sector now controls the supply and pricing of rice, and when prices start to rise, it responds with additional imports to assure a regular supply. Rice remains Senegal's largest grain import and on an annual basis, about one-third of the country's cereal needs must be met by rice importation according to an USAID evaluation in 2000.

The gross estimates of short run foreign exchange savings from rice import are as low as US$294 000 for Mali, US$1.2 million for Benin while reaching US$29.2 million, and US$59.7 million for Nigeria and Senegal. Additional savings could be made on wheat imports, where expenditures will decline by US$1.2 million in Mali, US$1.5 in Benin, US$7.8 million in Ghana, US$21 million in Senegal, and US$51 million in Nigeria, assuming an elasticity of substitution of 1.5. Additional savings maybe achieved when one considers the wide range of agricultural products that are currently imported in the subregion. For the rice sector in some of these countries, these savings represent a considerable resource that could be utilized in improving productivity and the quality of services within national agricultural, processing, and marketing channels. Particularly, other nontradable products such as cassava, yams, millet, sweetpotatoes, cowpeas, etc., could benefit tremendously.

While low food commodity prices on the world markets and continued food imports may increase availability, food security and consumer welfare in developing countries, many countries cannot afford it whether financially or strategically because a large share of their populations' livelihood depend on agriculture.

Further trade liberalization in the south without removal of producer supports and export subsidies in developed countries will only increase these countries' dependence on food imports, limit their potential for increasing productivity, and further compromise their food security and poverty alleviation. These effects can inflict enormous adjustment costs on the small farmers in West Africa. Under these conditions, unilateral liberalization would not be attractive.

The role of gender and social institutions in the agricultural sector of the Niger Delta region

by N. de Haan (IITA)

Gender. Women in the rural areas of the Niger Delta are involved in agriculture, though the degree may vary by village and community. Most rural women try to balance a livelihood strategy between their reproductive responsibilities and their productive ambitions. From the fieldwork, it also was clear that there is an increased feminization of agriculture going on, with women taking more and more responsibilities for the household. A case in point is the increased fluidity between what are male and female crops. In the past, yams were a male crop and cassava a female crop. However, now, males and females cultivate both crops. Similarly, women are ranking crops such as cocoa in Ondo, as their most important crop, because they can get a good income from it. However, the results also show that there is an increased pressure on women, with regards to labor and access to other resources, so though there is more pressure on them, they still do not have equal access to resources such as labor and land.

Implications for gender development interventions and policies

The main implication of these results is that a majority of farmers in the area are women and that the number and role will only grow in the future. Therefore, the following are some recommendations, which should be integrated in any future development interventions:

- Given that there are such different factors affecting the roles women play, including location, perception of gender roles, importance of productive ambitions and access to resources in agriculture, it is important that any action taken needs to analyze and integrate the location specific gender characteristics, if it is to benefit women.
- Stakeholders involved with rural communities should be sensitized in the gender implications of development programs, including participatory approaches to development. Implementing agencies should build upon resources and capabilities already present in the community.
- Due to the increased involvement of women in agriculture, and the increased demand on their reproductive roles, access to resources should be come more stable, whether that is to land, labor, or credit, keeping in mind that many of the changes required for this are long term, and solutions should not be easy and quick.
- Given that women are more and more involved with agriculture, the dissemination of information on new technologies should have an accompanying strategy that will ensure women benefit from it.
- In light of the increased appreciation of the role women play in agriculture by researchers and society, technology research for development should also be directed and increased towards subsistence, or "female", crops, technologies for specific female tasks such as weeding (for instance many of the technologies in cocoa production are geared mainly to male tasks) and postharvest, such as cassava processing.

- Within any intervention, but specifically with gender sensitive interventions, it is important to have mechanisms in place that will monitor the impact of the technology. This is vital to ensure that the technology does not disadvantage women or any other group within the society.

Social institutions

Social institutions form a vital part of the social fabric and live of people in the Niger Delta. From research done in the region, it was clear that there is dual governing strategies in most communities, with the traditional, in most cases complementing the government support decision-making bodies. Having said this the data also revealed that farmers depend on a variety of indigenous institutes for credit and resources, such as credit groups, church groups, cooperatives, and exchange groups. The institutional analysis clearly shows that that local populations within the Niger Delta put the most emphasis on their political institutions, followed by social, health and educational institutions in most communities visited.

Implications for social institutions in development interventions and policies in the Niger delta

As has already been stated in the forgoing, the research on social institutions was meant to give an overview of the institutions farmers have access to and use. As is clear, there are many, and they are diverse. Both men and women seem to have relative easy access to the institutions, and use them for a variety of purposes. Given this, what are the implications for any development program for the Niger delta?

It will be important and necessary at all stages of any development to include the appropriate stakeholders and social institutions. This is important because it allows for farmers to build upon what they already have.

Care needs to be taken, however, that development programs do not depend too much on social institutions, if they are weak. In line with this, some institutions might benefit from some institutional strengthening. As with all things, policymakers and development planners also need to be sensitized that social institutions can often constrain development, for instance, male rulers who deny women access to resources. Good monitoring mechanisms need to be in place to avoid this from happening.

Given that credit and extension services are important for the farmers, and that the results show that there is no formal credit and limited extension services are available, strategies need to be developed to ensure that people have access to services as those provided by formal credit services and information on new technologies provided by extension services. Extension and credit facilities will also need to be targeted specifically to women, since as has been shown, they are increasingly becoming more and more involved in agricultural production not only for reproductive purposes but also for productive purposes meaning.

The shaded agroforests of West Africa: environmental services and secondary benefits

James Gockowski (IITA), Stephan Weise (IITA), Denis Sonwa (IITA), Mathurin Tchtat (IRAD), Martine Ngobo (IITA)

The shaded cocoa-cropping system found throughout West Africa but particularly well-represented in Cameroon and Nigeria is a sustainable agricultural land use system that provides relatively high values of environmental services.

This research activity describes and quantifies some of its noncocoa economic and environmental values and examines the economic logic underlying smallholder management. Estimates of these values are developed from field surveys and on-farm research conducted with cocoa producers in West Africa over the last four years. The secondary products evaluated include the fruits of shade trees commonly associated and occupying the mid and upper canopy such as the African plum (*Dacryodes edulis*) and ndjassang (*Ricinodendron heudolotii*) along with introduced fruit species such as citrus and avocado.

The study found that in areas with good access to urban markets, gross fruit revenues averaged over US$200 per ha. In all areas where these systems are important, the nutritional contribution at the household level of fruits such as the bush mango, avocado, wild oil palm (*Elaeis guineensis*), and African plum was substantial. Timber is another economically important component of the upper canopy, with some species managed and maintained at densities above those found in primary and secondary forests for local exploitation in rural construction. Many medicinal plants are also maintained in the cocoa farm, which often serves as an in-situ herbal pharmacy for the household.

The environmental and ecological benefits of these systems include habitat conservation, climate change mitigation, hydrological cycling and watershed protection. The degree to which these services are provided depends in large part on the type and degree of shade maintained as well as their spatial coverage in the landscape. An econometric model of the determinants of shade level explores some of the driving forces behind shade management in Côte d'Ivoire, Ghana, Nigeria, and Cameroon. We conclude by arguing that because of the significant public goods associated with this land use system that there is a need for directed efforts to publicly support the development and maintenance of shaded systems.

New and ongoing output 2 activities

Agriculture and rural enterprises sector study of the Niger Delta Development Commission's (NDDC) master-plan project (degraded forest benchmark area)

> *V. Manyong, C. Legg, N. de Haan, K. Makinde, T. Alabi, I. Okike (Consultant). Executing Partners: GTZ/Wilhab (G. Malcha), Resource Consultants (NDDC-identified): Pinnacles Marketing and Services Ltd (Abia); K. Zuofa and Co. (Bayelsa); Eganejum Agroforestry Nig. Ltd (Cross River); Idomor Nig. Ltd (Delta); Takei International Investments Ltd (Ondo); and Okhu Resources (Rivers)*

Background/justification. Agriculture remains the most dominant sector in the process of development of Nigeria. In the Niger Delta region (NDR) agriculture was the central focus of the household with cash crops such as oil palm, rubber, cocoa, etc., providing sustainable livelihoods for many communities.

Other major crops such as yam, cassava, plantain, rice, and maize were also widely cultivated. The advent of oil boom, however, hindered attention to agriculture. Several other factors e.g., fragmented holdings, use of rudimentary technologies, low use or lack of inputs, weak extensions services, low priority to agriculture, no clear strategies for developing agriculture, pest and diseases, also impinged on agriculture and food production in the region. Declining land productivity and growing pressure on environmental resources marginalized the poor and stimulated community conflicts.

Location and target beneficiary group. The target beneficiaries are the peoples of the NDR, particularly resource-poor smallholder farmers in rural areas of the region located in the degraded forest benchmark area).

Hypothesis/research/development objectives. The development principles are geared towards transforming agriculture, in the region, from subsistence into being market-oriented and competitive-based on increasing productivity, strengthening processing, and promoting competitive marketing of agricultural products both locally and internationally.

