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1991

Edited by Cheryl R. Doss and Carol Olson

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FOREWORD

This volume represents research from the first two rounds of the African Rural Social Sciences Research Networks program sponsored by Winrock International Institute for Agricultural Development and funded by the Ford Foundation from 1986-1990. The research was conducted by African social scientists under a small-grants program designated for the study of African rural development issues and problems.

The program has served to establish networks of African scholars in the rural social sciences and to provide a mechanism for peer review and professional refereeing. The published results have been disseminated to policy-making institutions, universities, libraries, and other relevant organizations in Africa, Europe, and the United States.

The studies have been selected and organized in this volume to unify the research and provide an anthology which is concerned with problems and issues in African rural development. The selections have been organized by country and represent a wide range of social science fields and topics, all with policy-making implications.

A serious concern in Africa is the large gap between research and the real needs of the rural farmer or household. The studies in this collection reflect efforts by African scholars to close that gap by tackling problems that are relevant to the needs of rural development as well as intellectually stimulating and challenging.

A third round of the African Rural Social Sciences Research Networks has recently begun, funded by the Ford Foundation and the United States Agency for International Development. In this round the francophone countries have been included, which will further regional participation and widen the networks. This volume , therefore, is the first of a continuing collection of studies in African rural development.

Winrock International Institute for Agricultural Development is grateful to the Ford Foundation and the United States Agency for International Development for their support of the African Rural Social Sciences Research Networks and their dedication to excellence in African research and human resource development.

SOCIAL ACCOUNTS OF THREE ETHIOPIAN VILLAGES: A STUDY OF INSTITUTIONS AND POLICY

Taye Mengistae

SUMMARY

Following the introduction of land reforms in 1975, the Ethiopian government developed a package of agrarian policies to mobilize resources from the countryside for public investment in the socialist industrialization of the economy. The package *wolbanized* village farming and nationalized rural trade and credit. *Wolbanization* is the organization of rural households into units of village-level communal farming known as *wolbas*. As a program of institutional transformation, it has been pursued by giving *wolbas* preferential treatment in credit, agricultural extension, taxation, and marketing. In addition, government policy has attempted to render smallholders economically marginal. The program for nationalizing rural trade has been limited to a 10-year-old scheme of compelling grain delivery at government-fixed prices that are well below those offered in local free markets.

The government has announced that it intends to abandon the compulsory grain-delivery scheme and the smallholder-marginalization policy. This action is a belated response to widespread criticism that its marketing policy has drained too many resources from the countryside and, together with *wolbanization*, has dampened activities and investment in villages. This paper attempts to assess the magnitude of resources in the Ethiopian countryside that have been affected by government policy.

The paper is based on a case study of three villages conducted over the 1988-89 crop year. These villages differed little in natural-resource endowment, traditional farming technology, ethnic or religious composition, or proximity to urban areas. However, they differed substantially from one another in degree of *wolbanization*.

Traditional farming technology in all three villages consisted of the grain-plow culture that characterizes the so-called grain-surplus areas of Ethiopia. The villages share a territory extending for some 12 km along both sides of what is probably the busiest highway in Ethiopia; that highway links them to six major urban centers within a radius of 60 km. Thus, the commercial relationship of the villages to private-sector units of the urban economy was stronger than that of most farming villages in the country as was the enforcement of postreform agrarian policy.

Survey data collected in the three villages was used along with data from weekly activities and transaction sheets of selected households to piece together the 1988-89 social accounts matrix of

each village. According to these accounts, both smallholders and the *wolba* in each village have been subject to a net drain of resources to the public sector, although the drain is much greater for smallholders. For every EB 1 of services the government provided to smallholders; the government took out four times as much, mainly through transfers implicit in the grain-delivery scheme. On a per-household basis, village *wolbas* have received twice the amount of government services that smallholders received, but they too lost EB 1.7 for every EB 1 of services received.

Smallholder net transfers to the public sector stood at about 90% of their investment expenditure and 150% of their spending on consumer goods and services of urban origin. Net transfers from village *wolbas* to the public sector were a quarter of *wolba* investment and 135% of members' spending on urban consumer goods and services. Final demand spending of villagers would have been much smaller, and transfer rates to the public sector correspondingly higher, if it were not for favorable conditions in the local free market for grain. The prices of marketable village products have been pulled above their opportunity costs as measured by accounting prices until villagers have more than made up for their loss to the public sector.

Net transfer figures as read from the 1988-89 accounts fail to capture the full impact of government policy on the village economy. To measure the full opportunity cost of the net transfers, it was necessary to calculate what the levels of village activities and incomes would have been if the government had put back into the villages the exact amount of resources it took out. Each village lost at least EB 2.5 in forgone incomes for every EB 1 of net transfers.

The opportunity cost of net transfers to the public sector was much higher for smallholders than for *wolbas*. It was also higher in villages that were less *wolbanized*. Thus *wolbanization* complements the compulsory grain-delivery scheme in keeping down village activity and income levels by allocating village and government resources to relatively inefficient econcmic organizations. Although current policy favors the *wolba* in access to village farmland, agricultural extension services, and public credit, income per household is much higher for smallholders than for *wolbas*. The official justification for the policy of *wolbanization* -- that it raises the rural population's average propensity to save -- has yet to be demonstrated. The accounts showed that the savings ratio of village *wolbas* was higher than that of smallholders. But smallholders have been forced to finance a large share of *wolba* investment and have been subject to a greater net drain of resources to the public sector. Without these factors, their savings ratio might have been well above that of the *wolba*.

A corollary of these findings is that the villages would have been much better off with a policy revision aimed at a more balanced flow of resources between villages and the public sector and a greater mobility of farm resources within each village. The recent announcement of planned government policy changes may signal such a shift. However, the new policy must be instituted before its effect on the economic balance of villages can be evaluated.

The 1975 land reform in Ethiopia was immediately followed by the introduction of a new package of fiscal, marketing, pricing, and administrative instruments of agrarian policy. This package sought to support a government program to transform village farming institutions. The government took command of the flow of resources between the town and countryside during the following decade. Observers have pointed out that these policies drained resources from villages to the public sector (Mulugeta, Amare, and Solomon, 1987; Eshetu, 1989). As a result of the drain, village activity and investment levels, rural growth, and thus the amount of revenues that could be used to develop the urban areas were suppressed (Pausewang, 1988). In response to these effects, the government has announced that it intends to abandon crucial aspects of the postreform package.

ETHIOPIAN AGRICULTURAL POLICY

In 1988, the Ethiopian government was directly administering the distribution of farmland, the pattern of rural settlement, and the dynamics of the institutional structure of village farming. The 1975-82 reform laws restricted a farming village to a territory of up to 800 ha. Most farming villages are much smaller than that and have populations of 100 to 400 households.

The government is represented in each village by a permanent association of household heads, the village Peasant Association. To have access to farmland, a household head must be a resident of the village, a farmer, and a member of the village association. The association office distributes farmland among villagers in accordance with government rules and regulations. In addition, the office functions as the lowest unit of government for assessing and collecting taxes, maintaining law and order, and implementing government development projects. Perhaps most important, until the 1988 harvest season, the association was the lowest administrative unit for the government's compulsory grain-delivery scheme.

This system of rural administration gave the government direct control over the flow of resources within in each village and among villages and towns. During the decade following the first reform law of 1975, the government made a determined effort to expand and realize this power. The primary objective of development policy for the decade was declared to be the "socialist industrialization" of urban economic life through public investment of resources siphoned from the countryside.

Three programs were designed to facilitate socialist industrialization: *wolbanizing* village farming; nationalizing most rural trade and credit; and villagizing farmers' homesteads to facilitate the implementation of the other two programs.

Under *wolbanization*, rural households are organized into units of communal farming that are officially known as *wolbas*. Only one *wolba* can operate in a village. A household that is a member of a *wolba* is expected to earn the largest part of its income as remuneration for work contributed to the communal farm by household members. The executive committee of the *wolba* decides on remuneration (which is distributed at variable rates), production plans, work schedules, and the division of gross farm incomes among reserves investment, working capital, and remuneration of members. The decisions are made under the direction of the Ministry of Agriculture's regional office. When joining the *wolba*, a household relinquishes its private landholdings and any ownership titles to oxen and plows. The household then works as part of a production team on consolidated *wolba* fields using the *wolba's* draft animals and farm implements. The arrangement involves little division of labor among members -- the labor patterns and technology used on the *wolba* are the same as those used by smallholder farmers.

To induce villagers to participate in the *wolbas*, the government gave *wolba* farmers preferential treatment over smallholders. It

- allocated key positions of the association office to *wolba* members
- consolidated *wolba* landholdings on the best farming site in the village, thereby progressively marginalizing smallholdings as *wolba* membership expanded
- gave the *wolba* priority access to public credit facilities and agricultural extension services
- assessed lower land and income tax rates for the *wolba*
- imposed lower grain-delivery quotas on *wolba* farming

Despite the incentives, *wolbanization* has never been popular in the Ethiopian countryside -- less than 5% of rural households have participated in the program in the decade since its initiation. Where *wolbas* have operated for some time with sizable memberships, they have been generally less productive than smallholders' farms (Griffin and Hay, 1985; Dessalegn, 1989; Wogene, 1989). Indeed, some members are reportedly pulling out of established *wolbas* in defiance of government regulations. In response, the government announced that smallholders would not be coerced into membership and decreed that *wolbas* may be dissolved if members democratically decide to do so. The government also changed the land titles of smallholders to usufruct in perpetuity

-- the land is no longer subject to redistribution at the discretion of the village association. Thus, the government is no longer forcing the marginalization of smallholder farming. Whether this action is a prelude to the total abandonment of the program remains to be seen, since all other aspects of the preferential treatment policy remain in place.

The only visible aspect of the program to nationalize rural trade was the compulsory grain-delivery scheme initiated in 1981 and pursued rigorously in the so-called "grain surplus areas" by the government's Agricultural Marketing Corporation (AMC) until the 1988 harvest season. Under the scheme, each village farming unit was required to deliver a quota of grain to the AMC at prices fixed by the government. The scheme also required private grain dealers to be licensed subject to the delivery of 50% of their purchases to the AMC at government-set prices. The central government set the prices and quotas; the village association offices were responsible for enforcing the scheme. The associations worked under service cooperatives established by the government that had memberships of 3 to 10 villages. Over half of the total grain marketed by villagers passed through the scheme by 1989; most of it was collected by service cooperative offices.

The government has now abolished the compulsory grain-delivery scheme and announced its intention to purchase grain at free-market prices. However, it is unclear what marketing regime will replace the old one. The policy shift may change the balance of resource flows between villages and towns.

THE STUDY VILLAGES

This paper reports on a case study of three villages conducted over the 1988-89 crop year that measured the balance of resource flows between the villages and towns and quantified the relationship between village activity levels and village external balances. These social accounting questions cannot be examined regionally or nationally because reliable statistics for rural areas are lacking. One premise of this study was that significant diversity in rural Ethiopia begins at the village level. If the network of ties between villages and towns is ignored, the Ethiopian countryside is seen only as an agglomeration of self-contained village economies.

However, taken together, the selected villages capture the institutional diversity of the Ethiopian grain-plow culture as it is practiced in a relatively urbanized regional environment. Survey data collected in three villages was used, along with weekly activity data and transaction records from 10 households, to piece together the Social Accounting Matrix (SAM) for each village. The assumptions

of excess capacity and of constancy of average costs, budget shares, and transfer rates were used to measure the effect of current policy on village activity levels.

The villages selected for this study were Ude, Kumbursa, and Sirba-Godeti, which are adjacent on a territory extending south for 12 km on both sides of the Addis - Nazereth highway, starting 55 km southeast of Addis Ababa. This highway is probably the busiest in the country; it connects these villages to six major urban centers within a radius of 60 km. The villagers' commercial relations with the private sector of the urban economy were among the strongest in the country. Relations to the public sector were also strong. Nowhere else, it seems, was it possible to see greater government presence or more rigorous enforcement of the postreform agrarian-policy package than in these villages.

The three villages differed little in natural-resource endowment, farming technology, ethnic or religious composition, or degree of urbanization. As is typical in most of highland Ethiopia, each of these villages was administered by the village association office responsible to local offices of various ministers of the central government. The three villages formed a service cooperative with three other villages. Residential blocks occupied 20 ha to 25 ha of land in each village; the rest of the land in the village was farmland. About 5% of this farmland was enclosed under a Ministry of Agriculture afforestation program; another 7% was used as communal grazing fields.

However, the economies of the three villages differed significantly from each other in the importance of *wolba* farming relative to smallholder farming. With just under 40% of its residents holding membership in the village *wolba*, the village of Ude was highly *wolbanized*. The village of Kumbursa was substantially *wolbanized*; a quarter of its households belonged to the village *wolba*. The third village, Sirba-Godeti, was little *wolbanized*.

Ude was the largest of the three villages: It had a total territory of 680 ha and a population of 195 households. Seventy-four of the households belonged to the village *wolba*, which was established in 1982. The rest of the households were smallholder farmers. Kumbursa's territory of 600 ha borders Ude in the north. Its population of 183 households, of which 48 were members of the *wolba*, also was established in 1982. Sirba-Godeti borders Ude in the south. It has a territory of 640 ha and a population of 173 households. All of the households in the village were smallholders, except 13 who belonged to a *malba* -- a communal farming arrangement that preceded *wolbanization*, in which members kept titles to plow oxen and implements.

Production Activities

Some productive activities of the villages took place on the farm, some at home. Farm activities, both through the *wolba* and on smallholdings, used the technology of the grain-plow culture (Huffnagel, 1961; Westphal, 1975), which combined cereal production and animal husbandry. The major crops were teff, wheat, and pulses; more than half of the total cropland was used to grow teff. Vegetables, including peppers and onions, were often grown at the household level, but usually on plots of less than 0.1 ha. Except for the small government-sponsored afforestation program, no land was used for permanent crops.

In the grain-plow culture, animal husbandry involves raising cattle chiefly as "breeders needed to produce plowing team replacement" (Westphal, 1975). Excluding the cost of maintaining plow oxen, less than 3% of the gross value added of farming in the three villages originated from animal husbandry. However, animal-husbandry activities were a crucial link in the complex pattern of village production activities. The cost of the upkeep of plow oxen was one-half of the value of intermediate inputs in cereal production.

Unlike farm activities, home activities were organized at the household level on both the *wolba* and smallholder farms. These activities were not included in the national income statistics; however, if village resources were valued as highly when used in home activities as when used for farming, then only about 60% of the aggregate net output of the villages was due to farming. Grain allocated for home use is not a final product -- between harvest and consumption are many processing activities. These intermediate activities are supported by the regular collection or preparation of fuel and collection of potable water from substantial distances. The most important fuel materials in the villages are prepared cakes of cow dung, twigs collected from fields, and straw of pulse crops. Of the total village net output from home activities, 89% was from food and beverage preparation, 2% from postharvest processing, and 9% from activities related to water and fuel supply. Of the total cost of water and fuel supply, fuel costs accounted for 86%; and the cost of dung fuel accounted for 80% of total fuel costs.

Resources

Village households were the main source of farm labor on both smallholder farms and the *wolba*. Division of labor by sex and age groups was the same for both institutions. However, smallholders traditionally exchanged labor during weeding and employed migrant labor during harvest. The *wolba* often resolved labor shortages during these peak seasons by requiring smallholders (through the village association) to work on *wolba* fields without payment. *Wolbas* also had access to the services of the Ministry of Agriculture's harvesters.

Government policy has consolidated *wolba* holdings in each village on the farming site with the best location, soil quality, and size. So, the more a village is *wolbanized*, the less access the smallholders have to farmland, as illustrated by the average landholdings per household:

Village	Level of *wolbanization*	Average landholding per *wolba* member	Average landholding per smallholder
Ude	high	3.3 ha	2.1 ha
Kumbursa	moderate	2.9 ha	2.4 ha
Sirba-Godeti	low	2.4 ha	2.3 ha

Plow oxen were the most important form of farm capital in the villages. The market value of a pair of oxen could be up to 20 times the value of all of the household's other farm implements. While access to land is the greatest constraint to smallholder production, the limited supply of oxen is the greatest constraint to *wolba* production. Neither land nor oxen can be used in transactions between the institutions. In 1988, Ude had 1.85 oxen per smallholder compared to 1.62 oxen per *wolba* household. This translated into 0.9 ox per hectare of smallholder land compared to only 0.5 ox per hectare of *wolba* land. There were 1.5 oxen per smallholder household in Kumbursa in the same year compared to 1.2 oxen per member household of the village *wolba*.

Transactions and Transfers

Villagers were involved in transactions and transfers of resources at a number of levels. (Transactions involve exchange; transfers do not.) Within the villages, the poorer smallholders rented the services of oxen and herbicide-spraying equipment from richer households. They also often took part in labor-exchange schemes. Many households also supplemented their cash earnings by regularly selling *tella*, a local brew, to fellow villagers.

Village institutions, in contrast, engaged in no transactions but received substantial transfer flows. The village association collected membership and penalty fees from each village household. The fees financed a literacy program and supported regional political offices. Frequently, the association office obliged members to make cash and labor contributions to special projects. Most of the labor contributions ended up as indirect transfers to the village *wolba*. Smallholders worked on *wolba* fields, woodlots, and construction projects.

Villagers made three kinds of external transactions: those with other rural units, those with public-sector units in towns, and those with urban private units. Transactions with other rural units and the urban private sector took place in the

nearby towns of Debre-Zeit and Mojo and, occasionally, in Nazereth and Addis Ababa. Villagers sold little to other rural units, although their supplies of livestock, dairy products, and spices came from these same rural units. Most of the villages' farm produce was sold to dealers and consumers in the nearby towns, and a large part of it was absorbed by the AMC's compulsory grain-delivery scheme. Purchases from the public sector consisted almost entirely of improved farm inputs, including fertilizer, herbicides, and improved fodder. Those from the urban private sector included traditional farm implements, durable household goods, clothing and footwear, transportation services, and flour milling. Transactions with public enterprises occurred with the intermediation of the area's service cooperative, which had its office and stores in the village of Ude.

Few direct transfers took place between the villages and external private-sector units. However, significant direct transfers took place between the villages and the urban public sector.

Transfers from the public sector were in the form of government-financed educational and extension services provided at the service-cooperative level. The cost of extension services was usually provided in the form of the salary of the development agent assigned to the three villages under a training-and-visit program. Government policy concentrated extension services in favor of *wolba* farming. The government paid salaries to teachers assigned by the Ministry of Education.

Land-tax and income-tax payments to the Ministry of Finance are direct transfers from villagers to the urban public sector. Both taxes were paid at higher rates by smallholders than by the village *wolba*. The second form of direct transfers to the public sector was the payment of half of the village association membership fees, along with many special cash contributions, to regional offices of the Ethiopian Peasant Association, the Revolutionary Ethiopian Youth Association, and the Revolutionary Ethiopian Women's Association. The compulsory grain-delivery scheme of the AMC transferred resources from villagers to the public sector, indirectly. Both smallholders and the *wolba* of each village had to deliver annual quotas of teff and wheat to the AMC during the decade before 1989 and received government-fixed prices that were less than half the corresponding prices on the regional free market. The delivery quotas per household were lower for the village *wolba* than for smallholders. Among smallholders, delivery quotas were higher for richer households.

ACCOUNTING METHODOLOGY

Social Accounting Matrices (SAMs) were developed for the three villages to determine the balance of economic flows.

Valuing Nonmonetary Flows

To set up the accounts of the village economies, the first step was the valuation of nonmonetary flows to make them commensurable with the monetary flows linking each village to its external environment. Shadow prices of the village-activity outputs and inputs were sought that exactly sustained the output proportions observed during the accounting year. To obtain equilibrium prices of this kind, the physical input-output table of production activities in each village was needed. Thirty types of production activities were identified: 9 food- and beverage-preparation and other household activities; 10 postharvest processing activities; 3 fuel- and water-supply activities; and 8 farming activities. If it is assumed that all of these activities exhibit uniform capital intensity (as appears to be the case), the shadow price P_i of each activity covers the unit cost of externally supplied intermediate inputs and the unit cost of intermediate inputs of village origin at shadow prices, and it ensures a return to direct labor at the same rate for all activities.

Let $\hat{P}_i$ be the local market price of the ith village produce with $\hat{P}_i$ O if the produce is tradable and $\hat{P}_i$ = O otherwise. Let k_i be the relative share of the same produce in the total value of village sales and σ_i be the total of direct and indirect village labor inputs per unit of output of i. Let m_i be the unit cost of externally supplied intermediate inputs per unit of output. The value of w should be set as

$$w = \sum_{i=1}^{30} k_i w_i \qquad i = 1, 2, \ldots, 30 \tag{1}$$

where

$$w_i = \frac{\hat{P}_i - m_i}{\sigma_i} \qquad i = 1, 2, \ldots, 30 \tag{2}$$

Accounting prices can be calculated as

$$P_i = m_i + w\sigma_i \qquad i = 1, 2, \ldots, 30 \tag{3}$$

The procedure assumes homogeneity of labor across activity lines and respects the market insofar as m_i is at market prices and w is a weighted average of rates of return to labor, w_i, that are implicit in market prices of tradable village products.

The Social Accounting Matrix

The SAM format was used to draw the picture of each village economy. Each account in the table consists of a row of receipts and a corresponding column of expenditures. As a total of receipts, a row total is, by construction, identical to the corresponding total of expenditures of the same account. Thus t_1 is the column vector of annual receipts of the three village institutions while t_1' is the row vector of total expenditure of the same institution. Likewise t_2 is the vector of total demand for village products, t_3 that of village spending on external supplies, t_4 aggregate village savings, and t_5 the vector of aggregate external payment by external institutions. To make entries comparable across villages, all three SAMs were calculated in per household terms at the same set of prices (see tables 1, 2, and 3).

The structure of the village social accounting matrix

	Receipts	Expenditures 1	2	3	4	5	6
1	Village institutions	T_{11}	T_{12}	0	0	T_{15}	t_1
2	Production	T_{21}	T_{22}	0	T_{24}	T_{25}	t_2
3	External supplies	T_{31}	T_{32}	0	T_{34}	0	t_3
4	Combined capital	T_{41}	0	0	0	T_{45}	t_4
5	External institutions	T_{51}	0	T_{53}	T_{54}	0	t_5
6	Total	t_1	t_2'	t_3'	t_4'	t_5'	

Injections and Leakages

The SAMs are snapshots of what occurred in 1988; they can not illustrate how village activities interact with government policy and external transactions. Yet the real cost of the external balances read from these accounts cannot be measured without considering the opportunity cost -- as well as the absolute costs -- of external balances. This means the flows must be estimated that would have taken place in 1988 if government interventions and external transactions had been different. To measure the value of resources for the village in this sense, the SAM format must be reinterpreted by identifying T_{11}, T_{12}, T_{21}, and T_{22} as endogenous subsystems of the village economy that respond to transfer injections x_1 or final demand injections x_2 through accounts external to institutions, external supplies,

or capital accounts. The row vectors λ_1' and λ_2' are the corresponding leakages to the same exogenous accounts with r as the balancing item between total leakages from and total injections into the endogenous accounts.

Village matrix of endogenous flows

Receipts	Endogenous flows 1	Endogenous flows 2	Injections 3	Total 4
1 Village institutions	T_{11}	T_{12}	x_1	t_1
2 Production	T_{21}	T_{22}	x_2	t_2
3 Leakages	λ_1'	λ_2'	r	t_x
4 Total	t_1'	t_2'	t_x	

A READING OF THE 1988 ACCOUNTS

The three village economies have broadly the same structure; therefore, a description of the economies can be based largely on references to any one of them.

Internal Structure and Trade

As a reflection of the degree of urbanization of the region, all of the village economies were highly monetized. Monetary expenditure in Ude, for instance, was 44% of net income when the value added from home activities was included and even higher, 70%, otherwise. The annual value of "exports" was EB 2,218 per household, the expenditures for supplies from urban public enterprises were EB 1,235, expenditures for supplies from other rural units were EB 623, and those from the urban private sector were EB 190. The value of the demand met by external supplies was 38.7% of the village's gross product if the net output of home activities was included and 63.2% if the aggregate gross product was measured without including this output.

The accounts also indicate that these three villages were better off than most villages in the country. The average gross incomes of the study villages may have been as much as three times the national average. If labor involved in home activities was valued the same as labor used in farming, the annual gross income per household was EB 5,291 in Ude, EB 4,766 in Kumbursa, and EB 4,970 in Sirba-Godeti. If the value added in home activities was ignored, the figures were

much lower: EB 3,243 in Ude, EB 2,911 in Kumbursa, and EB 3,093 in Sirba-Godeti.

Despite policies giving the *wolba* institution favorable access to land, government extension, and credit services, the average smallholder household was far richer than the *wolba* member household. In Ude, the village *wolba* accounted for only a quarter of the village's gross product, although 38% of the households in the village were members and nearly 50% of the total farmland was held by the *wolba*. Average household income for smallholders in Ude village was EB 6,367 when the value added from home activities was included and EB 3,884 otherwise. The corresponding figures for the *wolba* institution were EB 3,531 and EB 2,154. In Kumbursa also, farm capital per household was considerably larger for smallholders than for the *wolba* institution. However, the difference in capital endowment was not large enough to explain income differentials of this size, thus this finding confirmed the result of earlier studies that the *wolba* institution is less efficient than smallholders in using farm resources.

The most common official justification for the governments' *wolbanization* policy has been that smallholders have a lower propensity to save than members of the *wolba*. However, a calculation of the average propensities to spend challenges this hypothesis, if the pattern of transfers in relation to each village economy are taken into account. The average smallholder in Ude invested 3.6% of the household's income and 2.9% of its receipts. If the net income generated by home activities was ignored, the households' average propensity to save rose to 6% compared to 14% for the *wolba* in the same village. In addition, the average smallholder transferred EB 137 of gross receipts to the *wolba* and EB 51 to the village association but had an investment expenditure of EB 234. The annual per-household investment figure for the village was EB 449. By subtracting EB 224 of transfers from smallholders of the village, the internally financed investment figure for the *wolba* is revealed as EB 225. Smallholders' per-household net transfers to the public sector exceeded similar transfers from the village *wolba*.