Methodology and implementation strategies. The study involves the use of primary and secondary data with primary data collected using household, rural enterprises, rural sociology and GIS modules; and the secondary data collected using structured datasheets on crop and livestock statistics and farm budgets. A total of 2170 households from 62 communities in the 31 LGAs of the nine states of the NDR were sampled. The rural enterprises surveys used the snowball sampling procedure to identify, locate, and interview about 1200 rural entrepreneurs in each of the 9 states.

Expected results/deliverables in 2004. The final output of this project is a report on the master plan for the agriculture and rural enterprises sector in the NDR delivered to NDDC.

Ending date. June 2004.

Gender mainstreaming within PROSAB Project

N.C. de Haan (IITA), Jan Helsen (IITA), Paul Amaza (IITA), Alpha Kamara (IITA), and other collaborators and partners (I am the gender specialist in the project)

Objective. To ensure gender mainstreaming throughout the project, by concentrating on three different levels of interactions. At community level, to ensure that both men and women benefit from the technologies provided, and that there are interventions geared at dealing with the gender specific production issues. And thirdly, at project level, to make sure project staff, partners and collaborators understand and actively work at ensuring gender equity in their interventions.

Background. In Borno State, Nigeria, rural livelihoods are being undermined by poverty and rapid environmental and resource-base degradation due to desertification, drought, *Striga* infestation and unfavorable policies. These constraints are causing hardship to people in the state, particularly in rural communities. This project was thus developed to:

- Arrest environmental and resource degradation caused by land-use expansion and intensification, through the promotion of widespread adoption of sustainable natural resource management practices by small-scale farming communities in Borno State.
- Promote the diversification of land use systems and processing of food crops to improve the livelihood of the people and protect the environment on a sustainable basis.
- Increase agricultural productivity and incomes of male and female farmers through pro-poor policies, identification of market opportunities, and linkages to profit crop and livestock markets.
- Enhance the capacity of male and female farmers, communities and other stakeholders (GOs, NGOs, and CBOs) to develop, implement, and monitor community policies, as well as to acquire and transfer land, crop and livestock management technologies for arresting and protecting land and environmental degradation as well as desertification in the state.

This activity is specifically geared towards gender mainstreaming within the project.

Location. Thirty communities, within southern Borno State.

Methodology. The first six months was dedicated to developing the CIDA required gender strategy for PROSAB, in which several methodological approaches were highlighted such as the role of gender training for staff and clientele, research approaches to understanding the role of women in Borno State, using action research to develop gender specific interventions, and develop sustainable linkages with specific NGOs and CBOs.

Expected results. To ensure that the interventions promoted by PROSAB are gender equitable, and the women of southern Borno State gain benefits.

Research on harmonized policies for increased commercialization and trade among the SADC countries

V.M. Manyong C. Muchopa, T. Takavarasha (FANRPAN), and FANRPAN country nodes of five SADC countries

Background. Countries such as Mozambique, Angola, Malawi, and Zambia have suffered from a series of natural disasters that have also been compounded by poor short-term policy decision-making in the past decade. Often, policies are country-specific while the effects of climate, pests or trade span borders. In periods of severe crisis, such as the most recent drought, specific trade policies appear to be inappropriate to address issues of a regional dimension. It is therefore important to better understand both country level agricultural policies and regional policies and their contribution to the mitigation of the food crisis that has emerged.

Location/target beneficiary group. The study is targeting five countries of the SADC region (Botswana, Malawi, Mozambique, Tanzania, and Zambia). The beneficiaries of this study are the smallholders who can diversify their rural economy in order to become less vulnerable to natural disasters.

Hypotheses/research objectives. The goal is to provide critical policy analysis leading to dialog and enhancement of policies within selected SADC countries.

Methodology/implementation strategy. The study involves the GIS mapping of the countries in development domains, identification of commodities with a comparative advantage in the target countries and the region. Many policy consultations will be organized at the country level and for the region as a whole. The study will include policy analysis, policy technology formulation, communication to national governments, a regional ministerial conference, and follow up (with SADC) of ministerial decisions with national governments.

Expected results/deliverables in 2004. Three intermediate results are expected:

- Policy constraints evaluation and prioritisation.
- Effective policy dialog initiated and strengthened in and across the target countries.
- Mechanism established for monitoring and evaluation of policy technologies.

Milestones for coming year. Organization of country policy workshops and that of a ministerial conference, a technical report will be published.

Key findings to date in 2003. The workplan for the implementation module was developed and discussed during the inaugural meeting of the project, which took place at Lilongwe on November 2003. Representatives of FARNPAN nodes from five countries endorsed the workplan: Malawi, Tanzania, Zambia, Mozambique, and Botswana. Results from preliminary GIS analysis indicated that Botswana falls outside of potential development domains for this

project. Therefore, this country was not retained for the first year of this project while four countries were selected: Malawi, Mozambique, Tanzania, and Zambia.

Open-economy, multimarket, and partial equilibrium model of cocoa and related markets

J. Gockowski, (IITA), P. Abbott (Purdue University)

Objective. Develop a simple (relative to CGE) but robust tool for policy analysis of major macro impacts in the cocoa sector of West Africa.

Background. When prices change abruptly due to either policy or supply shocks e.g., FCFA devaluation in 1994, civil conflict in CÔTE 'IVOIRE 2002, producers respond by reallocating labor and to a lesser degree, land between food crop and cocoa production. When this happens, numerous questions arise, including: How large of a shift in land use resulted? What will happen to government revenues? Employment? And economic growth? What are the environmental impacts? How might food prices be affected? This effort will develop a generic modeling tool for such analysis that will then be calibrated according to the conditions of supply and demand in the STCP countries.

Location. Yaoundé.

Milestones. Complete generic model by 15 January 2005. Calibrate model in four countries by 10 March 2005. Hold workshop in use of model for policy analysts May 2005.

Status. A model of cocoa and food crops for Cameroon has already been estimated and published.

Agriculture in Nigeria: identifying opportunities for increased commercialization and investment

V.M. Manyong, A. Ikpi, J.K. Olayemi, S.A. Yusuf, R. Omonona, and F.S. Idachaba (University of Ibadan), with input from IFPRI

Background. Nigeria is a well-known country for its flourish agriculture before the period of oil boom. Since then, the relative importance of agriculture has been falling down in the national accounts. In spite of the existence of a well-articulated agricultural policy document for Nigeria since 1988, the country has never established a systematic focus in her agricultural planning history that shows a conscious effort to purposively prioritize her agricultural development based on strong methodologies. Besides, the private sector is yet to play the role it is expected to be playing to boost the agricultural production within the country. These gaps affect negatively farmers' productivity.

Location/target beneficiary group. The study is targeting the country as a whole. The beneficiaries of this study are found along the production-to-consumption continuum. However, the private sector is the main target of the study.

Hypotheses/research objectives. The primary purpose of the study is to provide development investors with an analytical basis for them to design new strategies that contributes to unlocking constraints to commercialization and investment in the Nigeria' agriculture sector. The specific objectives of the study are to review previous studies on constraints to commercialization and investment in Nigeria's agriculture, to define development domains within the Nigerian political economy framework, to identify constraints to commercialization and investment in Nigeria's agriculture, to design appropriate strategies for mitigating the effects of the identified constraints, and to recommend more profitable ventures for investment in Nigeria's agriculture.

Methodology/implementation strategy. The study involves the GIS mapping of the country in homogeneous domains, constraints analysis and mapping, regression analysis of the determinants of investments in agriculture by both private and foreign investors, and ex-ante evaluations of returns to investments on priority commodities using the IFPRI DREAM Model. The study made a consultation with a wide range of stakeholders including traders associations, commodity groups, banking institutions, policymakers, researchers, women associations, NGOs, civil society, etc. Most of the quantitative data were from secondary sources. However, a large amount of qualitative information came from surveys undertaken by field teams in the country. Field teams received a prior training through a methodology workshop. For data analysis, an expert from IFPRI assisted the team for the DREAM analysis. The report from this study will be widely distributed to officials (Federal and state levels) and donors. USAID/Nigeria funded this study.

Expected results/deliverables in 2004. Defined development domains, recommendations for investments options, constraint mapping.

Key findings to date. The experience gained in Nigeria from this study is being used to conduct a similar policy study for the SADC countries.

Market access, technology adoption, and optimal resource allocation under credit constraints: the case of cowpea growers in the dry savannas of Nigeria

A.D. Alene, V.M. Manyong, P. Kormawa, and B.B. Singh

Background/justification. Access to input and product markets is an important factor in the process of agricultural commercialization and technology adoption. With better access to markets, farmers have both the incentives for technology adoption and the access to the technology itself that enables them to increase agricultural production in response to growing market demands. Farmers respond to the market demands through resource reallocations and new cropping patterns, such as by allocating more land and labor to more profitable and improved varieties of crops. However, the commercialization process is conditioned by a number of other factors, including availability of improved technology and access to credit, which are the major constraints to technology adoption among poor farmers in developing countries. When appropriate technologies are available and farmers have good market access, poor access to credit becomes a serious constraint to the adoption of modern inputs and results in suboptimal allocation of resources.