External Transfers

Villages could dispose of their entire farm produce in the local free markets without affecting the prices. The AMC's compulsory grain-delivery scheme, which required villagers to sell their produce at less than half of the free-market prices, was therefore an important mechanism for transferring village resources to the public sector. Such transfers can be called implicit, in contrast to explicit transfers that occur through the budgets of the central government or political organizations.

Constructing SAMs on the basis of shadow prices leads to identifying a third form of transfer -- the accounting transfer. To the extent that free-market prices exceed accounting prices, villagers benefit from such transfers. On the aggregate, this was the case in the study villages; thus, the accounts showed net transfers from the private sectors of nearby towns.

The relative magnitude of transfers was similar across the villages; the drain of resources from each village to the public sector was relatively large. And because most of the drain was through transfers implicit in AMC's grain-delivery scheme, it is not surprising that the government's agricultural marketing policy was criticized by both researchers and villagers. The average smallholder in each village was subject to a much greater drain of resources than the average member of the village *wolba*. Despite those balances between villagers and the public sector, the overall balance between each village and the urban public and private sector as a whole was in favor of the village. Villagers benefited from net accounting transfers in their trade with the urban private sector.

For instance, during the accounting year, smallholders in Ude benefited from government educational and agricultural-extension services worth EB 53 per household. They transferred EB 243 per household to the government directly plus EB 19 per household through the village association, which passed part of its annual receipts to offices of the regional hierarchy of mass organizations. The net outflow to the public sector of EB 209 was 89% of smallholders' per-household investment and 142% of their expenditure on consumer goods and services of urban origin. Accounting transfers from the urban sector amounted to EB 549 per smallholder, which left a net inflow of EB 340 per household from the urban sector as whole.

Annual government services to the Ude *wolba* were worth EB 108 per member household -- just over twice the figure for smallholders. The direct transfers to the public sector of EB 182 plus transfers of EB 19 through the village association resulted in a net outflow from the *wolba* of EB 93 per household -- 135% of the *wolba* households' expenditure on urban goods and services and 25% of *wolba* investment spending per member household. With accounting transfers worth EB 255 per *wolba* household from the urban private sector, the *wolba's* balance with the urban sector came to a net inflow of EB 143 per household.

POLICY, EXTERNAL BALANCES, AND VILLAGE ACTIVITY LEVEL

For the past three decades, the Ethiopian government's agrarian policy has been based on the premise that government development and extractive intervention should be concentrated in parts of the countryside that are well endowed and conveniently located. It is still being argued that only by concentrating government resources in such areas is it possible to extract the maximum possible returns to support urban ventures. In the study villages, the rate of return to public investment has been dramatic. Over the decade -- of which the accounting year of the study appears to be typical -- the government has been taking out EB 3 for every EB 1 it has returned through developmental services. Most of the return is due to the government's agricultural marketing and pricing policy rather than the more explicit instrument of taxation. In line with the government's *wolbanization* policy, smallholders have been subject to greater extraction for the same services than the *wolba* institution. The resources extracted from both institutions have been high relative to expenditure on village investment or on urban goods and services. If favorable demand conditions had not pulled free-market prices significantly above their opportunity cost as measured by our accounting prices, final demand expenditure of villagers would have been much lower, and the corresponding rate of net transfer to the public sector would have been higher.

Whether they are read in absolute terms or relative to expenditure levels of the village, figures of net transfers to the public sector fail to capture the full impact of policy on the village economy. To measure the full opportunity cost of net transfers, the following formula must be applied to the actual accounts.

Let A be the matrix of average coefficients computed from the matrix of endogenous flows T. If we assume that each element of A is invariant with the vector of injection x and that all productive resources are underemployed in each village, the vector y of village receipts and output is determined as

$$y = (I - A)^{-1}x \tag{4}$$

However, the system of equations on which the formula is based assumes that injections rather than leakages are the explanatory variables. Therefore, the model cannot be used directly to assess the effect of the net drain of resources from the villages to the public sector. However, the government can be assumed to put back the resources it has taken out through elements of λ' by increasing those of x by the same magnitude. This can be done in two ways. One way is through transfer injections (increases in elements of x_1), to provide more free government services, subsidize village imports, or purchase village products at prices higher than their accounting cost of production. The second way is, through final demand

injections that increase elements of x_2, to purchase village produce at accounting prices or to government finance village capital-construction projects that use some village inputs.

The multiplier matrices, $(I\text{-}A)^{-1}$, derived from the disaggregated SAMs of the three villages indicate that an increase in government transfers to smallholders of EB 1,000 would increase the village's aggregate receipts by an additional EB 1,458 in Ude, EB 2,136 in Kumbursa, and EB 4,756 in Sirba-Godeti (see table 4). A final demand injection of the same magnitude would increase the aggregate village receipt by EB 10,250 in Ude, EB 15,417 in Kumbursa, and EB 25,541 in Sirba-Godeti (see table 5). Thus, for every EB 1 of net transfers to the public sector from smallholders of Ude, the village lost at least EB 2.5 in foregone incomes. The EB 3.00 net transfers per household read from the 1988 SAM are thus equivalent to a total loss of EB 7.50 per household to the village for every birr's worth of government services received.

In addition, the opportunity cost of transferred resources is generally greater for smallholders than for the *wolba* institution. A transfer injection of EB 1,000 to smallholders in Ude would increase village receipts in Ude by EB 1,458, but the increase would fall to EB 989 if the same transfer were through the *wolba*. Thus, a village that is less *wolbanized* will have a greater opportunity cost of a given net transfer to the public sector.

CONCLUSIONS

It is clear that the policy package that followed land reform overtaxed the economics of the villages studied rather than stimulated their growth. Although the government has justified its involvement in grain marketing as a means of defending rural incomes against the vagaries of the free market, its marketing scheme has turned out to be the most important instrument of villager taxation in favor of short-term urban interests. The local free market in grains is not an institution from which village incomes should be protected, instead it has been the only cushion for such incomes against the demands of the AMC and increases in the prices of urban goods and services. Despite the official enthusiasm for *wolbanization*, village *wolbas* have also been subject to resource drain to the public sector. The government's marketing policy and its policy of *wolbanization* thus appear to be independent. However, they both dampen village-activity levels, especially since fewer resources are allocated to the more productive agricultural institutions.

An obvious corollary to these findings is that villages would be better off with a new policy package aimed at a more balanced flow of resources between villages

and the public sector and a greater mobility of resources within each village. The first requires a redefinition of the government's role in agricultural marketing while the second requires the abandonment of *wolbanization* as a tool of resource allocation among villagers. The government's abandoment of the compulsory grain-delivery scheme and its promise that it will no longer seek to marginalize smallholders are hopeful signs of a policy shift. However, they are no more than signs. Whether the announced change in land-tenure policy will be followed by the complete abandonment of *wolbanization* remains to be seen. The implications of the abolition of the compulsory grain-delivery scheme to the balance of resource flows between town and countryside also cannot be assessed until the new agricultural marketing policy has been established. In addition, the mere absence of government intervention does not guarantee a regime of prices that will turn the balance of resource flows more in favor of villagers. The government policy was based on clear evidence before the reforms that a pure regime of private grain dealing was holding farmgate prices too low.

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Table 1. Simplified Social Accounting Matrix (in per-household terms), Village of Ude, Ethiopia, in birr at Ude prices, 1988.

	Small-holders	Wolba	Village assoc.	Pro-duction	External supplies	Combined capital accounts	Other rural	Urban (private)	Urban (public)	Balancing items	Total
Smallholders				6,367				549	53		6,969
Wolba	137			3,531				255	102	86	4,117
Village Assoc.	51	46								-46	49
Production	6,157	3,358		6,515		204		1,515	266	-4,421	13,594
External supplies	147	83	6	1,789		132				-106	2,050
Combined capital accounts	234	449	21							-368	336
Other rural			3		623	-626					
Urban (private)					190	1,762					1,952
Urban (public)	234	182	19		1,237	-1,136				-205	340
Balancing items				-4,608				-367	-87		-5,062
Total	6,969	4,117	49	13,594	2,050	336		1,952	340	-5,062	

Table 2. Simplified Social Accounting Matrix (in per-household terms), Village of Sirba-Godeti, Ethiopia, in birr at Ude prices, 1988.

	Small-holders	Wolba	Village assoc.	Pro-duction	External supplies	Combined capital accounts	Other rural	Urban (private)	Urban (public)	Balancing items	Total
Smallholders				5,145.6				503.5	52.7	-0.6	5,701.2
Wolba	22.0			2,823.8				346.7	108.5	247.3	3,548.3
Village Assoc.	42.8	54.5								-53.6	43.7
Production	4,924.3	2,857.2		6,223.6		30.5		1,631.3	257.1	-3,013.5	12,910.5
External supplies	159.1	145.8	7.1	1,716.8		598.2				-146.8	2,480.2
Combined capital accounts	317.5	324.5	16.6						343.0	-324.0	667.6
Other rural			3.0		678.0	-681.0					
Urban (private)					272.6	1,850.3					2,122.9
Urban (public)	236.0	166.4	17.0		1,529.6	-1,120.4				-171.6	657.0
Balancing items	-0.5	-0.1		-2,999.3				-358.6	-104.3		3,462.8
Total	5,701.2	3,548.3	43.7	12,910.5	2,480.2	677.6		2,122.9	657.0	-3,462.8	

Table 3. Simplified Social Accounting Matrix (in per-household terms), Village of Kumbursa, Ethiopia, in birr at Ude prices, 1988.

	Small-holders	Wolba	Village assoc.	Pro-duction	External supplies	Combined capital accounts	Other rural	Urban (private)	Urban (public)	Balancing items	Total
Smallholders				5,420.5				522.9	52.7	-0.1	5,996.0
Wolba	5.0			2,923.5				238.0	55.4	9.1	3,231.0
Village Assoc.	49.9	39.5								-42.3	47.1
Production	5,263.0	2,819.5		6,317.7		32.1		1,376.4	231.6	-3,460.4	12,579.9
External supplies	152.7	88.1	9.4	1,496.7		220.3				-105.1	1,862.1
Combined capital accounts	282.7	198.7	14.7							-220.7	275.4
Other rural			3.0		555.4						
Urban (private)					221.9	1,602.7					1,824.6
Urban (public)	242.6	85.0	20.0		1,084.9	-1,021.3				-126.2	285.0
Balancing items	0.1	0.2		-3,578.5	-0.1			-312.7	54.7		3,945.7
Total	5,996.0	3,231.0	47.1	12,579.9	1,862.1	275.4		1,824.6	285.0	3,945.7	

Table 4. Total effect of a transfer injection of EB 1,000 on village aggregates by entry of account and by village in birr, Ethiopia, 1988.

Village aggregates	Ude		Kumbursa		Sirba-Godeti	
	Small-holders	Wolba	Small-holders	Wolba	Small-holders	Wolba
Receipts of smallholders	2,208	704	2,745	653	4,572	1,837
Receipts of *wolba*	412	1,270	364	1,553	160	1,801
Receipts of village association	18	15	27	46	24	16
Village consumption of village produce	1,911	1,360	4,258	2,799	4,291	2,207
Output of farm activities	968	663	2,357	1,518	2,744	1,412

Table 5. Total effect of a final demand public sector injections of EB 1,000 on village aggregates by accounts of entry in birr, Ethiopia, 1988.

Village aggregates	Ude		Kumbursa		Sirba-Godeti	
	Food/ beverages	Farm output	Food/ beverages	Farm output	Food/ beverages	Farm output
Receipts of smallholders	9,220	8,887	15,298	15,918	29,246	33,479
Receipts of *wolba*	3,525	4,047	3,169	3,529	1,293	1,923
Receipts of village association	94	96	170	179	152	228
Output of food and beverages			24,072	18,060	33,582	41,027
Farm output	9,716	13,178	14,236	19,380	23,470	36,225

THE EFFECTS OF DOMESTIC POLICIES ON EXPORTABLE PRIMARY COMMODITIES: THE CASE OF GHANA AND COCOA

W. Asenso Okyere

SUMMARY

Over the past few decades developing countries have struggled to raise domestic living standards by experimenting with policies aimed at improving economic growth and stability. Policies pursued over this period have had mixed and often disappointing results. Instead of increased prosperity, many developing countries have been plagued with high foreign debt and balance of trade deficits, stagnating or declining export markets for their primary products, high rates of domestic inflation, an overvalued currency, and an overdependence on foreign imports. Much of the blame for the disappointing rate of economic progress has been placed on the deteriorating terms of trade between developed and developing countries in the exchange of manufactured items for primary products. As a result, solutions to developing nations' economic growth and trade problems have often focused on schemes to either enhance their trade position through creation of cartels or a new international economic order, or insulation from the world market through import substitution policies or formation of preferential trading communities.

This paper argues that it is not just international market problems, but also the misguided and conflicting domestic economic policies of developing countries that are responsible for the economic difficulties which these nations face. Steps such as formation of preferential trading communities or a new international economic order will not suffice to restore or safeguard the economic progress of developing nations until their domestic economic policies are, themselves, in order.