In the dry savannas of Nigeria, farmers have been exposed to several improved varieties of cowpea that are high-yielding and resistant to major insect pests and diseases. Although initial efforts concentrated on varieties with high grain yield, IITA has developed a number of improved cowpea varieties (e.g., IT90K-277-2 and IT89KD-288) with generally high grain yields as well as fodder and resistance to major insect pests and diseases. Efforts to disseminate these varieties to farmers in the dry savannas started in 1993/1994 and the adoption levels and rates and the resulting benefits in the "pilot" villages were reported to be quite encouraging (Inaizumi 1999; Kormawa et al. 2000; Tarawali et al. 2000). Improved cowpea varieties have generated considerable demand on the part of farmers mainly because of increased opportunities for income generation due to stable and high prices during harvesting periods and food security during a critical period of the year when there are food shortages. It is hypothesized that good access to input and product markets is an important factor conditioning adoption of improved cowpea varieties and the supply response of farmers. However, lack of credit facilities in the area could undermine the role of access to markets.

Increased adoption levels by farmers to the extent that existing traditional cropping patterns are changed in pursuit of higher incomes through optimal resource allocation could be constrained by the observed lack of credit necessary to acquire the accompanying packages of inputs, such as fertilizer, insecticides, and sprayers. It is of interest in this study to assess the role of market access in technology adoption and resource allocation in the presence of credit constraints.

Location/target beneficiary group. The study will be conducted in Kano, Kaduna, and Jigawa states in northern Nigeria.

Research objectives. The specific objectives of this study are to:

- Investigate the linkages between market access and agricultural intensification in terms of use of improved seeds, fertilizer, pesticides, and improved cropping practices.
- Assess the influence of market access on optimal resource allocation under different scenarios of credit access.
- Determine the potential production and income gains from better access to credit and optimal resource reallocations.

Methodology/implementation strategy. This study will mainly use the survey data to be collected for the cowpea adoption and impact study in northern Nigeria. Survey data will be supplemented with data on technical coefficients of production, variable costs, and yields of major crops. Mathematical programing techniques will be used to derive optimal farm plans for representative farms to be identified based on market access and credit constraint. These will be compared against actual farm plans to assess the allocative efficiency of farmers with and without credit constraints.

Expected results/deliverables in 2004

- Examine the role of market access in agricultural intensification and technology adoption, including extent of use of improved seeds, fertilizer, pesticides, and improved cropping practices.
- Assess the role of market access in optimal resource allocation under different scenarios relating to credit access.
- Determine the potential production and income gains from better credit services and market access and resource reallocation.

Milestones for coming year

- Design questionnaire, train enumerators, and survey farm household
- Enter and analyze data
- Write and submit a manuscript for publication
- Write report

Starting date. January 2004

Ending date. December 2004

Farmer-to-farmer diffusion of improved cowpea seeds and the technical efficiency of "primary" vs. "secondary" farmers in northern Nigeria

A.D. Alene, V.M. Manyong, P. Kormawa, and B.B. Singh

Background/justification. The major constraint to the rapid and widespread adoption of improved crop varieties is multiplication and distribution of improved seeds. The formal seed systems in Nigeria, as is the case with most African countries, are not well-developed.

The private seed industry is poorly organized and has shown little interest in the marketing of self-pollinated crops such as improved cowpea varieties. Given this constraint, direct involvement of farmers in seed production and dissemination was considered an efficient way of promoting improved cowpea varieties. IITA and the Kano Agricultural and Rural Development Authority (KNARDA) thus initiated a project in 1997 to promote farmer production and distribution of improved cowpea seeds (Singh 2002). Under this farmer-to-farmer seed diffusion scheme, breeder seeds are produced and supplied by IITA to the so-called "primary" farmers each year and the rest of the farmers, called "secondary" farmers, secure their seeds from the "primary" farmers. Identified as one of the most promising improved varieties, IT90K-277-2 has been widely disseminated to most villages in Kano through this farmer-to-farmer seed diffusion project.

However, it is not well-known whether the high productivity potential of improved cowpea varieties is being exploited by both groups of farmers. In this regard, the technical efficiency of primary and secondary farmers is an important area of investigation. Differences between and within the two groups of farmers in exploiting the potentials of improved cowpea varieties depend on the quality and timely availability of seeds, credit access, technical assistance, and other factors. The circumstances under which these two groups of farmers operate are actually different: while the primary farmers receive packages of new seeds, fertilizer, and insecticide on credit and also receive technical assistance, the secondary farmers do not get such support. The secondary farmers obtain uncertified improved seeds from the primary farmers through direct contact or from the market, apply suboptimal levels of recommended packages such as fertilizer and insecticides in view of credit constraints, and receive little or no technical advice on improved cowpea production. It is, therefore, of interest in this study to investigate the levels and determinants of technical efficiency differentials among improved cowpea producers within and outside the seed diffusion project. The results will help identify the necessary policy and institutional support needed to enhance the effectiveness of the farmer production and distribution of improved seeds.

Location/target beneficiary group. The study is being conducted in Kano State, northern Nigeria.

Research objectives

The specific objectives of this study are to:

- Identify the constraints to the production and distribution of improved cowpea seeds.
- Measure the individual technical efficiencies of improved cowpea producers.
- Compare the levels of technical efficiencies of the primary and secondary farmers.
- Identify the factors underlying efficiency variation among improved cowpea producers.
- Make policy recommendations that could help enhance the effectiveness of farmer-to-farmer seed diffusion.

Methodology/implementation strategy. The study will be conducted in Kano State, northern Nigeria where the farmer-to-farmer seed diffusion has been underway since 1997. Data will be collected through household surveys using structured and pretested questionnaires. A sample of four villages will be randomly selected from the beneficiary villages and adopter farmers in the selected villages will be stratified into primary and secondary farmers. From each sample village, 25 farmers will be randomly selected from each group of primary and secondary farmers, making the total sample size 200 farmers. Depending on the distribution of beneficiary villages across the four resource use domains- high population-high market

(HPHM), high population-low market (HPLM), low population-high market (LPHM), and low population-low market (LPLM)- sampling of villages will be accomplished in such a way that each domain will be represented through stratification. The data will be rigorously analysed using descriptive and robust econometric techniques.

Expected results/deliverables in 2004

- Identified the constraints to the seed production and distribution system.
- Derived the individual technical efficiencies of improved cowpea farmers.
- Quantified the technical efficiency differences between the primary and secondary farmers.
- Identified the factors underlying technical efficiency variation.
- Identified appropriate policy measures to improve the effectiveness of the seed system.

Milestones for coming year:

- Design questionnaire, train enumerators, and survey farm household
- Enter and analyze data
- Write and submitting a manuscript for publication
- Write report

Starting date. January 2004

Ending date. December 2004

3 Scaling up and scaling out IITA research innovations

Geospatial Laboratory activities 2003

Christopher Legg (IITA)

Remote sensing and GIS

General. The work of building up a comprehensive spatial database for sub-Saharan Africa has continued through the year. Africover land-use maps for Sudan were released early in the year, so that we now have recent, uniform quality land-use/cover maps for Kenya, Uganda, Tanzania, Burundi, Rwanda, DRC, and Sudan in our archive. Less detailed land cover maps for South Africa, Zimbabwe, and Mozambique were acquired during a visit to Mozambique in June. The 90 meter SRTM DEM for Africa was made available in May, and all tiles were downloaded. Mosaicked and corrected DEMs have been prepared for Nigeria, Cameroon, Tanzania, Malawi, Mozambique, Burundi, Rwanda, and Zambia, and other country mosaics could be rapidly prepared if required. Maps of protected areas throughout Africa were obtained from the World Conservation Monitoring Center. A series of recent digital maps were obtained for Mozambique, including soils and census data.

Many new Landsat scenes were downloaded during the year to serve ongoing projects. The purchase of a high-capacity data store, large enough to accommodate the complete sub-Saharan archives of 1990 and 2000 epoch Landsat TM imagery was approved as a capital expense for the year, and a suitable system has now been ordered. Once delivered to IITA, it will be transported to Nairobi, and the entire 3.5 terabyte archive copied at UNEP.

Continuing support was provided to scientists at IITA centers in producing maps for data analysis and incorporation in reports. A disappointing small number of IITA scientists regularly make use of desktop GIS themselves to process their data on produce their own maps.

Further GIS awareness campaigns and training will be undertaken in 2005 to improve this situation.

NDDC consultancy. GIS work for the NDDC masterplan consultancy was completed early in the year. A series of maps showing farming systems, agricultural innovation, and the distribution of agricultural rural enterprises were prepared for the reports to NDDC, and poverty indicators calculated from the household survey were extrapolated to the entire Delta region.

Livelihood and nutrition mapping. Field work in four additional states was completed early in the year, and poverty indicators delivered to the GIS Laboratory by June. Extrapolation of poverty indices and child micronutrients by regression and geostatistics was completed by mid-July, and an interim report was prepared for the World Bank. A paper and poster were produced for a special workshop on poverty mapping held in San Diego as part of the Annual ESRI user meeting. Attempts are currently being made to refine extrapolation of poverty and nutrition indicators using small area estimation (SAE), and a peer-reviewed paper is to be submitted by mid-November.

SSA-CP. A meeting at FARA in Accra in January, initiated the SSA-CP final preparatory phase (FPP), within which pilot learning sites (PLS) for the challenge program were to be selected by African subregional organizations with technical support from IITA and ILRI. The Spatial Analysis Working Group met at ILRI in Nairobi in March, and following a meeting with representatives of the SROs and FARA, IITA and ILRI GIS staff prepared a range of spatial data to assist in the site selection process. Meetings of task forces of ASARECA, CORAF/WECARD, and SADC were held in April, attended by members of SAWG as resource-persons, and large numbers of potential pilot learning sites were selected on the basis of spatial criteria. The task forces then applied local knowledge and other nonspatial data at further meetings in May to reduce the number of potential sites to three per subregion. At a final meeting at FARA in June, the number of sites was further reduced to one per region, the selected sites being complementary, representative of large areas and large populations, and likely to demonstrate rapid response to IAR4D.

USAID Southern Africa Livelihoods Program. The GeoSpatial Laboratory has contributed in two ways to this project; through preparation of maps of development domains and through training in GPS techniques for the socioeconomic baseline surveys. Maps of topography, road networks, population centers, protected areas and climate were combined to produce market-orientated development domains for Tanzania, Malawi, Mozambique, and Zambia. These in turn were combined with biophysical requirements for IITA mandate crops to produce targeting maps for IITA interventions. Training in field GPS techniques was given to enumerators and supervisors from government departments, NGOs and IITA in Chipata (Zambia), Lilongwe (Malawi), Dar-es-salaam (Tanzania and Nampula (Mozambique) during May and June. The baseline surveys have now all been completed, and GPS locations of households sampled sent to IITA for further processing.

Agroclimatology

The two Ibadan weather stations were maintained through the year, and technical assistance was given to Kano, Cotonou, and Onne regarding their stations. Regular data was received from these three stations for the archive and for weekly publication in *The Bulletin*. Numerous special requests for climate data from IITA scientists were responded to. IITA has been invited to participate in a workshop on climate change organized by the Nigerian Meteorological Agency, and technicians of the GeoSpatial Lab will present a paper.

Capital provision was made for the purchase of new weather equipment this year, and two different automatic weather stations were ordered for evaluation. Both are relatively low-cost, and will be tested in Ibaban for a full year before the most durable model is ordered for other IITA sites. A Davis station was installed in September, and is operating well, providing real-time information from seven sensors via a radio link. This data will soon be accessible to all in IITA through the Ibadan intranet. A second station, the HOBO from Onsett, has not yet been delivered.

Database

Work has continued through the year on the ICIS-based crop genetic database, with data provided by the main plant breeders. This database is now accessible online to selected users in IITA. Work also continues on data entry for the Project Management System, a first module of the RDBMS. The independent development of PROMIS by G&GO resulted in potential duplication of effort, but meetings between GeoSpatial Lab staff and the PROMIS team agreed to merge the two systems, with the RDBMS PMS component contributing mainly to historic data on IITA projects and PROMIS to the actual and projected state of projects.

Landscape modeling

The local consultant (Bakam) worked throughout the year to complete the Cameroon village models, with limited contribution from the GeoSpatial Lab Manager. V. Robiglio (JPO) completed her contract early in the year, having completed land-cover mapping of the humid forest benchmark and a detailed study of land tenure practices in the more traditional forested portions of the study area. Two workshops presenting the main conclusions and recommendations resulting from ASB work in Cameroon were held during the year, and presentations of the models were made at both. It is hoped that the models will be completed by the end of the year, although additional work to fully test the models and then simplify them and improve their user accessibility will continue into 2005.

Ongoing activities output 3

Spatial dimension of a resource management system at the village level in the FMBA of southern Cameroon

V. Robiglio IITA + W. Mala CIFOR

Background/justification. The targeted cropping and land use systems targeted by Project E only make up a part of resource management systems of rural households in the humid forest. An understanding of the resource management system at the landscape level is required to better contextualize farming systems in the area and evaluate management options on a broader scale.

Location and target beneficiary group. Forest margins benchmark area, Nkometou, Awae, and Akok communities, and IITA researchers.

Hypotheses/research objectives. There is a strong connection between resource agricultural management at the plot level and overall resource management system at the landscape level. Landscape level analysis of land use systems provides clues for plot level intervention and the definition of management options at the community level.

Methodology/implementation strategy. Integration of PRA techniques with GIS.

Expected results/deliverables. Landscape maps and local information database integrated in benchmark GIS + report, assessment of the validity of the method

Land cover map of forest margins benchmark area in southern Cameroon

V. Robiglio IITA

Background/justification. The characterization of the land cover at the benchmark level is considered a key to assess land use dynamics for monitoring and scaling out from village level.

Location and target beneficiary group. FMBA, IITA research

Hypotheses/research objectives. Characterization of land cover units suitable to be analyzed in combination with other spatial datasets (e.g., transports etc.) to derive information on general use dynamics at the benchmark level.

Methodology/implementation strategy. Remote Sensing, on screen visual interpretation.

Expected results/deliverables. Land cover maps.

Assessment of bidirectional scale relationships in biophysical and socioeconomic contexts

V. Robiglio and Chris Legg, IITA

Background/Justification. Datasets and information at various spatial scales allow the identification of inter-scale relationship.

Location and target beneficiary group. FMBA, IITA research

Hypotheses/research objectives. Characterization of land cover units suitable to be analyzed in combination with other spatial datasets and to be aggregated according to hierarchical models.

Methodology/implementation strategy. GIS modeling.

Expected results/deliverables. Spatial GIS models * report.

4 Priority setting and impact assessment of IITA research

Economic gains from maize research in West and Central Africa: an overview

by V.M. Manyong, O. Coulibaly, and K.O. Makinde

Maize was introduced in Africa in the course of the 16th century, most likely through the Portuguese traders. In 1900, it was a relatively minor food crop in Africa. In eastern and southern Africa, maize became a staple of the African population. Malawi cultivates 80% of its area to plant maize. In West and Central Africa, maize never reached the level of importance it acquired in eastern and Central Africa. Until 1970, millet and sorghum were the only major cereal grown in West and Central Africa. The most dramatic expansion of maize production occurred from 1970s onwards as a result of adoption of new maize germplasm, development of road infrastructure in rural areas, good extension services, and urban demand.

For the period 1998–2000, 70% of the area grown to maize in sub-Saharan Africa (SSA) was from West and Central Africa. About 30 years ago (1968–1970) the same analysis led to a percentage as low as 22%. Maize production from West and Central Africa represents 43% of total maize in SSA in 2000 against 17% in 1970. This paper describes the economic gains from research and extension on maize over the last three decades in West and Central Africa.

The paper is based on the literature review. In addition, a multiple regression analysis was performed on data from 11 countries (over 90% of maize production in West and Central Africa) to analyze the relationship between the area planted to improved maize varieties and a set of explanatory variables. The empirical model with the dependent variable and the expected signs on the explanatory variables was as follows:

Area planted to improved maize = urban population + income + infrastructure + nitrogen fertilizer + scientists + released varieties + yield advantage + e

Gains can be analyzed through the increases in crop productivity. Yields improved by 41% from an average of 858 kg ha^{-1} in 1970 to about 1210 kg ha^{-1} in 2000. Countries such as Ghana, Mali, and Burkina Faso experienced a 4.8–6.7 annual growth rate of maize production (far above that of 3% for total population) because of the rapid introduction and adoption of new maize technologies. An IITA study in 2003 indicated on average, a yield advantage of 45% of improved varieties over local varieties in 1998 because of the adoption of improved varieties on farmers' fields. However, maize yields in West Africa (1.2 tonne ha^{-1}) and Central Africa (0.99 tonne ha^{-1}) remain low compared to countries in eastern Africa such as Kenya (1.4 tonne ha^{-1}) and in southern Africa such as Zimbabwe (1.5 tonne/ha). Reasons for low yields in West and Central Africa could be in a little proportion of area sown to hybrid (e.g., 2% for Nigeria, 4% for Côte d'Ivoire versus 62% for Kenya or 96% for Zimbabwe) and the low adoption rates of the recommended practices. It was found from a sample of 1050 maize farmers in Kaduna State, Nigeria that 100% of farmers applied fertilizers to maize, only 33% observed the correct planting dates, 23% applied an adequate seed rate, 18% weeded as required, 10% used the dig-and-cover method of fertilizer placement, and a mere 0.4% had the right fertilizer rate.

The aggregate net economic benefits of maize research in the northern Guinea savanna of Nigeria where maize has evolved from a backyard crop in the 1970s to a major commodity in the 1990s resulted in an internal rate of return (IRR) of 23% and the net present value (NPV) of ₦42.7 million during the 1986–1997 period. A multi-country study on the benefits from the maize research and extension used the concept of gross economic benefit (GEB) to estimate economic returns from research and extension and impact on food security from the use of improved maize varieties. For the 11 countries surveyed, GEB was on average US$162 ha^{-1} (minimum = 36, maximum = 209) and the incremental production due to the adoption of improved maize varieties could feed up to 9.3 million persons in 1998 or 3.77% of the population in the 11 countries.

Household-level surveys indicated positive changes in farmers' incomes thanks to the adoption of improved maize germplasms and accompanying agricultural practices. In the Sudano-Guinea zone of Burkina Faso, an increase in 1996 was reported of about 58% for total farm income, 43% for per capita income, and 62% for wages per hour after the introduction of improved maize and inorganic fertilizer for hand-hoe households. The results for animal traction households were 59%, 13%, and 24% respectively.