This paper illustrates the strong connections between a developing country's domestic economic policies and the well-being of its export sector by focusing on a historical analysis of Ghana's domestic economic policies and its principal export industry, cocoa.

Cocoa farming was introduced into Ghana in 1895 and rapidly became the mainstay of Ghana's economy. By 1911, Ghana had become the world's leading cocoa producer, exporting about 23,000

tons of the product annually. Ghanaian cocoa production rose to more than 200,000 tons per year by 1947, peaking at 572,000 tons in 1965. This increase was followed by a period of dramatic decline. Production fell by 72% over the next 20 years, to a low of about 159,000 tons in 1984. Ghana's lead in cocoa production was taken over by Côte d'Ivoire and Brazil, and Ghana's share of the cocoa market fell from about 33% to less than 10%.

The dramatic decline in Ghana's cocoa export production between 1965 and 1984 is attributed to low and declining real producer prices for cocoa, the declining price paid for cocoa relative to other crops, the low and declining price of cocoa relative to prices in neighboring countries, the overvaluation of Ghana's currency, labor shortages in cocoa farming areas, and the inadequate marketing infrastructure and limited supply of inputs available to cocoa farmers. Historical data shows that these problems in the cocoa sector arose largely as a result of domestic policies that were first implemented in the 1960s and 1970s.

Policies of the 1960s and 1970s that sought economic growth through rapid industrialization tended, in practice, to overtax the cocoa sector while inducing rural laborers to migrate to better-paying jobs in industrializing areas. They also resulted in the concentration of capital improvements in the urban-industrial sector at the expense of needed transportation, marketing, and production improvements in cocoa farming areas. These problems were compounded by policies that increased the value of other crops relative to cocoa and that allowed the accumulation of large domestic and foreign debts, which were then financed by increased cocoa taxes and money creation. In addition, balance of trade deficits led to currency overvaluation, which made imports and merchandise trade more attractive than the production of tradable commodities.

The importance of real producer prices in determining cocoa output is supported by the results of a time-series regression analysis in which Ghanaian cocoa output is estimated as a function of the producer price of cocoa lagged one year and variables representing smuggling incentives, insecticide use, the opportunity cost of farm labor, and the real effective exchange rate of Ghanaian currency. Although only the lagged price variable is found to be significant, the model has a high explanatory power (adjusted correlation coefficient = 0.85) which supports the premise that real producer prices are a key determinant of primary commodity output, even in the short term.

Changes initiated in Ghana's domestic economic policies in the 1980s signal a hopeful trend in the Ghanaian economy. Overvaluation of the currency has been significantly reduced, economic growth as measured by gross domestic product has increased, the rate of inflation has decreased, and real prices received by cocoa producers have increased. Surveys conducted in 1987 indicate that as a result of these positive trends, acreage devoted to new cocoa plantings has risen substantially.

Much progress has yet to be made, however. Ghana is still faced with serious economic handicaps such as a high debt-servicing burden, a lower than desirable economic growth rate per capita, and dependence on a single primary commodity for most of its foreign-exchange earnings. Clearly, there are no quick or easy solutions to these or many other serious economic problems confronting developing countries today. As shown in the case of Ghana, however, developing countries can move a long way toward resolving international trade crises by careful examination and adjustment of domestic economic policies.

Over the last several decades, the developing countries of Africa have struggled to raise their domestic living standards by experimenting with policies aimed at improving economic growth and stability. The obstacles in the path of these nations' economic development are immense, typically including a low level of industrial development and capital formation, inadequate market infrastructures, high population growth rates, inadequate citizen access to formal education and training, lack of product diversification, low elasticities of demand in world markets for exportable agricultural products, and heavy reliance on trade with developed countries for manufactured items and production inputs.

The challenge for developing countries has been to set policies which assist in the removal of one or more of these obstacles without exacerbating other problems or creating new obstacles to development. This challenge has been met with mixed success. For example, in some cases inappropriate industrial development has been pursued which has resulted in increased reliance on developed nations for manufacturing inputs and spare parts and without the necessary market infrastructure or demand in place to profitably expand production. In other cases, the production of primary commodities has been heavily taxed to generate a surplus to support a fledgling industrial sector, creating stronger than intended disincentives for primary commodity production and resulting in lower than expected tax revenues and exportable surplus. Similarly, the focus of development capital on urban, as opposed to rural, development has sometimes encouraged excessive labor migration to the cities and delayed necessary rural transportation improvements, creating labor shortages and marketing difficulties for the nation's primary commodity sector.

Ghana's efforts to industrialize and diversify production over the last 30 years and the unintended, detrimental effects these efforts have had on its main

export industry are a case in point. This paper examines the role of domestic economic policies in determining levels of primary commodity export production by focusing on the case of Ghana and its principal export sector, cocoa, between 1957 and 1985.

RISE AND DECLINE OF GHANA'S COCOA SECTOR

Cocoa is native to South America where, for hundreds of years, cocoa beans have been harvested annually from the pods of mature cacao trees and sold for use in the production of chocolate, cocoa, and cocoa butter.

Cocoa farming was introduced into Ghana in 1895 and rapidly became the mainstay of Ghana's economy. By 1911, Ghana had become the world's leading cocoa producer, exporting an average of 23,000 tons of the product annually which equaled about one-third of the world's consumption. By 1947, cocoa had been established as Ghana's principal export commodity. Ghanaian cocoa production had risen to more than 200,000 tons per year and accounted for more than half of Ghana's cultivated agricultural land and about one-fourth of its employment.

Ghana's cocoa production continued to rise until the mid-1960s, reaching a high of 572,000 tons in 1965. However, this was followed by a period of dramatic decline. Production fell by 72% over the next 20 years, to a low of about 159,000 tons in 1984. Ghana's share of world cocoa exports also declined over this period. By the late-1970s, Ghana's export share had dwindled to about 18%, ranking third behind Côte d'Ivoire and Brazil. Although Ghana still ranked third, its cocoa export share continued to decline to a low of about 10% of total cocoa exports in 1984. Total cocoa production in Ghana has risen slightly since then, to about 228,000 tons in 1987.

DOMESTIC POLICY AND THE GHANAIAN ECONOMY

To better understand the reasons behind the dramatic rise and decline of Ghana's cocoa sector, it is helpful to examine the events which have taken place in Ghana's overall economy throughout the years.

Pre-Independence Era (1874 to 1957)

Ghana's period under British rule was one of economic laissez-faire, with limited direct governmental participation in production enterprises. Economic policy was basically conservative; the budget was balanced and no active monetary policy existed under the currency board system that presided passively over a sterling exchange standard. The period was characterized by relative domestic price stability and external equilibrium, and coincided with a golden age of consistently high world prices for Ghana's dominant export commodity -- cocoa. Annual balance of trade surpluses in every year except 1956 led to an accumulation of sterling reserves and an average gross domestic product (GDP) growth rate of about 6.5% per year.

Agricultural and mining policy during the period was oriented away from the well-established trade between Ghana and its neighbors along the north African coast and towards the production and export of crops and minerals that were in demand in Britain and the countries with which Britain traded. Rich deposits of gold, diamonds, bauxite, and manganese were mined for export. Cocoa production was introduced into southern Ghana in 1895, after which the small-scale farmers of that region rapidly transformed Ghana into the leading producer of the crop.

In 1947 the Cocoa Marketing Board was established with the following objectives:

- to purchase locally produced cocoa
- to stimulate the production of small-scale cocoa farmers
- to protect farmers from extreme fluctuations in world cocoa prices
- to increase the country's export earnings

Since its inception, the board has evolved various marketing systems. During the pre-independence period it used a multiple purchasing system whereby private firms purchased cocoa directly from farmers which they then sold to the board.

Post Independence Era (1957 to 1966)

Ghana achieved independence in 1957. The first three years following independence were accompanied by relatively high rates of economic growth and a faster rate of expansion of the country's stock of capital assets. Both savings and investment rates were high, averaging close to 20% between 1958 and 1960.

Ghana had an open economy and was heavily dependent on foreign trade. Foreign trade accounted for about 30% of Ghana's GDP. Trade and payments to producers were largely unregulated and tariff levels were generally low. Most capital goods and consumer goods had to be imported and exports were dominated by cocoa. Annual revenues from cocoa were highly volatile, but usually provided about 60% of total foreign exchange earnings. By 1960, therefore, Ghana had developed an expanded stock of capital assets, high saving and investment rates, a large accumulation of reserves, and adequate import capacity to foster economic development.

Ghana became a republic in 1960. The republic's newly formed constitution conferred wide executive powers on its first president, Kwame Nkrumah. The Nkrumah administration adopted a socialist ideology with a heightened spirit of economic nationalism and a commitment to economic growth through industrialization. The result was a vigorous interventionist economic policy. Multipurpose and long-range development plans were implemented to promote import substitution and social welfare improvements, and the government began to participate directly in productive enterprises. Many quasi-government institutions were established, such as a commercial bank, an investment bank, an industrial development corporation, workers' brigades, and farming cooperatives. Domestic expenditures increased rapidly to support the burgeoning bureaucracy and to finance the construction of new hospitals, schools, and industrial development projects such as the Volta River hydroelectric and aluminum plants. Amid charges of corruption, a 1964 referendum gave Nkrumah dictatorial powers and established a one-party socialist state.

In the agricultural sector, small-scale farming was determined to be inefficient and an obstacle to socialist reform. The United Ghana Farmers' Cooperative Council was formed to organize small-scale farmers to take advantage of mechanized agriculture through cooperative efforts. This council was also made the sole buyer of cocoa in the country. The State Farms Corporation was formed to undertake large-scale mechanized farming and the Food Distribution Corporation was established to undertake the distribution of food throughout the country.

The domestic policies of the Nkrumah era eventually led to severe economic problems for the country due to their high costs and some unprofitable investment decisions. For example, factories were established and financed that relied almost entirely on imported raw materials and expatriate management. Rising government expenditures were largely financed through heavy cocoa taxes and external borrowing. At the same time, export receipts stagnated and increasing trade deficits resulted in the dwindling of foreign exchange reserves.

The latter part of this period marked the beginning of a long-term crisis of disequilibrium in the Ghanaian economy. Features of the crisis included the following:

- persistent balance of trade deficits, scarcity of foreign exchange, and a high level of foreign debt
- persistent and increasing federal budget deficits
- domestic price inflation
- scarcity of imported consumer goods and lack of domestic substitutes
- excess capacity in the manufacturing sector, due partly to shortages of imported spare parts and raw materials
- overvaluation of Ghana's unit of currency, the cedi

The Post-Nkrumah Era (1966 to 1981)

When Nkrumah was overthrown in 1966, the National Liberation Council (NLC) rejected the notion of the planned, regulated, and centralized economy in which the state was the predominant economic agent. Both the NLC government and the civilian administration which followed in 1969 turned, instead, to a strategy that put stability above growth and reopened the economy. State-owned enterprises, machinery, and equipment were sold to private entrepreneurs and the economy was returned to a private enterprise, market-oriented, and decentralized system. Experiments with import liberalization were carried out and rural development was emphasized in the government's economic programs. The United Ghana Farmers Cooperative Council was abolished and the multiple buying system for cocoa was re-established and remained in charge of local cocoa purchases until 1977.

The civilian administration was ousted by a coup in 1972, bringing the National Redemption Council of Acheampong into power. This government dismantled the open-market policies of the previous administration and reinstituted a command economy. Comprehensive import controls were restored, the scope of price controls was widened, and some imported consumer goods were subsidised. A unitary system of cocoa purchasing was reinstated in 1977.

The regime of Acheampong was characterized by rapid expansion of the money supply to finance the government's budget deficits. The money supply was expanded at an average annual rate of 31% between 1971 and 1974 and an average annual rate of 50% between 1975 and 1977. Between 1974 and 1979, more than 70% of every budget deficit was financed by the creation of money. This led to a period of Ghana's highest inflation rates ever. Inflation rose from 3% in 1970 to nearly 18% in 1973. By 1976 the inflation rate had climbed to 56%, reaching as high as 116% in 1977.

These high rates of inflation combined with continuing balance of trade deficits made the cedi so overvalued relative to other currencies that a lucrative black market in foreign currencies sprang up. Smuggling operations also became commonplace as farmers and entrepreneurs recognized the monetary advantages of illegally trading in the markets of neighboring countries. By 1977 the real value of the cedi reached its lowest point and Ghana suffered its worst trade deficit.

During the Acheampong admiministration, interest dramatically increased in raising agricultural production to self-sufficiency levels. This led to the institution of the Operation Feed Yourself and Operation Feed Your Industries programs. These programs spearheaded a campaign to increase food production and the production of agricultural raw materials needed for domestic industries. The attempt was made to increase the production of small-scale farmers by increasing the acreage available to them. While these efforts met with some success, much of the gains in food production, especially rice production, corresponded with a dramatic decline in cocoa production. Cocoa output dropped 41% during the Acheampong years, from about 462,000 tons in 1972, to 271,000 tons in 1978.