The adoption of new technologies is likely to modify the social relationship among households and empower vulnerable groups such as women. In Burkina Faso, it was found that the welfare of women in three different household decision-making models (competition, exploitation, and cooperation-conflict) increased when new agricultural technology replaced the traditional agriculture. The improvement in the welfare was even higher when processing technologies were added on top of the new agricultural technology.

Gains to consumers are obvious. In northern Nigeria, the introduction and adoption of a new maize germplasm of white color has resulted in maize consumption, replacing the traditional food staplesmade of millet and sorghum flour. The increased maize productivity and concentration in the Guinea savannas of West Africa has resulted in the flow of maize grain from the drier ecologies toward the mega cities (Lagos, Port Harcourt, Cotonou, Accra, Abidjan, etc.) located in the wet ecologies along the coastal zone. Gains to consumers can be vividly shown through a decline of retailers' maize real price in the market. In Nigeria, while maize production increased over time, the real consumer's price for maize (i.e., nominal price deflated by the consumer price index) increased less proportionately.

It was a significant relationship between the economic gains and variables on maize research (number of maize researchers and number of varieties released). The "research" variables were both highly significant at $P = 0.01$. Therefore, the institutional capacity and efficiency of national research and extension systems to develop and make new technologies available to farming communities are important drivers of the adoption of new maize varieties. The other expected significant variables were urban population (a proxy for the demand of maize) and the yield advantage (productivity of new maize varieties).

In conclusion, there is evidence from case studies from literature that research on maize in West and Central Africa has resulted in economic gains at various spatial layers: microlevel (such as producers, consumers, traders), meso-level (at the village and community-levels), and at regional and national levels. Research on maize is strongly contributing to these economic gains.

New and ongoing activities output 4

Impact assessment of improved soybean production and utilization in Nigeria (northern Guinea savanna benchmark area)

I.A. Ojiako (PhD Student), V.M. Manyong (Supervisor, IITA), A. Ikpi (Supervisor, University of Ibadan)

Objectives. The general objective of this study is to assess the impact of production and utilization of the improved soybean technology on the households and immediate community in the drier savanna. The specific objectives are to:

- identify the factors that influence adoption of improved soybean production technology in the drier savanna;
- examine the factors, which distinguish between the adopters and nonadopters of improved soybean production technology in the drier savanna;
- analyze the "ex-post" impacts of adoption of improved soybean technology on livelihoods of farmers and communities in the drier savanna;
- estimate the supply function for soybean and identify the factors, which explain farmers' supply of soybean in the drier savanna.

Methods. This study will be conducted on heads of soybean-growing households from five communities in northern Nigeria (extended northern Guinea savanna benchmark area) using structured questionnaire. Anthropometric survey of children of 0–120 months was also taken. Specific methods for the collection of qualitative data include focus groups discussion (3 per village for men, women, and youth), pairwise matrix ranking of legume crops, wealth and well-being ranking, and key informants interviews (KIIs). The techniques of data analysis include the descriptive statistics, Tobit analysis, the anthropometric indexes (weight-for-age,

weight-for-height, height-for-age, and upper arm circumference-for-age), and multivariate analysis of determinants of farmers' supply of soybean.

Expected results/deliverables in 2004. The PhD thesis will be completed in 2004 and recommendations will be made on policy implications from the research.

Milestones for coming year. To complete data collection, processing, and analysis. Drafting of one journal/conference paper out of the research.

Key findings to date. Data collection was completed on 310 households. Three groups of farmers were defined on the basis of a risk parameter. Four types of risks facing farmers were identified and described.

Impact and policy analysis of biofortified cassava-based diets in West and Central Africa

V.M. Manyong and A.G.O. Dixon, H. Bouis (IFPRI), Kankonde Mukadi and Charles Kinkela (University of Kinshasa), Jean-Pierre Banea (PRONANUT), and R. Sanusi (University of Ibadan)

Background. Cassava is a major staple food crop in sub-Saharan Africa (SSA) where more than 200 million people get more than half of their calories from foods made from cassava roots. SSA produces about 60% of cassava in the world and West and Central Africa represents about 73% of cassava in SSA. The consumption is highest in Democratic Republic of Congo (DRC) with about 1043 cals/caput/day. The next countries are Republic of Congo (785), Ghana (662), Mozambique (603), Angola (595), Central African Republic (417), and Nigeria (396). Unfortunately, cassava roots are known to be very poor in micronutrients and micronutrient deficiencies are reported to be frequent in cassava growing and eating environments.

Location/target beneficiary group. The study will be conducted in the cassava growing areas of two countries: Nigeria and DRC. The beneficiaries are millions of consumers of cassava and cassava-based diets that form the major food in the target countries. Other beneficiaries are cassava breeders who will incorporate findings from this study in their breeding programs.

Hypotheses/research objectives. The objectives of the impacts and policy analysis component of HarvestPlus are to:

- ensure efficient use of resources through accurate targeting of countries and target groups,
- document and measure impact of the introduction of biofortified varieties,
- improve understanding of the role of dietary quality in food security,
- analyze role of policies (including biofortification) in improving dietary quality.

Two hypotheses will be tested: there is a widespread neglect of micronutrients in the nutrition policies of the two countries and the impact of biofortified cassava is expected to be high.

Methodology/implementation strategy. The methodology includes three approaches:

- compile existing literature on consumption patterns for cassava in as disaggregated manner as possible and review of policies in the agriculture and health sectors, which are relevant to micronutrients;
- estimate ex-ante impacts of adoption and utilization of biofortified varieties of cassava from micronutrient models using disability adjusted life years (DALYs) models,
- design and implement qualitative surveys.

Expected Results/Deliverables in 2004. To constitute country teams and collect secondary information relevant for the review of nutrition policies and the conduct of the DALYs analysis.

Milestones for coming year. To complete data collection, processing, and analysis. Drafting the report to be presented at the 2004 September progress meeting at IFPRI Washington.

Key findings to date. None.

Study on the adoption of extra-early maize varieties in the dry savanna of Nigeria (northern Guinea savanna benchmark area)

A.T.J. Yangbula (MSc Student at University of Ibadan), V.M. Manyong and A. Kamara, and J.O. Akintola (University of Ibadan)

Background. New extra-early maize varieties from IITA were introduced to farmers in the Sudan savanna of Nigeria in Katsina State through the extension services. This area belongs to the northern Guinea savanna benchmark area and has low rainfalls that do not allow early-, medium-, and long-maturing varieties to reach harvest time. The availability of the new extra-early maturing varieties pushes the ecological frontier for maize to grow in the Sudan savannas. The potentials for adoption are high because of the high biomass production for maize compared to that of adapted cereals to these harsh environments such as millet. Three years after the introduction of the new technology, a survey is being conducted to gain insight on the adoption of the new varieties.

Location/target beneficiary group. The study area is conducted in the eastern border of the northern Guinea savanna in Nigeria. Katsina State has a population of about three million people who could benefit from the new technologies. Other populations in similar ecologies of the Sahelian countries could also indirectly benefit from the outcomes from this research.

Hypotheses/research objectives. The main objective is to understand the processes involved in the adoption (or rejection) of the new varieties in the new environment. The specific objectives are to:

- measure the extent of adoption of the new varieties, to assess farmers' perceptions of the new technology,
- analyze factors involved in the adoption of the technology,
- make recommendations for the improvement of varieties and their targeting to suitable environments for maximum impact.

We hypothesize that the adoption of the new technology is high and that farmer-to-farmer spread is the dominant mechanism of technology transfer in the study area.

Methodology/implementation strategy. The study will apply a snow bow sampling technique to identify villages where the technology is being spread. Then a proportionately sampling approach will be used to identify farmers for this study. We anticipate a sample size of about 200 farmers including adopters and non-adopters. Data will be analyzed with the aid of econometric models. Anthropometric indices will be taken on children of less than five years old to assess the social impact of the new technology.

Expected results/deliverables in 2004. The MSc thesis will be completed in 2004.

Milestones for coming year. To complete data collection, processing, and analysis. Drafting the MSc thesis out of the research.

Key findings to date. None.

Adoption and impact of improved cowpea varieties on rural livelihoods in the dry savannas of Nigeria

by A.D. Alene, V.M. Manyong, A. Tipilda, and B.B. Singh

Objective. To assess the impact of improved cowpea varieties on gender relations, and childrens' welfare (education and health).

Research objectives

- Assess the rate and level of adoption of improved cowpea varieties.
- Identify the technology characteristics and the socioeconomic, demographic, and institutional factors influencing the adoption and intensity of use of improved cowpea varieties.
- Assess the role of access to credit and markets in technology adoption and resource allocation.
- Examine the linkages between market access and agricultural intensification in terms of use of improved seeds, fertilizer, pesticides, and improved cropping practices.
- Assess the role and constraints associated with the farmer-to-farmer diffusion of improved cowpea seeds.
- Assess the impact of improved cowpea varieties on cropping pattern, farmers' asset endowment, gender relations, children's education and health status, household income, and food security.

Background/justification. Cowpea is an important grain legume and an essential component of the cropping systems of the semi-arid and marginal areas of West and Central Africa. Nigeria is the largest producer and consumer of cowpea. Under traditional technology, however, the grain yield potential and the availability of good quality fodder is limited by several factors, including insects, pests and diseases, low and erratic rainfall, and the long dry season (Inaizumi et al. 1999). Although initial efforts concentrated on varieties with high grain yield, IITA has developed a number of improved cowpea varieties (e.g. IT90K-277-2 and IT89KD-288) with generally high grain yields as well as fodder and resistance to major insect pests and diseases. Efforts to disseminate these varieties to farmers in the dry savannas started in 1993/1994 and the adoption levels and rates and the resulting benefits in the "pilot" villages were reported to be quite encouraging (Inaizumi 1999; Kormawa et al. 2000; and Tarawali et al. 2000).

In an effort to enhance the adoption of improved cowpea varieties by farmers, IITA in collaboration with state agricultural development departments and NGOs, initiated a project promoting farmer production and distribution of improved seeds in 1997. This is basically a farmer-to-farmer seed diffusion strategy, with breeder seeds supplied by IITA to the primary farmers each year and the rest of the farmers securing their seeds from the primary farmers. This could be partly based on the experience gained from the dissemination of the dry-season dual-purpose improved cowpea variety, IT89KD-288, through farmer-to-farmer seed diffusion (Inaizumi et al. 1999) at the early stages of popularization of the varieties.

However, there is lack of adequate empirical evidence on the rate and extent of adoption as well as the factors influencing the level of adoption of improved cowpea varieties. Furthermore, there is lack of knowledge of the role of improved cowpea varieties in the productivity and sustainability of the mixed crop–livestock systems and in food security and other liveli-

hood outcomes of farmers. This study, therefore, aims to assess the extent and determinants of adoption as well as the impact of improved cowpea varieties on cropping pattern, land use, asset endowment and other livelihood outcomes of farmers.

The concern for gender equity in agriculture has passed through three distinct phases and is now receiving wider attention. In the early 1970s, African extensions services focused mostly on the male head of the family, with little attention given to women, who also had farms of their own. It was only in the 1980s that it was recognized that it was inefficient to neglect the other half of the farmers. To date, it has been widely accepted that women account for 70–80% of agriculture in sub-Saharan Africa.

Nigeria is one of the countries where research has shown that female farmers are equally efficient as male farmers, and in some places are more efficient (Ijebu et al. 2001). According to a recent report conducted between IITA and ILRI on the role of women farmers on agriculture, it was found that where there was same access to input levels as men, there was an increased productivity of 7% with even higher increases where there was at least one year of education.

Women also participate in the selection, collection, and storage and dissemination of seeds that are to be used in the following season. Within the cropping systems, they play a role given their participation in livestock rearing and feeding, the outcome of which is manure. In addition to this, they are the principle providers of nutrition, food safety and quality of food in households, and for sale in urban areas. Within the households, women often have the main responsibility of providing food. This has important implications in children's welfare in terms of health. Income accrued by women through petty trading of agricultural products is often used in childrens' health and education needs.

This study will focus on the impact of improved cowpea on varieties on the farmer households in the dry savanna region of northern Nigeria. It will particularly focus on the socioeconomic impacts of improved varieties on cowpea, an important crop in West Africa. According to FAO figures, the total harvested cowpea acreage in West and Central Africa has increased from four million hectares in 1988 to an estimated 9.4 million hectares of land in 2000, a considerable proportion of the global total, currently quoted as being 12.5 million ha (Singh et al. 1997). Farmers prefer cowpea due its dual role in agricultural systems.

Trading and marketing of cowpea in West Africa consist of well-established and hierarchical systems originating from Nigeria. Women comprise of the bulk of the traders in Nigeria, as well as the whole of West Africa, with 100% composition in the humid coastal regions of Benin, Ghana, and Togo (Langyintuo 2000).

Efforts to develop improved varieties of cowpea have been carried out by IITA concentrating on improving yields and increasing resistance to diseases and pests. Dissemination of these varieties started in the mid-90s with adoption rates and resulting benefits reported to be promising (Inaizumi 1999, Tarawali 2000). To increase dissemination of the seeds, IITA in collaboration with NARS started the farmer production and seed diffusion strategy.

Currently, there is a gap in the adequate documentation on the impact of improved cowpea varieties on livelihood outcomes of farmers. This study will focus on the impact of improved cowpea varieties on the gender relations of farmer households, as well as the impact on their childrens' welfare (both health and nutritional).

Location/target group. The study will be conducted in Kano, Kaduna, and Jigawa states in northern Nigeria.

Methodology/implementation strategy. Household surveys, focus group meetings, use of anthropometrics surveys will be used. Participatory appraisals (with a gender equity perspective) will be of central importance to the study.

Expected results/deliverables in 2003/2004. The socioeconomic, demographic, institutional, and technology-related factors influencing widespread adoption of improved cowpea varieties will be identified and documented.

The impact of improved varieties on household asset endowments (e.g., livestock holdings), incomes, gender relations, children's education and health status, and food security will be assessed and documented

Appropriate policy recommendations will be made.

Milestones

- Prepare questionnaire and focus group meeting checklists.
- Train enumerators and survey farm household.
- Enter and analyze data
- Write and submit a manuscript for publication
- Write report

Start date. December 2003

End date. December 2004

The impact of agricultural technology development on poverty reduction in West Africa towards setting priorities for research

A.D. Alene, V.M. Manyong, P. Kormawa, and J. Gockowski

Background/justification. Substantial resources have been invested in agricultural research in sub-Saharan Africa for the generation and transfer of improved agricultural technologies in order to enhance agricultural productivity, food security, and natural resource management. Technical change, the major source of increased productivity in agriculture, requires sustained investments in research and extension. However, publicly funded agricultural research budgets in sub-Saharan Africa have been declining in recent years, and there has been increasing pressure to direct agricultural research towards the needs of small-scale farmers and the rural poor. As a result, policymakers are increasingly calling upon research managers to explicitly consider poverty reduction objectives when carrying out priority-setting exercises and making resource allocations. Agricultural research in sub-Saharan Africa is now coming under heavy scrutiny because of the growing concern for poverty reduction. With an increased focus on poverty outcomes, research managers need to rigorously evaluate impacts on poverty of alternative research portfolios (Alwang and Siegel 2003).

IITA in partnership with national agricultural research systems (NARS) and other collaborating institutions, have developed numerous improved varieties of cassava, maize, cowpea, plantain and banana, soybean, and yam primarily for West and Central Africa. IITA has been supplying improved germplasm to NARS and strengthening their research capacity, and this has contributed to the generation of some new crop technologies in these countries. However, the constraints to agricultural productivity and the demands for improved technology for most of the crops are enormous as new pest problems, resource degradation, population pressure, and policy changes put additional demands on the research system. Research managers face the challenge of responding to the constantly changing demands for

productivity-enhancing as well as poverty-reducing new technology in the face of the current general budget declines. In this situation, there is need to set priorities for research based on its likely impact on poverty reduction. This study aims to assess the *ex ante* impact of alternative research portfolios with a view to set priorities for research in West Africa, with implications for IITA's work.

Location/target beneficiaries. The study will be conducted in Nigeria, Ghana, and Côte d'Ivoire.

Research objectives. The specific objectives of this study are to:

- Assess the *ex ante* impact on poverty and inequality of alternative crop technology development programs of selected West African countries and to decompose poverty impacts of crop technologies by socioeconomic category and agroclimatic zone in the countries.
- Set priorities for crop technology development research programs of selected West African countries with emphasis on the implications for IITA's research work.

Methodology/implementation strategy. The first step will involve working with the researchers and research managers of IITA and NARS to develop a list of commodity (or crop) research programs and key disciplinary areas (such as plant breeding, plant protection, agronomy, etc). The second step involves identifying key agroclimatic zones in the selected West African countries.

The third step will involve collecting market-related and technology-related data. Market-related data includes such items as input and output prices. Technology-related data includes estimates of likely yield changes and input use changes. However, this research will heavily rely on data that are hoped to be available from national statistical offices conducting national sample surveys of agriculture. Baseline national, regional, and socioeconomic group-based poverty indices will be calculated from these data sets. Data on agricultural production and input use, off-farm incomes, adoption and level of use of improved technologies, and input and product prices will be of particular interest in this study. IITA and NARS researchers and research managers will be interviewed to estimate crop-specific yield changes and input use associated with each research program, both with current and increased level of funding. In a household income determination framework, the data on yield and production cost changes will be used to recompute poverty indices associated with each technology.

Expected results/ deliverables in 2004

- Measured impact on poverty and inequality in aggregate and by socioeconomic category and agroclimatic zone of crop technology development research.
- Prioritized crop technology development research programs of the selected West African countries with emphasis on the implications for IITA's research activities.

Milestones for coming year

- Obtain secondary data on household incomes and technology use
- Obtain primary technology-related data from IITA and NARS researchers
- Analyze data
- Write and submit a manuscript for publication
- Write report

Starting date. January 2004

Ending date. December 2004

The impact of IPM technologies on cassava production in West Africa

A.D. Alene, V.M. Manyong, and Project B members

Background/justification. IPM technologies have played an important role in maintaining the productivity of important crops in West and Central Africa through effective control of devastating pests. There has been considerable amount of empirical work accomplished in the area of IPM technology development by IITA. However, there is need to organize the IPM works to help enhance the awareness of the public and to guide future research.