The Acheampong regime was ousted in 1978 and more government coups followed in 1979 and 1981. The economy continued to decline into the early 1980s. Real per capita GDP fell and the domestic savings rate fell from over 12% in 1972 to less than 3% in 1981. Increasing budget deficits continued to be financed through money creation, so that by 1981 inflation rates were well over 100%. Mining production fell to about half its 1971 level and the manufacturing sector was operating at less than 25% capacity. Despite the declines in other areas of the economy, cocoa production's contribution to Ghana's GDP fell from about 10% in 1971 to less than 2% in 1981.

In short, the economic problems of the Nkrumah administration intensified during the years of the Acheampong government and continued into the early 1980's. These problems were

- declining real output
- continued budget deficits
- rapid monetary expansion
- high domestic inflation rates
- persistent balance of payments deficits
- overvaluation of the cedi
- a flourishing black market in foreign currency
- loss of domestic goods and government revenue through smuggling

Economic Recovery Era (1981-present)

In 1981 the Provisional National Defense Council (PNDC) government came into power under Chairman Jerry Rawlings. Mindful of the economic problems facing the nation, it launched a four-year economic recovery program in April 1983. The main objectives of the program were as follows:

- to restore incentives for the production of food, industrial raw materials and export commodities, and thereby increase output
- to increase the availability of essential consumer goods and improve the distribution system
- to increase the overall availability of foreign exchange in the country, improve its allocation mechanism, and channel it into selected high-priority activities
- to lower the rate of inflation by pursuing prudent fiscal, monetary and trade policies
- to rehabilitate the physical infrastructure of the country
- to conduct research and analysis leading towards an appropriate restructuring of the nation's economic institutions

The program has achieved some success. In 1983 the growth rate of the economy increased by a modest 0.7% after years of decline and by 1985 the growth rate reached a healthy 5.4%. The budget deficit was reduced to 2% in 1985 and the rate of inflation was reduced from its peak of 123% in 1983 to about 10%. Cocoa exports continued to decline into 1984, but recovered slightly over the next three years. This recovery in export production has been overshadowed by increased borrowing of foreign capital, however. Revenues required to service foreign debt rose to 64% of total export earnings in 1985, up from 12% in 1982 and 40% in 1983.

The PNDC government has also made improvements in the valuation of the cedi. In 1981 the ratio of the real currency-exchange rate to the official currency-exchange rate reached a high of 23.7. By periodically adjusting the official exchange rate this ratio was reduced to 2.0 in February, 1986. Foreign exchange is currently allocated through an auction conducted weekly by the Central Bank.

In 1987 the government launched an ambitious medium-term program aimed at restructuring Ghana's economy. Objectives of this program are

- to attain a 5% average annual rate of GDP growth (which is expected to improve real per capita income by about 2% per year once adjustments are made for population growth)

- to bring the annual inflation rate down from 25% in 1986 (38% in 1987) to 8% in 1990
- to maintain balance of payment surpluses averaging about US$ 110 million per year which are expected to enable Ghana to pay off all external debt arrears by 1990

Although it is too early to judge the success of Ghana's efforts towards these goals, it is significant that such goals have been chosen and that such efforts are being made. The economic programs and policies of the PNDC government represent a gradual and stable approach to economic development compared to the headlong rush attempted by earlier administrations.

EXPLANATIONS FOR COCOA SECTOR DECLINE

The difference in policies among the various governments and the resultant state of Ghana's economy creates a contrasting economic backdrop against which fluctuations in Ghana's cocoa production can be analyzed.

Role of the International Market

Many reasons have been cited for the dramatic decline in Ghana's cocoa production between 1965 and 1984. One frequently mentioned reason for the economic difficulties confronting a number of developing countries, including Ghana, is the structure of the international market.

The major exports of most developing countries in Africa continue to be primary products in agriculture, forestry, and mining. Of these, agriculture typically provides the largest share of the African nation's export earnings and employment. In contrast, the principal imports of developing countries have been manufactured items produced by developed countries. Over time, the prices of manufactured items have increased faster than the prices of most agricultural commodities on the world market. This deterioration in the terms of trade between primary products and manufactured goods (or, between developing and developed countries) is often presented as the key obstacle to economic progress in developing countries.

The problems of marketing some export commodities, such as cocoa, are compounded by the product's low price elasticity of demand. That is, a decrease in the world market price of cocoa will stimulate a less than proportionate increase in world demand for cocoa. Therefore, if the supply of cocoa in the world market increases faster than the world demand for cocoa, the market clearing price of cocoa will plummet. The International Monetary Fund (1987) estimates that the short-term price elasticity of demand for cocoa lies between

-0.15 and -0.20. When longer-lagged responses are considered the price elasticity of demand is about -0.30. Because world demand for cocoa has been relatively stable, changes in the market supply of cocoa are particularly important in explaining price movements for cocoa. In turn, lower prices paid for cocoa are theoretically expected to depress future cocoa production.

Various remedies for these market problems have been sought, including a call for a new international economic order which would better address the terms-of-trade grievances of developing countries, the establishment of commodity agreements under the International Cocoa Council, and the formation of regional trade associations such as the Preferential Trade Area for eastern and southern African states, the Economic Community of West African States and the Southern African Development Coordination Conference.

International market factors may help account for the volatility in cocoa's export price and for the deteriorating balance of trade in some developing countries. However, they alone cannot account for the dramatic decline in Ghana's cocoa export production relative to the production of the other major cocoa exporting countries. As shown in table 1, of the major cocoa producing countries only Ghana and Nigeria suffered declines in the average annual volume of cocoa exported between 1974 and 1985. Over the same period, Côte d'Ivoire, Brazil, and an aggregate of all other producers increased their average annual volumes of cocoa exported, as well as their export shares.

Role of Domestic Policies

A number of interrelated factors influenced by Ghana's domestic policies have been indentified as contributing to the decline in Ghana's cocoa exports (La Anyane, 1972; Ghana Cocoa Board, 1974 and 1987; Kotey et al., 1974; Nyanteng, 1977; Dapaah, 1982). These include

- low and declining real producer prices of cocoa since the 1960s
- smuggling of cocoa beans to neighboring countries
- competition from other crops for the use of production resources
- inadequate infrastructure and supply of inputs
- labor shortages on cocoa farms

Producer price incentives. The nominal price paid to Ghana's cocoa producers has increased dramatically over the years, escalating from a low of 145 cedis per ton in 1965 to a high of 140,000 cedis per ton in 1987 (see table 2). This 965% increase was due almost entirely to domestic inflation. When nominal producer prices are divided by Ghana's consumer price index it can be

seen that real producer prices over this period have fluctuated between a high of 174 cedis per ton and a low of 96 cedis per ton, after falling from 220 cedis per ton in 1963.

The level and direction of real producer prices in the cocoa sector can be expected to have both short-term and long-term effects on the total amount of cocoa produced. Studies by Bateman (1973) and others (Stern, 1965; Nyanteng, 1980) conclude that in the short term, the real producer price of cocoa can affect output in the next season or two by influencing the amount of maintenance, pesticide spraying, and harvesting that is done. When prices are low, cocoa farmers are less apt to have sufficient cash, credit, or incentive to hire the labor and buy the pesticides necessary to maximize output. They also are less apt to have sufficient resources or incentives to replace aging trees or to plant new acreage, both of which are important to production in the long term. Standard cocoa tree varieties require about seven years to reach maturity while hybrid varieties require about three years. It is unlikely, therefore, that farmers would risk making large new investments in tree planting so long as prices received are low, unstable, or declining.

A lagged supply response to cocoa price trends is evident in table 2. For example, when total cocoa production is compared with real prices received it can be seen that output fell along with lagged real prices between 1974 and 1984, and rose modestly as real prices rose between 1984 and 1987.

This role of price in the production of cocoa has been recognized by many writers. Oni (1973) presented empirical evidence on the need for the use of price incentives to expand cocoa production in both the short term and the long-term in Western Nigeria. Bateman (1974), Boateng (1974), and Nyanteng (1980) attributed the increase in cocoa output in Ghana from 1956 to 1965 to the attractive prices paid to producers in the 1950s. Their findings support the conclusions of Green (1960), who argues that cocoa price policy in Ghana prior to 1946 tended to depress output and that this trend was exacerbated by disease. He further argues that it was the disease control and higher prices in the 1950s that led to a boost in production beginning in 1958 after a period in which output fluctuated between 200,000 and 280,000 metric tons.

Much of the drop in real producer prices after 1963 can be explained by the heavy and increasing tax burden placed on cocoa to finance foreign debt and government programs such as industrial development. Cocoa farmers were paid between 40% and 50% of the world price of cocoa between 1952 and 1963. This dropped to less than 30% by 1965 and sank to about 10% between 1975 and 1981. Heavy taxes on the cocoa sector were somewhat self-defeating as a source of revenue, since total tax revenues declined as cocoa output sank under the

heavy tax burden. Since 1981, farmers have been paid an increasing fraction of the world market price for their cocoa, obtaining nearly 40% of the world market price in 1987 (see figure 1).

Smuggling. It is well known in Ghana that not all of the cocoa crop produced in the country is made available to be purchased by the Ghana Cocoa Board. Atsu (1965) and Manu (1974) estimate that between 40,000 tons and 70,000 tons of cocoa beans are smuggled out and sold in neighboring countries each year. Nyanteng (1980) attributes this high incidence of smuggling to three main factors: (1) the declining real producer price of cocoa in Ghana relative to the prices prevailing in neighboring countries, (2) the desire to obtain the foreign exchange necessary to purchase goods not readily available in Ghana, and (3) a flourishing black market in foreign currency which makes smuggling more lucrative. All three of these incentives for the illegal trade of cocoa have been present in Ghana over the period in which cocoa export production has declined. High cocoa taxes lowered producer prices below prices received in neighboring countries. High federal budget deficits financed in part by the creation of money resulted in high rates of inflation which, when coupled with governmental reluctance to depreciate Ghana's overvalued currency, made it extremely difficult to obtain foreign currency without resorting to the black market.

To reduce smuggling, Nyanteng echoes Osei-Kwane and Murphy's (1973) call for cocoa price levels in neighboring countries to be considered in the determination of the producer price of cocoa in Ghana. He also suggests that the unofficial exchange rates for the currencies of neighboring nations be considered in the producer-price determination process.

Competition with other crops. In addition to evaluating trends in the real producer price of cocoa and the real producer price of cocoa relative to the price available in neighboring countries, it is important to consider the producer price of cocoa relative to the prices of other crops which the farmer could be growing. Since 1964 the prices of other domestically produced crops have been allowed to increase at a much faster rate than the price of cocoa (see table 3). This is due to a conscious effort on the part of Ghana's policymakers to increase food production to support a growing urban-industrial sector and achieve food self-sufficiency for Ghana's growing population.

While price incentives have helped to increase Ghana's food production, they have done so partly at the expense of cocoa production. Many of Ghana's cocoa farmers also produce other food crops. As the returns to these other crops increase relative to cocoa, it is only logical that farmers should shift their time and investment toward the crops bringing the higher returns.

Inadequate supply of inputs. Programs of the 1960s and 1970s aimed at achieving economic growth through industrialization diverted Ghana's scarce capital resources away from its agricultural sector. As a result, needed improvements in rural infrastructure, such as farm-to-market roads and the availability of inputs and credit, were not made. For example, there were acute shortages of insecticide, spraying machines, and machetes which the Cocoa Board (1987) now recognizes as being among the fundamental causes of the cocoa sector's decline.

At some point Ghana did adopt an input subsidy policy designed to encourage technological advances (such as insecticide spraying) in agricultural production. However, shortages continued as some of the subsidized inputs were smuggled into neighboring countries where higher input prices prevailed. To remedy this situation, Nyanteng (1980) has proposed that all input subsidies be eliminated in favor of appreciable increases in the prices farmers receive for their crops. He reasons that when factor markets are allowed to establish input prices, smuggling is reduced and inputs are more available in local markets to be purchased by bona fide farmers.

Difficulties in obtaining credit and payment for crops have also been disincentives to maintenance and expansion of cocoa farms. Cocoa is an annual crop with a season that peaks between October and November. Because farmers receive bulk payment for their cocoa production they must rely on financial management, and sometimes credit, to maintain or expand their investment in their farms during the off-season. However, institutional credit has not been readily available to most cocoa farmers due to a lack of credit institutions in cocoa farming areas and the diversion of credit resources to industrial development and the production of priority food crops. What credit is available is usually through local money lenders or in the form of cash advances from the Cocoa Board.

Prior to 1982, cocoa farmers were supposed to be paid cash on the spot by buying clerks at the cocoa purchasing centers. However, due to liquidity problems of the Ghana Cocoa Board a chit system was introduced to substitute for cash on the spot. Problems such as failure to honor chits, losses of chits, corruption of some paying clerks, and the long time lag between the sale of produce and the conversion of a chit into cash greatly reduced cocoa farmers' incentives and abilities to maintain and invest in their farms.

Difficulty in securing rights to land has also limited cocoa crop production. In most cocoa growing areas the outright sale of land is not permitted. Instead, the right to use land must be obtained from the village chief, the head of a family, some other individual who has land, or through government appropriation.