Location/target beneficiary group. West and Central Africa.

Research objective. To review literature relating IPM as well as empirical works on IPM by IITA and collaborators and produce an IMPACT document on the impact of IITA's IPM technologies.

Methodology/implementation strategy. Review of theoretical and empirical literature, especially IITA's work on IPM.

Expected results/deliverables in 2004. An IMPACT document will be produced.

Starting date. January 2004

Ending date. December 2004

Timber and fruit productivity of cocoa agroforests in southern Cameroon

J. Gockowski, (IITA), M. Tchatat-IRAD, J.P. Dongjang, T. Fouda, J. Betti—University of Dschang

Objective. Evaluate the private revenue streams of cocoa-fruit-timber agroforestry systems in Cameroon and highlight the net social losses associated with current property rights regime vis-a-vis on-farm forestry.

Background. Environmental services and economic values of secondary crops from the cocoa agroforests are not well-known among policymakers dealing with cocoa sector which can lead to inappropriate policies and avoidable welfare losses. Previous anecdotal evidence suggests that the proportion of cocoa revenues from these systems may be less than 50% of total system revenues in some regions. Technical recommendations (e.g., FFS) for such systems need to consider all revenue streams and their interactions. Cocoa farms are one of the best examples of permanent agriculture in the humid tropics. In some of the degraded forest landscapes of Nigeria and Cameroon and they serve as minirefuges for biodiversity and wildlife, unlike food crop production, which involves crop-fallow rotations with regular human disturbance of the agroecosystem. Cocoa agroforests are a variant of cocoa production in which the farmer selectively (and sometimes nonselectively), maintains an array of other tree and plant species for various reasons. Studies in Cameroon have characterized this biodiversity in terms of species and plant functional attributes from which we know there is a wide variety of useful indigenous species maintained in these minirefuges. In addition to "secondary products" these systems also contribute a number of environmental services including nesting sites for bird, bat and reptilian insectivores, food sources and habitat for important forest seed dispersers such as hornbills and parrots, watershed services, maintenance of forest biodiversity, and carbon stocks.

There is also a major policy distortion regarding property rights to timber which may be costing millions of dollars in lost revenues in Cameroon. Farmers are currently unable to

sell timber produced from their agroforests into legal markets. They instead sell this timber illegally at a fraction of its international market value to chain saw operators who saw these valuable hardwoods into planks and roofing lattes for the local markets. This study will attempt to quantify these losses.

Farmers often overlook the relative value of these services when discussion turns to the cocoa system innovations, extension, and adoption. As environmental services are generally considered, public goods benefits accrue to society at large, whereas farmers are concerned with private returns, the socially optimal level of these services is often not attained. To counter this situation, governments should consider policies to encourage the greater provision of such services. To begin to devise such policies informed decision-making needs to know what is the value of those commodities and services. The objective of this activity is to develop estimates of these benefits.

Location. Cocoa agroforests of Lekie, Mefou Afamba, and Ebolowa Divisions, Cameroon.

Methodology. A multidisciplinary effort involving the Forestry Department of the University of Dschang, IRAD, and IITA is conducting full inventories of timber, fruit tree, and medicinal plants species on 45 cocoa farms in nine villages of southern Cameroon. Management practices regarding timber, fruit production, and medicinal plants production and marketing are also being gathered from the 45 producers whose farms are being inventoried as well as an additional 45 persons.

Valuation of four components of cocoa agroforests—timber production (actual and nondistorted scenarios), fruit production (value of sales and home consumption), and medicinal plant provision (types of illness treated, costs of treatment using "modern" medicine versus medicinal plant medication), and cocoa production are being determined.

Milestones

- Complete field surveys by July 2004
- Monographs on:
  - timber inventories and management;
  - fruit and medicinal plant inventories and management;
  - management of all system components prepared in draft form by December 2004.
- Journal articles on
  - timber management, timber resources, and valuation
  - fruit and medicinal plants submitted by February 2005.

Costs and benefits of fungicide use in zones of high *P. megakarya* incidence

J. Gockowski, (IITA), Jonas Mva (IITA), and S. Oduwole (CRIN)

Objective. Establish the economic impact of fungicide use among smallholders on the productivity of cocoa agroforests in Cameroon and Nigeria. Evaluate health and environmental issues with current practices

Background. Cameroon and Nigeria had much higher costs of fungicide use per hectare than Ghana or Côte d'Ivoire. Yield regressions suggest fungicide levels as a major determinant of output in these two countries and indicate that within the range of recent prices in these markets, farmers may be underutilizing this resource. An economic assessment of their use will help to inform policy making in this domain.

Location. Desktop analysis in Cameroon.

Methodology. Multiple regression analysis of yields and production function models underlying yields in Cameroon and Nigeria will be used to determine marginal effects of fungicide use. Baseline survey data will be used. Updated simulation model of cocoa output market and fungicide input market to isolate impacts of subsidized credit etc. (this study is linked to activity 1.2 on credit mentioned above). Analysis will include focus on the environmental and health costs and risks posed by current practices.

Milestones

- Technical report by 30 September 2004
- Journal article submitted to peer review by 15 November.

Update on milestones. Regression analysis completed, policy model of output and input markets being developed.

Costs and benefits of fertilizer use in Côte d'Ivoire

G.B. Nkamleu, J. Gockowski, (IITA), Yaya Kehoe ENSEA Abidjan, Yapo A. (IITA)

Objective. Establish the economic impact of fertilizer use among smallholders on the productivity of cocoa production systems in Côte d'Ivoire.

Background. Côte d'Ivoire was the only countries found to have a significant proportion of its producers cite the use of fertilizers. Yield regressions suggest fertilizer level is a significant determinant of cocoa output in Côte d'Ivoire. This study will determine the farm demand for fertilizers under a range of output and input price scenarios.

Location. Desktop analysis in Cameroon.

Methodology. Multiple regression analysis of yields and production function models will be used to determine marginal effects of fertilizer use. Baseline survey data will be used. Updated simulation model of cocoa output market and fertilizer input market to isolate impacts of subsidized credit, changes in world price of fertilizers, rehabilitation of urea production in Nigeria, etc.

Milestones

- Technical report by 21 November 2004.
- Journal article submitted to peer review by 21 December 2004.

Update on milestones. Regression analysis completed, policy model of output and input markets being developed.

Improving tree stocks, age, and yield effects

G.B. Nkamleu and J. Gockowski (IITA), and W. Masters (Purdue University)

Objective. Determine where and why breeding programs have made a difference to farmers' incomes.

Background. Masters et al. at Purdue University have documented significant yield gains among Ghanaian cocoa farmers adopting hand-pollinated hybrids produced by government-sponsored seed gardens. In other countries such as Cameroon, farmers less anecdotally accept cross-pollinated hybrids from seed gardens. This study will analyse the various country experiences with improving cocoa genetics looking at the issue mainly from the perspective of the producer.

Location. Cameroon, Ghana, Nigeria, and Côte d'Ivoire.

Methodology. Field survey of a subset of baseline survey producers on their production practices, and tree stocks including GPS measures of productive cocoa and verification of planting material.

Milestones

- Technical report on baseline parameters by 31 September 2004.
- Develop questionnaire, pretest and train enumerators (1 February 2005).
- Complete field surveys and enter data for Côte d'Ivoire and Cameroon (10 April 2005).
- Analyze data and technical report (14 June 2005).

The feasibility of a "for profit" marketing cooperative institutional model

G.B. Nkamleu, J. Gockowski, I. Tchamou (University of Dschang, Cameroon)

Expected results. Costs and returns of starting and operating a profit-marketing cooperative determined for southern Cameroon.

Objective. Determine the feasibility and economies of scale necessary to achieve profitable cooperative marketing of cocoa between farmgate and exporters at Douala port.

Background. Currently, about 25% of farmers in the cocoa sector of southern Cameroon are organized into primary groups at the village level, which have generated a certain level of benefits. To move to a full cooperative marketing institutional model, investments in warehousing, trucking and managerial capacity will have to be made. This study will address the current spatial configuration of groups loosely federated under FORCE and make suggestions regarding potential configurations for the development of viable self-sustaining marketing cooperative.

Location and beneficiaries. Southern Cameroon.

Methodology. Cost engineering approach based on key informant interviews with existing market agents, government officials and FORCE personnel. Descriptive survey of 1993 Fos in central, south, and southwest Cameroon.

Milestones

- Analysis of survey data (15 October, GBK & ZI).
- Draft technical report (15 December 2004, GBK).
- Estimate costs for cocoa marketing in pilot project zones.
- Final comprehensive report February 2005.

Update on milestones. A survey of 93 farmers' organizations was conducted in July 2004. Data entry is ongoing and will be completed by September 2004.

Costs and benefits of farmer field school extension model

S. David, J. Gockowski, J. Mva Mva, I. Gyampfi, A. Yapo, and C. Okafor

Expected results. Cost benefit analysis, cocoa IPM delivered via FFS approach.

Executing partners. Pilot project PPM and FFS personnel, Gockowski, David, Nkamleu, Mfouapon, I. Zebaze.