Consideration for use of the land is either free, cash rent, or sharecropping, depending on the circumstances under which the right to farm the land was obtained. This land-tenure arrangement affects the ability of farmers to expand their operations, the ability of new farmers to get started, and the security with which farmers hold their land. Difficulties in obtaining farmland are compounded by the increasing demand for land to accommodate Ghana's rapid population growth rate, which was about 3.2% in 1987.

Labor shortages. Cocoa production in Ghana is labor intensive. Cocoa farmers typically rely upon hired laborers or assistance from friends and relatives, particularly at harvest time. However, government emphasis on urban industrial growth has led to urban-rural income differentials and the expectations of improved standards of living in urban areas. This has resulted in a rural-to-urban migration of Ghana's labor force. Therefore, cocoa farmers have faced both a decreasing real price for their crop and increasing costs for hired farm labor.

This labor shortage grew worse after the passage of the Aliens Compliance Order in 1969. The order required aliens without the requisite immigration papers to obtain them or leave the country. Adomako-Sarfoh (1974) reports that by June 1970, 213,750 aliens had left Ghana. Consequently, seasonal labor shortages became acute in Ghana, particularly on new farms (Robertson, 1987).

ESTIMATION OF SUPPLY RESPONSE

A behavioral model and a regression model were used to estimate supply response.

The Behavioral Model

To better understand the effects of key economic variables on cocoa export production in Ghana, a model of the relationship between cocoa output and selected economic variables can be specified and tested. It is difficult to specify a true supply function for cocoa, because crop yields depend on the ages as well as the numbers of trees tended (Franco 1981). However, given a stock of trees, the short-term supply response can be specified and estimated. This study specifies and estimates a short-term supply function for cocoa using time-series observations of selected economic variables as explanatory variables.

The underlying hypothesis for the structural equation is given by

$$\text{Cocoa output} = f(L_{price}, D_{price}, L_{insecticide}, Wage, EFX)$$

where

L_{price} is the real producer price of cocoa lagged one year

D_{price} is the difference between the producer price of cocoa in Côte d'Ivoire and the producer price of cocoa in Ghana, when the former is converted into cedis at the black market rate

$L_{insecticide}$ is the volume in liters of insecticide sold to farmers, lagged one year

Wage is Ghana's minimum wage

EFX is the real, effective exchange-rate index of the cedi

Farmers' price expectations are expected to be adaptive and so the familiar cobweb formulation is hypothesized where current cocoa output is a function of the real price received one period before.

The variable D_{price} represents losses of exportable output due to smuggling. Bhagwati (1974) has shown that the level of smuggling of an agricultural commodity is dependent on the difference between domestic and foreign prices paid for the commodity when the purchasing power of the currencies is equated. Because of the high volume of currency exchange transactions in black markets, it is assumed that the exchange rates prevailing in these markets are the equilibrium (purchasing power parity) exchange rates for border currencies. Therefore, cocoa prices paid in Côte d'Ivoire have been converted into cedis using the prevailing black market exchange rates. Smuggling is considered only for the Ghana-Côte d'Ivoire border because of the substantial and increasing cocoa production in this area and the decline in production near the Ghana-Togo border.

The variable $L_{insecticide}$ is intended to represent the volume of insecticide used by cocoa farmers. Data limitations require that the amount of insecticide sold to cocoa farmers be used instead. This information, which was obtained from the Cocoa Services Division of the Cocoa Board, is flawed as an indicator of pesticide used because it is known that some pesticide is smuggled to neighboring countries and some is used on crops other than cocoa.

The availability of hired farm labor is expected to vary according to the difference between farm wage rates and rates obtainable elsewhere. The opportunity cost of farm labor is assumed to be urban employment. Therefore, the minimum wage rate has been used as a proxy for the availability and use of farm labor. As the minimum wage rate increases, it is hypothesized that less farm labor will be used and that this will adversely affect production.

The real, effective exchange-rate index of the cedi measures changes in the valuation of the cedi relative to other currencies. It has been calculated as a weighted sum of the ratios of various purchasing-power-parity exchange rates (*PPP*) to the nominal exchange rates for Ghana. Ghana's nine major trading partners (Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, and the United States) have been used to calculate the *PPP*, and the weights used are the respective shares of each country in Ghana's trade.

According to conventional economic theory, exchange rates move quickly to keep the effective prices of goods equal across countries. That is, the exchange rate always equals the ratio of the foreign price level to the domestic price level given a base year exchange rate. The year 1975 was chosen as a base year since it represents a normal year in which prices were relatively stable (Okyere, 1985). Consumer price indexes have been used as an indicator of the price levels in the countries.

The formula for calculating the *PPP* for Ghana relative to another country is

$$PPP_{i,t} = \frac{(CPI_{Ghana,t})}{CPI_{i,t}} (E_{i,75})$$

where

$PPP_{i,t}$ is the purchasing-power-parity exchange rate for country i, in year t

$CPI_{Ghana,t}$ is the consumer price index for Ghana in year t

$CPI_{i,t}$ is the consumer price index for country i, in year t

$E_{i,75}$ is the exchange rate of country i, in 1975, in cedis per unit of foreign currency

The effective exchange rate index (RPP) is then the ratio of the PPP to the exchange rate of country i, in year t, in cedis per unit of foreign currency. That is, $RPP_{i,t} = PPP_{i,t} / E_{i,t}$. The trade-weighted, effective exchange rate index for the cedi is then given by

$$\sum_{i=1}^{9} \{(RPP_{i,t})(S_{i,t})\} = EFX_t$$

where

EFX is the trade-weighted, effective exchange rate index for Ghana in year t

$S_{i,t}$ is country i's share of Ghana's trade in year t

As shown in figure 2, the EFX was relatively stable through the 1960s and early 1970s. It rose sharply between 1975 and 1976, and even more sharply between 1980 and 1983, after which it fell back sharply to 1975 levels. A rising index indicates the cedi is appreciating and a falling index indicates the cedi in depreciating. An appreciating cedi is a sign of an increasingly overvalued currency. The cedi was highly overvalued in the late 1970s and early 1980s -- the same period over which Ghanaian cocoa production was at its lowest point.

The Estimated Model

The regression model for estimating cocoa output is given by $Y = XB + E$, where Y is a 15 x 1 vector of cocoa output in tons per year, X is a 15 x 5 matrix of observations on the explanatory variables, B is a 1 x 5 vector of parameters for the explanatory variables, and E is the error term -- a 15 x 1 vector of errors. The error term is assumed to be independent and randomly distributed with a mean of zero.

The model was estimated over the period 1972 to 1986 using ordinary least squares. The regression produces a high F-value of 15.6 and a high adjusted correlation coefficient of 0.85, which indicates a strong correlation between cocoa export production and the explanatory variables taken together. That is, the estimated model produces good estimates of cocoa output over the sample period. This high explanatory power of the model is illustrated by the close fit of estimated to actual cocoa export production obtained by feeding the observed values of the explanatory variables back into the estimated model over the sample period (see figure 3).

As shown in table 4, all of the parameters have the signs which would be expected for each of the explanatory variables to influence cocoa output in the

direction hypothesized. However, due to the high standard errors of the other parameter estimates, only the coefficient for the lagged real price is significant at the 10% level (that is, has a probability of error of 10% or less). While high standard errors can result from using a sample size that is too small or from faulty specification of the regression model, it is expected that in this case they are an indication of multicollinearity -- which is a common phenomenon in time-series regressions. The fact that the parameter for the lagged real price is significant despite any correlation between the explanatory variables indicates the strength of the relationship between producer prices and cocoa output, and supports the premise that real producer prices are a key determinant of primary commodity output, even in the short term.

PROGNOSIS FOR THE GHANAIAN COCOA SECTOR

The decline in Ghana's cocoa export production between 1965 and 1984 has been attributed to low and declining real producer prices for cocoa, the declining price paid for cocoa relative to other crops, the low and declining price of cocoa relative to prices in neighboring countries, the overvaluation of the cedi, labor shortages in farming areas, and the inadequate marketing infrastructure and supply of inputs available to cocoa farmers. Analysis of the historical data shows that these problems in the cocoa sector arose largely as a result of domestic policies that were first implemented in the 1960s and 1970s.

Policies which sought economic growth through rapid industrialization tended, in practice, to overtax the cocoa sector while inducing rural laborers to migrate to better paying jobs in industrializing areas. The concentration of capital improvements in urban-industrial areas was at the expense of needed transportation, marketing, and production improvements in cocoa farming areas. These problems were compounded by policies that increased the value of other crops relative to cocoa and that allowed the accumulation of large domestic and foreign debts, which were then financed by increased cocoa taxes and money creation. In addition, balance of trade deficits led to currency overvaluation which made Ghanaian exports, such as cocoa, less competitive on the world market.

Recognizing the need for change, the current administration has undertaken an ambitious program of economic and agricultural policy reforms. Efforts are being made to reduce the levels of budget deficits, inflation, and currency overvaluation while encouraging the production of food, industrial raw materials, and export commodities.

With respect to cocoa the government has adopted the following measures since 1985:

- an extensive rehabilitation program, with the help of the World Bank, to provide farmers with hybrid seedlings to replace lost and aging stock

- increased producer incentives through higher producer prices (with a target price of 55% of the long-term world market price by 1990), improved methods of payment, and increased supplies of consumer goods to cocoa farming areas
- a major reorganization of the Cocoa Board to make it more efficient and to focus its efforts on basic purchasing, marketing, and extension services

- the privatising of the procurement and retailing of all inputs in the cocoa sector by 1992

- improved border policing and other anti-smuggling measures

- improvements in infrastructure to reduce transportation bottlenecks in the marketing of cocoa

The World Bank (1987) has reported that already the Cocoa Board has begun to divest itself of 52 of its plantations, transferred responsibility for the construction and maintenance of cocoa feeder roads to the Ministry of Roads and Highways, and retrenched 10,000 of its staff. The bank also reaffirmed that the Cocoa Rehabilitation Project being financed by the International Development Association, the African Development Bank, and the Arab Bank for Economic Development in Africa will support policy reforms in the cocoa sector. This support will be directed toward increasing cocoa production and yield, improving cocoa evacuation and quality control, rehabilitating roads in cocoa areas, and strengthening cocoa research.

These changes initiated in Ghana's domestic economic policies in the 1980's signal a hopeful trend in the Ghanaian economy, particularly with respect to cocoa production. Although foreign debt remains high, there have been reductions in inflation and overvaluation of the currency and increases in GDP. Real prices received by cocoa farmers have increased about 150% since 1983, reaching nearly 40% of the world market price in the 1987-88 crop year. A national survey conducted in 1987 indicates that as a result of these positive trends, the acreage devoted to new plantings has increased substantially, with

as much as 33% of the land devoted to cocoa farming having been planted within the last four years (Okyere and O'Mara, 1988). If these trends continue, it is estimated that Ghana's cocoa production will reach at least 300,000 tons per year by the year 2000, which is an 89% increase over Ghana's 1983 production levels (Bateman, 1988).

The improvements in the Ghanaian economy and in the health of its cocoa sector have not been wrought by improvements in international terms of trade or dramatic changes in consumer demand for cocoa. They have resulted from Ghana's careful examination and adjustment of its domestic economic policies. The importance of international market issues not withstanding, little can be achieved through the call for a new international economic order or the formation of international product associations or regional economic groupings so long as developing countries do not adopt prudent domestic economic policies. In the long term, the continued recovery and health of Ghana's cocoa sector will depend on both its domestic economic policies and the exigencies of the international market.

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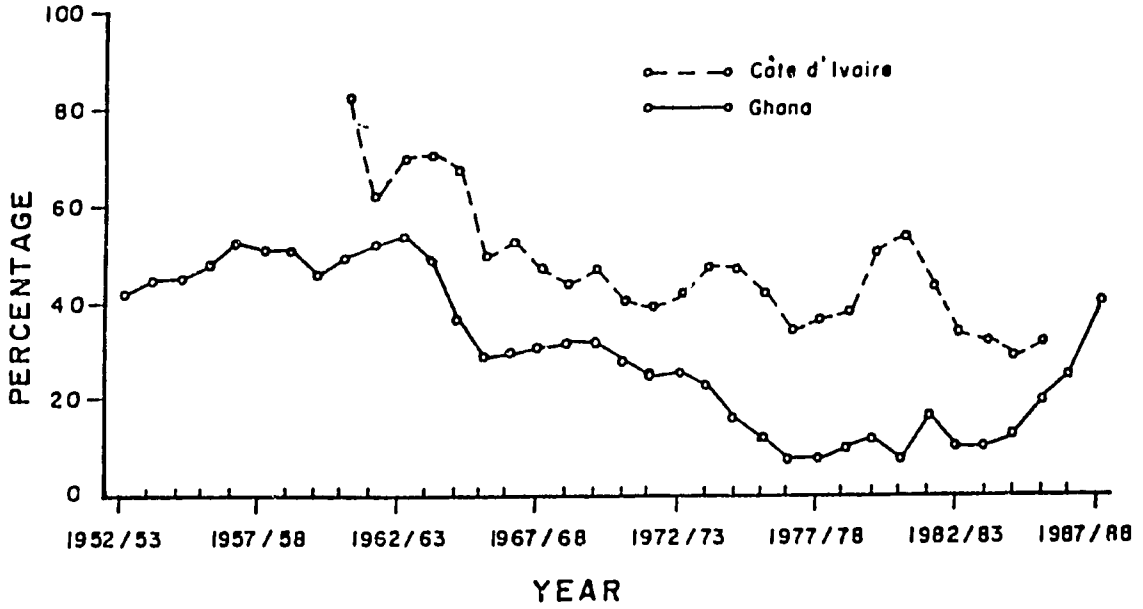

Figure I. Ratio of producer prices to world prices of cocoa in Cote d' Ivoire and Ghana. (Source: International Cocoa Council.)