Objective. Determine the net social benefits of cocoa IPM and improved management administered using a FFS approach. Among the secondary objectives:

- Recommendations on institutional options for implementing FFS
- Country specific estimations of returns to investment in cocoa IPM

- Better understanding on farmer-to-farmer dissemination mechanisms specifically:
  - The process and channels of knowledge/information sharing used by cocoa farmers and identify activities that can be systematically supported to encourage diffusion
  - Farmers' decision-making capacity and empowerment
  - Retention of knowledge and experiences.

Background. As an accompaniment to liberalization, many cocoa extension programs have fallen into disarray. The FFS approach was developed in Asia for addressing complex knowledge transfers concerning rice IPM. It has been successfully adapted to cocoa by the USAID GDA in Indonesia focused on the IPM of a single pest—cocoa podborer. The STCP pilot programs are implementing cocoa IPM focused mainly on blackpod, and to lesser degrees capsids, stemborer, and mistletoe. There is a need to assess the returns to these efforts in the four pilot sites where these activities are ongoing.

FFS programs are typically expensive to implement because of the initial high investment costs in training trainers and the season long training cycle. The approach would be more cost effective if there was a strong multiplier effect through farmer-to-farmer diffusion of the skills and knowledge acquired. Evidence from Asia however suggests that, while FFS graduates retain their acquired knowledge, there is limited diffusion of that knowledge.

Few studies have investigated knowledge levels of FFS graduates in Africa and documented their diffusion behavior. Studies in Ghana and Mali show that FFS graduates shared information on specific technologies or management practices, but principles and concepts were less often discussed (Simpson and Owens 2002). There is already evidence from all STCP countries of FFS participants sharing their new skills and information through the formation of work groups, a traditional labor saving strategy common in many parts of Africa. More detailed understanding of the diffusion process and channels is crucial to devising systematic strategies to support farmer-to-farmer diffusion of skills and knowledge. An assessment of participants' knowledge will also provide important feedback on training quality.

An important goal of FFS is to improve farmers' decision making, increase their confidence and empower them broadly to solve their own problems. This aspect, though often overlooked, is the justification for key elements of FFS including discovery learning, agroecosystem analysis and the emphasis on group strengthening. Few, if any studies, in Africa have investigated the impact of FFS on these more intangible empowerment goals. Demonstrating the impact of FFS on improving human and social capital is vital for justifying the high expenditure on FFS programs.

Between 60 and 70% of farmers in Nigeria and 20–25% of farmers in Côte d'Ivoire and Ghana employ sharecroppers on a 1/3rd share basis. These households are stuck in chronic poverty. There is a need to open a dialog with these workers to see how their lot can be improved. Approximately 80 sharecroppers participated in the Nigerian FFS in year one with smaller numbers in Ghana and Côte d'Ivoire. These strata of the cocoa producing population will be included among survey participants of the adoption surveys to see if they have retained and are applying the knowledge acquired.

Location. FFS sites in Côte d'Ivoire, Ghana, Nigeria, and Cameroon.

Methodology

- Farmer participant adoption study and livelihood impacts. N=225 participants plus 135 nonparticipants.
- Pod evolution during season.

- FFS field harvest data.
- Cost analysis of FFS implementation.
- Farmer-to-farmer knowledge diffusion study.

Milestones

- Develop general questionnaire (JJG, GBK, SD 31 December).
- Adapt and translate, pretest of questionnaire to specific country situations (6 February GBK, JJG, AM, ZI).
- Train enumerators (12 February JG, GK, ZI, AM).
- Complete field survey (21 April survey teams JJG, GBK, ZI, AM).
- Enter data (casual hires supervised by PPM, 15 May JJG, GBK, ZI, AM).
- Clean data (21 May casual hires supervised by PPM JJG, GBK, ZI, AM).
- Analyze data (15 August 2005, JJG, GBK, ZI, AM),
- Technical report (1 May 2005, JJG, GBK, ZI, AM).
  - Count pod in FFS plots to determine blackpod incidence in control and IPM plots. Nigeria w/hired pod counters, Côte d'Ivoire and Ghana up to 2 m, For Y2: collect and scan data sheets from each school (30 Sepember 2004 and 7 January 2005, PPM, JG, AM). Data entry (AM, 21 January 2005). Data analysis (JJG, GBK, ZI, AM, 15 February 2005). Technical report (JJG, GBK, ZI, AM, 15 March 2005).
  - Collect harvest data from IPM plots and farmer practice plots in FFS. For Y2: collect and scan data sheets from each school (7 January 2005, PPM, JG, AM). Data entry (AM, 21 January 2005). Data analysis (JJG, GBK, ZI, AM, 15 February 2005). Technical report (JJG, GBK, ZI, AM, 15 March 2005).
  - For Y3: collect and scan data sheets from each school (Jan 7, 2006, PPM, JG, AM). Data entry (AM, 21 January 2006). Data analysis (JJG, GBK, ZI, AM, 15 February 2006). Technical report (JJG, GBK, ZI, AM, 15 March 2006).
- Cost analysis of differing institutional/organizational arrangements for implementing FFS by country.
  - Develop a checklist of all cost items for implementing FFS (AM & SD, 15 October 2004).
  - Collect accounting data from Adolf (AM 30 October).
  - Request for costs and additional information from PPM e.g., number of farmers trained, etc. (AM, JJG 15 November 2004).
  - Provide addition information (PPM, JJG, AM 15 December 2004).
  - Draft technical report on cost estimates (15 January JJG, AM, GBK, ZI);
  - Final report after country visits 8 February 2005.
- Farmer-to-farmer diffusion survey of knowledge. [Informal interviews will be held with participants from 2003 to 2004. FFS in Ghana to collect detailed information on how cocoa farmers acquire skills, knowledge and information. Formal surveys will be conducted with a sample of 50 participants from 2003 FFS to investigate their knowledge about key topics covered in the FFS training, document farmer-to-farmer diffusion and assess improvements in their decision-making capacity, confidence and level of empowerment. Interviews will be conducted with a sample of 50 cocoa farmers in nearby villages to assess their knowledge of integrated crop and pest management.]

Status. In the 2004/2005 cocoa growing season, biweekly pod counting exercises have been initiated, these are proposed to continue in the 2005/2006 season. Harvest data for 2004/2005

and 2005/2006 campaigns from FFS is to be collected. Farmer adoption surveys of first year participants have been completed in Côte 'ivoire and Cameroon and are being analyzed. Farmer to farmer diffusion study is new for Y3.

Cost benefit analysis of organizational capacity development efforts: the case of Côte d'Ivoire

J. Gockowski, G.B. Nkamleu, and A. Yapo, consultant (IITA)

Expected results. Costs and benefits evaluated for eight cooperatives in Côte d'Ivoire, which have participated to varying degree in the capacity development efforts in recent times.

Objective

- Establish baseline situations of cooperatives prior to interventions.
- Determine the strategic targets of operational plan.
- Evaluate the implementation of OP.
- Evaluate the outcomes of the OP.
- Analyze the impact of reformed cooperative law (1999).
- Assess quality and quantity of impacts.

Background. In 2002, about 25 % of farmers in the cocoa sector of Côte d'Ivoire reported selling cocoa to cooperatives and according to baseline statistics, this marketing channel accounted for about one-third of all cocoa sold by farmers. SOCODEVI has been working with cocoa cooperatives and farmer organizations in Côte d'Ivoire for the last 4–16 years. This study will document the institutional, organizational, economic, and social factors affecting the performance of Côte d'Ivoire cooperatives and the costs and benefits of capacity strengthening efforts by SOCODEVI for the eight cooperatives, which they have worked with over the aforementioned period.

Location. Eastern, Central Côte d'Ivoire including Soubre area.

Methodology. Institutional analysis, cost engineering (marketing costs), key informant interviews with cooperative membership. Survey interviews with cooperative and noncooperative members.

Milestones

- Collect archived reports from SOCODEVI-Que (1 October 2004, Boivin).
- Complete archival documentation review of Socodevi reports (Gockowski and Nkamleu 29 October 2004).
- Produce baseline technical report of coops pre SOCODEVI interventions on basis of archival review (Nkamleu JJG, 30 November).
- Develop terms of reference for consultant (Gockowski, and Yapo, 17 September 2004).
- Engage consultant (Yapo 15 January)
  - Field visit consultant report (consultant 31 March 2005).
  - Technical report by consultant (15 April 2005).
- Final comprehensive technical report (Gockowski, and Nkamleu 15 May 2005).

5 Strengthened NARES capacity for social science

Social science laboratory and development of training modules for impact assessment

O. Coulibaly, IITA Cotonou-Benin

One of the year's major accomplishments was the inauguration of the social science laboratory in Cotonou. This modern computing facility is being used to train national system partners in the various approaches to impact assessment. Partners learn in an interactive environment developing their analytical skills through the application of new methods and models. An ongoing effort is underway to develop training modules for the impact course. Intriguing subject matters such as:

- Market access, technology adoption, and optimal resource allocation under credit constraints: the case of cowpea growers in the dry savannas of Nigeria.
- Agricultural research, policy reforms and food security: policy analysis matrix.
- Impact assessment: concepts, indicators and practical application to agricultural research and development in sub-Saharan Africa are included in the training materials.

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