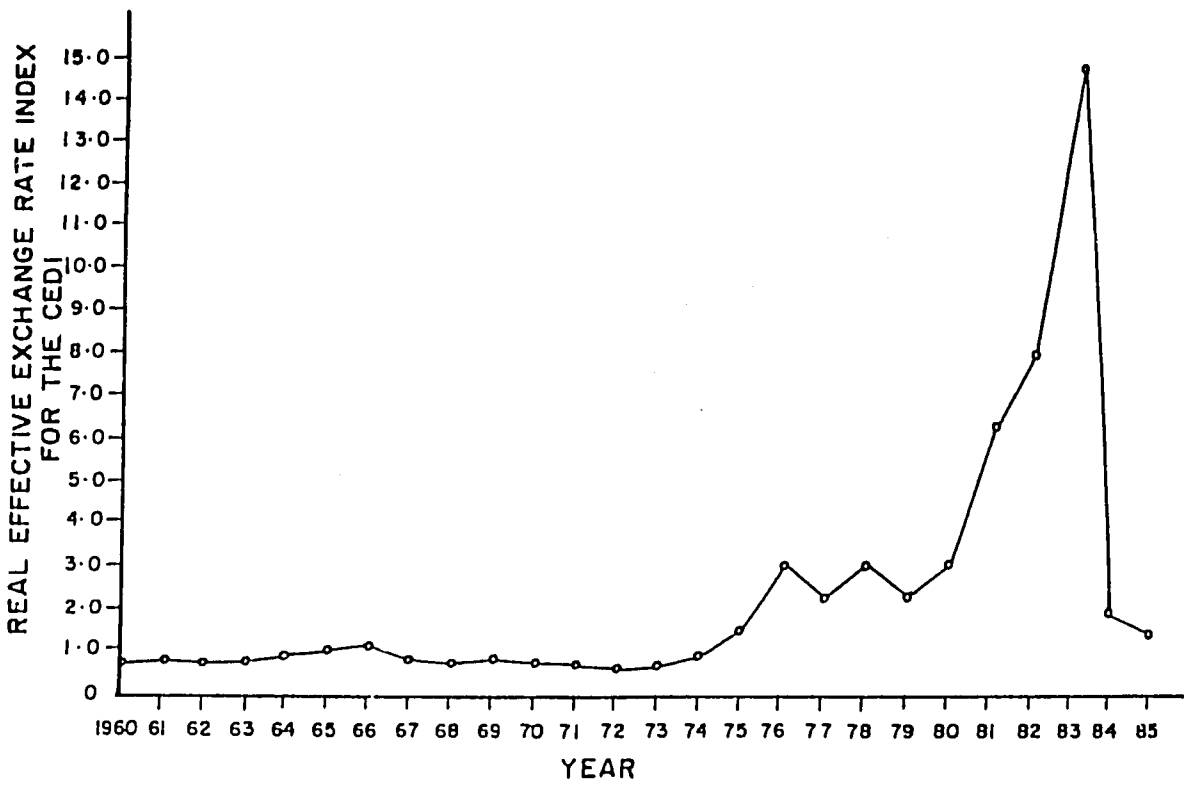

Figure 2. Import-weighted real effective exchange rate for the cedi.

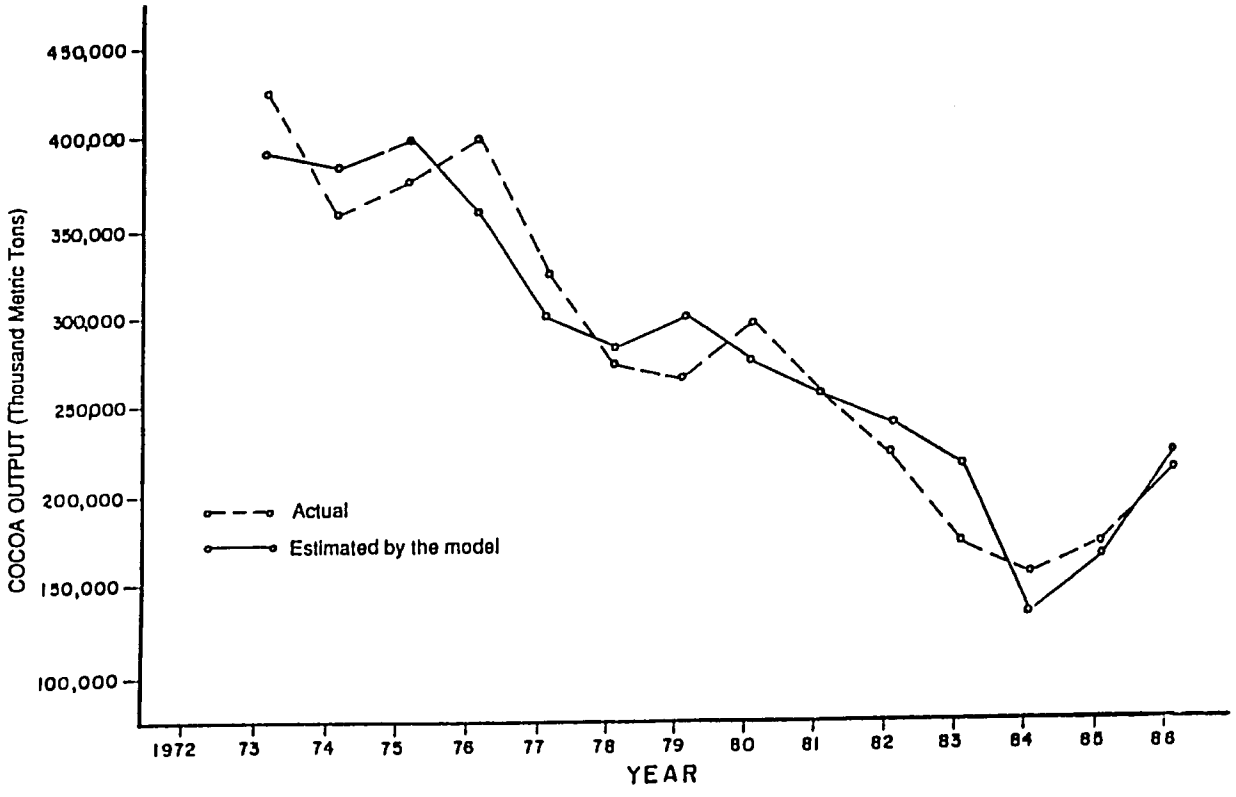

Figure 3. Estimated and actual values of cocoa output. Data collection began in 1972, but simulation graph is from 1973 because of the lag in the price variable.

Table 1. Volume of cocoa exports and export shares of major cocoa producing countries.

Exporter/time period	Average annual volume exported (1,000 MT)	Export share (%)
La Côte d'Ivoire		
1974/75-1975/76	224.66	16.44
1977/78-1979/80	290.16	21.73
1980/81-1982/83	436.30	27.91
1983/84-1984/85	488.85	28.93
Brazil		
1974/75-1975/76	221.30	16.20
1977/78-1979/80	259.00	19.39
1980/81-1982/83	275.13	17.60
1983/84-1984/85	315.54	18.91
Ghana		
1974/75-1975/76	375.29	27.47
1977/78-1979/80	239.48	17.93
1980/81-1982/83	220.31	14.09
1983/84-1984/85	167.48	9.91
Nigeria		
1974/75-1975/76	202.70	14.83
1977/78-1979/80	169.98	12.73
1980/81-1982/83	153.99	9.50
1983/84-1984/85	122.61	7.25
Other Producers		
1974/75-1975/76	342.27	25.00
1977/78-1979/80	376.93	28.22
1980/81-1982/83	483.08	30.90
1983/84-1984/85	591.43	35.00

Source: Data was compiled from ICCO Quarterly Bulletin of Cocoa Statistics.

Table 2. Ghana: Nominal and real cocoa producer prices and total production, 1963 to 1987 (cedis, 000 ton).

Year	Producer price per ton	National CPI	Producer price in real terms	Real producer price index 1963=100	Total cocoa production
1963	220	100	220	100	422
1964	220	120	183	83	421
1965	145	151	96	44	572
1966	198	171	115	52	409
1967	238	157	152	69	375
1968	256	170	151	69	424
1969	293	182	161	73	350
1970	293	189	155	71	411
1971	293	206	142	65	421
1972	366	226	162	74	462
1973	439	266	165	75	415
1974	549	315	174	79	349
1975	585	409	143	65	376
1976	732	639	114	52	394
1977	1,333	1,383	96	44	319
1978	2,667	2,393	111	51	271
1979	4,000	3,695	108	49	265
1980	5,333	5,547	96	44	296
1981	12,000	12,010	100	45	258
1982	12,000	14,688	82	37	225
1983	20,000	32,729	61	28	179
1984	30,000	45,681	66	30	159
1985	56,600	50,423	112	51	175
1986	83,333	62,808	133	60	219
1987	140,000	91,735	153	69	228

Source: Bateman, 1988.

The estimates are based on data supplied by the Policy Planning, Monitoring, and Research Department, Cocoa Board and Statistical Service, Accra, Ghana.

Table 3. Cocoa and food price indices, 1963 to 1981 (1963=100).

Year	Cocoa	Maize	Cassava	Plantain	Cocoyam	Palm Oil
1963	100	100	100	100	100	100
1964	100	127	104	77	100	98
1965	66	164	179	126	168	140
1966	90	167	158	123	173	145
1967	108	93	118	100	148	145
1968	117	150	124	123	167	152
1969	133	220	159	118	169	149
1970	133	177	155	146	207	144
1971	133	181	203	215	271	163
1972	167	261	239	195	294	215
1973	200	279	244	290	395	289
1974	250	304	288	295	457	334
1975	267	378	441	379	548	471
1976	333	862	938	772	1,045	690
1977	607	1,799	2,378	2,303	2,725	1,210
1978	1,215	1,835	2,216	3,574	3,277	2,810
1979	1,822	2,602	2,584	3,823	4,055	3,568
1980	2,186	6,275	5,535	5,610	6,519	5,120
1981	2,915	15,152	11,200	8,923	14,135	N.A.

Source: Ministry of Agriculture, Accra, Ghana.
N.A. = not available.

Table 4. Summary of regression results.

Explanatory term	Parameter estimate	Standard error	t-statistic
Intercept	152,803	56,530.89	2.703
Price-L_1	2,457	669.30	3.671
Price-D	-0.07	0.85	-0.082
Insecticide-L_1	18.03	21.59	0.835
Wage	-36.16	27.19	-1.330
EFX	-6,251	5,222.22	-1.197

THE ECONOMIC FEASIBILITY OF USING LOCAL FEED INGREDIENTS IN THE LIBERIAN SWINE INDUSTRY

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SUMMARY

Current price trends indicate that Liberia's swine industry is in jeopardy unless a practical alternative is found to relying upon expensive imported pig feed. Although some research has examined the feasibility of feeding pigs locally produced feedstuffs, none has emphasized identifying a locally derived pig feed that is both nutritionally complete and less expensive than imported feed.

Local feedstuffs that have potential as pig-feed ingredients include cassava flour, rice bran, fish scraps, brewer's spent malt, corn bran, wheat bran, rubber seeds, blood meal, coffee husks, cassava leaf powder, and tropical kudzu leaf powder. After an initial screening, the first six of these ingredients were selected for nutritional analysis. The diet worksheet method was used to determine a low-cost feed comprising these local ingredients that would meet the nutrient requirements of pigs. The results indicated that one such feed would include about 55% rice bran, 20% cassava flour, 15% brewer's spent malt, 10% fish meal, a vitamin premix, and salt at a total cost of about $30.90 per 100 kg.

Feeding trials were conducted in 1987 to test the performance of this feed relative to that of imported feed. Twelve male Segher pigs, which were about 3 mo old, were divided into six groups of two pigs each. Each group was randomly assigned a different feed combination ranging from 100% local feed to 100% imported commercial feed. At the end of 20 weeks the pigs were slaughtered, and average live weights, dressed weights, and backfat thicknesses were compared.

The lower cost of the locally derived feed contributed to higher gross margins for the pigs that were fed rations consisting of at least 60% local feed. Pigs fed 100% local feed had the highest gross margins at $63.57 for live weight and $77.02 for dressed weight. Pigs fed 100% imported

weight ($50.28). The lower protein and higher energy content of the locally derived feed resulted in greater average backfat thickness than did the imported feed. Therefore, locally derived feeds, such as the one investigated, should be used for finishing only, and grower pigs should be fed a higher-protein ration -- such as 60% locally compounded feed and 40% imported commercial feed -- for the first 8 wk to 10 wk.

Additional research is needed in Liberia to identify and perfect potential feedstuffs that are, or could be, available in sufficient quantities to support a growing swine industry. The results of the feeding trials indicated that the information and technology are available for analyzing the nutrient contents of local feedstuffs and compounding nutritionally balanced diets for pigs from these feedstuffs that are comparable in performance to imported feeds but are cheaper.

African diets are chronically deficient in protein, partly because not enough meat is available and affordable. Producing more pig meat domestically is one means to alleviate this problem. Pigs' relatively quick response rates to breeding and feeding programs and consumers' positive responses have led to increased pig production and consumption in many African countries, including Liberia. Available statistics on the consumption of meat and meat products in Liberia indicate that consumption of pig meat already exceeds that of any other meat and the share of pig meat in the average Liberian diet is growing (see table 1).

Nevertheless, the livestock industry is not well developed in Liberia, as is evidenced by the large quantities of meat imported into the country each year (see table 2). Since 1962, the Liberian government has sought to improve nutrition and reduce expenditures for imported meat by encouraging local production of livestock -- especially swine -- and poultry and eggs. While the poultry industry has shown some improvement in recent years, progress in the swine industry has lagged due to technical and financial constraints.

The most noticeable problem for the Liberian swine industry is the high cost of pig feed: Most Liberian pig farmers rely on imported commercial feeds, which are expensive. Between 1987 and 1988 alone, the price of imported feed rose from $22.00 to $40.00 per 45.5-kg bag. The resulting high cost of production has made domestically grown pig meat less competitive with imported meat products, dampening local farmers' enthusiasm for the swine industry. Furthermore, the main supplier of commercial pig feed stopped importing feed early in 1986, due partially to foreign-exchange constraints. This has forced some pig farmers to

resort to using poultry feed and has intensified the already urgent need to find a long-term solution to the problem of feeding swine in Liberia.

The importance of developing a low-cost alternative to imported pig feed was recognized as early as 1954 by Fennel (1954), who recommended that swine feed include 87% local feedstuffs and 13% imported feed to reduce overall feeding costs. More recently, Asante noted that the swine industry would be economically viable in Liberia only if ways could be found to reduce the cost of swine feed by about 36% (Broderick, 1983). Despite the availability of local feed ingredients that could be substituted for imported feed, little research has been directed toward developing local feed alternatives. Instead, most pig farmers continue to rely on imported commercial feeds while potentially suitable local feedstuffs are exported to other countries.

This study is directed toward alleviating Liberia's swine-feeding problem by

- identifying local feed ingredients that are readily available to both small-scale and large-scale pig farmers and that could be developed to support a growing swine industry
- formulating a nutritionally balanced, least-cost feed from these local feedstuffs that compares favorably with imported feed
- experimenting to determine the combination of the two feeds that minimizes the production costs of pig meat

EXISTING WORK ON LOCAL FEEDSTUFFS

Among the few documented research efforts that have examined the feasibility of feeding locally produced feedstuffs to pigs are the feeding trials conducted by Clark and Bright (1968). In their first experiment, six Poland China weanling pigs weighing about 12.73 kg each were divided into two groups. The first group was fed an imported feed, which contained 16.4% protein and 69% energy components along with vitamins and medication, at the daily rate of 2.73 kg/head. An additional 0.455 kg/head of green forage was fed. The second group's daily diet was 1.36 kg/head of imported feed and 4.55 kg/head of green roughage. (The composition of the green forage and roughage was not specified.) The first group was slaughtered after 173 days; the second group was slaughtered after 243 days. The first group gained weight at an average rate of 0.49 kg/day and the second group gained 0.30 kg/day. Despite the greater number of feeding days, however, the feed cost per kilogram of pork produced was 8% lower for the second group of pigs.

Although the researchers noted that the low growth rate of the second group was probably due to a low protein intake, there is no indication that they were able to determine the extent of the protein deficiency or that they were aware of the nutrient composition of the green forage and roughage used to supplement the imported feed.

In Clark and Bright's second trial, two groups of grower pigs weighing about 49 kg each were fed combinations of imported feed and fresh cassava. The first group was fed 1.82 kg/head of the imported feed described above and 1.82 kg/head to 2.73 kg/head of fresh cassava daily. The second group was fed 0.91 kg/head of a different imported feed, which contained 30.7% crude protein, and 2.73 kg/head to 3.64 kg/head of fresh cassava daily. In addition, all pigs were fed 0.46 kg of green forage each day. The pigs in the first group were slaughtered after 82 days, and the pigs in the second group were slaughtered after 94 days. In this trial, although the average growth rate for the pigs in the first group was 0.59 kg/day, compared with 0.44 kg/day for the second group, the cost of feed per kilogram of pork produced was 4% higher for the first group.

Other studies on animal nutrition by researchers at the Central Agricultural Research Institute (CARI) have identified rubber seeds, tropical kudzu leaves, blood meal, coffee husks, and cassava leaf power as potentially suitable components of a pig's diet (CARI, 1985). Although these studies have provided useful information, none has emphasized formulating a locally derived pig feed.

For example, research at CARI on rubber seeds, which are abundant in Liberia, has focused on neutralizing the effects of the poisonous hydrocyuanic acid they contain so their high protein content can be used. Stosic and others found that rubber seeds could be detoxified by storing them for 6 mo in sacks, either on concrete floors or in wooden frames enclosed by chicken wire. Kaykay reported that the safety level of rubber seeds for weaner pigs and gestating sows was attained after 3.5 mo of storage in a well-ventilated warehouse. However, later observations of abortions among sows whose diets included rubber seed meal indicated that 3.5 mo of storage was not conclusively safe for all pigs at all de eiopmental stages.

N ow the results of that research must be used in developing feeds that incorporate 'ocally available ingredients, are nutritionally complete, and are less expensive than imported feed per kilogram of pig meat produced.

COMPOUNDING A BALANCED DIET

The quantity and quality of pig meat produced on a given farm depends not only upon the genetic attributes of the pigs, but also on environmental and management factors, especially the quantity and quality of pig feed provided. The pigs must be given a well-balanced ration to ensure good health and satisfactory growth performance. Because no single feed ingredient provides the necessary amounts of all the essential nutrients, balancing a feed means carefully combining feed ingredients to avoid nutrient deficiencies.

The basic nutrient requirements for pigs include energy, protein, vitamins and minerals, and water. Energy is provided mainly by carbohydrates, oils, and fats. Protein also can be used as an energy source, although this is usually considered wasteful due to its greater expense and its essential role as the supplier of amino acids for the manufacture of new body tissues.

The usable energy available in feed can be measured by calculating the feed's total digestible nutrients (*TDN*) or its metabolizable energy (*ME*). *TDN* refers to the total quantities of nutrients ingested less the total quantities of nutrients recovered in the fecal matter, measured in kilograms or pounds. *ME* refers to the gross energy stored in the feed, less the energy stored in the fecal matter, less energy losses in urine and gases. It is measured in megajoules per kilogram (MJ/kg). For conversion purposes, 1 MJ *ME* is equivalent to 0.057 kg *TDN*.

In general, increasing pigs' daily intake of energy feedstuffs will increase their average backfat thickness. Recommended energy allowances have been developed for various classes of pigs. These allowances should be used as general guidelines only, since they do not necessarily take into account the need to minimize costs.

Protein for pig feed can be obtained from both animal and plant sources, although the animal sources are typically more expensive. A feed's crude protein content is determined by multiplying the kjeldahl nitrogen content of the feed by 6.25.

Complete proteins are combinations of about 20 amino acids. When digested, these amino acids are released and resynthesized by the pigs to form muscle tissue. Most amino acids can be converted into others or manufactured by the pigs from other nutrients, as necessary. Nine of these amino acids, however, cannot be synthesized by the pigs and must be included in the feed; they are essential amino acids. Because most feedstuffs do not contain the essential amino acids in the right proportions, several feedstuffs may have to be combined to achieve the right feed balance. Devendra and Fuller (1979) have developed recommended protein and amino acid allowances for pigs in the tropics.

Vitamins and minerals, usually required in small quantities, play important roles in the health and development of pigs. They cannot be synthesized by pigs and therefore must be supplied in the diet. Commercial mixes are available, and recommended allowances for pigs have been developed.

Optimal pig feed rations are most easily determined by using computer programs that estimate the least-cost combinations of available feedstuffs that supply the recommended levels of nutrients. For the farmer without access to computer facilities, optimal pig diets can be approximated using the diet worksheet method and a desk calculator. To use this method, the farmer must know the basic nutrient requirements of the pigs and the costs and essential-nutrient contents of locally available feed ingredients. Reliable tables detailing the average nutrient compositions of basic feedstuffs have been published by various authors, including Morrison (1959), Crampton and Harris (1969), Eusebio (1974), Devendra and Fuller (1979).

The diet worksheet also lets the farmer restrict the relative proportion of a particular feed ingredient in the mix. For example, recommended upper limits for energy sources are 70% to 75% of the diet, and recommended upper limits for protein sources are 25% to 30% of the diet. An upper limit of 15% is recommended for fish meal because higher levels tend to transmit a fish flavor to the pork. Upper limits for other feed ingredients may be set to meet the feed compounder's specifications or requirements.

In using the diet worksheet procedure, the farmer begins by making educated guesses about which ingredients should be included in the mixture and what proportions of those ingredients should be used. From the results, the farmer adjusts and refines the proportions of ingredients until the formula is acceptable. Thus, the farmer

- chooses likely feed ingredients according to their nutrient contents and unit costs

- develops a trial composition of the ingredients, taking into account the quantity restrictions mentioned above, so that the percentages assigned to the ingredients total 100%

- using published tables, determines the amounts of nutrients available in each feed ingredient and, from this information, derives the amounts of nutrients available in the feed mixture

- compares the nutrients supplied by the mixture with the nutrients required by the pigs

- determines the cost of each ingredient and, from this information, derives the total cost of 100 kg of the feed mixture
- compares the cost of the feed mixture to the cost of imported feeds
- if the results are not satisfactory, adjusts the composition of the ingredients until a nutritionally adequate, low-cost formula is obtained

ANALYSIS OF LOCALLY AVAILABLE FEED INGREDIENTS

A survey was undertaken to determine which feed ingredients could be obtained locally in large enough quantities for pig feeds. Those identified included cassava flour, rice bran, fish scraps, brewer's spent malt, corn bran, wheat bran, rubber seeds, blood meal, coffee husks, cassava leaf powder, and tropical kudzu leaf powder. The availability and average unit prices of the first seven of these feedstuffs were estimated (see table 3), and the first six feedstuffs were selected for analysis of protein, fat, and sugar content by the Chemistry Department of the College of Science and Technology at the University of Liberia (see table 4).

Coffee husks were not analyzed because their high caffeine content distorts the measurement of protein content, and the high nitrogen content of caffeine is considered useless as a feed nutrient. No samples of blood meal were collected due to the limited quantities of animal blood available from the slaughterhouse and the high demand for this commodity for human consumption. While cassava is also prepared for human consumption, it is of secondary importance as human food in Liberia and can therefore be developed as a dependable swine feed. Additional nutrient information and requirements were obtained from previous work by Devendra and Fuller (1979) and Crampton and Harris (1969).

The diet worksheet method was then employed to determine the least-cost feed that would meet the pigs' nutrient requirements. The final worksheet results indicated an optimal local feed mix would include about 55% rice bran, 20% cassava flour, 15% brewer's spent malt, and 10% fish meal, in addition to salt and a vitamin premix, for a total estimated cost of $30.92 per 100 kg (see table 5).

The protein and energy levels of the compounded, least-cost feed were less than those quoted for commercial feeds, which were 20% and 13.38 MJ/kg *ME* respectively. Devendra and Fuller (1979) indicated that growing pigs (50 kg to 90 kg) can be fed a ration with 13% protein and 11.7 MJ/kg *ME* on a low-energy diet. This suggests the compounded feed may be suitable for finishing purposes because a high-energy diet tends to increase the backfat thickness of the pigs. Protein

levels of 20% are recommended for pigs weighing 9 kg to 20 kg and protein levels of 18% are recommended for pigs weighing 20 kg to 50 kg. This suggests that a regime that limits the feeding of a high-protein diet to the first 2 mo can yield better results than a diet with a fixed protein level. At present, rubber seed meal has the greatest potential as a vegetable protein source; however, work on it is still in the experimental stages at cari.

Results of Feeding Trials

Twelve male segher pigs were used for the feeding trials, which lasted for 20 weeks from August 1, 1987, to December 19, 1987. The pigs were about 3 mo old on arrival and were castrated 2 wk after arrival. They were dewormed 2 days before the feeding trial and 5 wk into the feeding trial with piperazine citrate at the rate of 2 gm per 10 kg body weight.

The 12 pigs were divided into 6 groups of 2 pigs each, and each group was randomly assigned a different feed combination ranging from 100% local feed to 100% imported commercial feed. The feeding rate was 0.91 kg/head for the first week, 1.1 kg/head for the second week, and 1.36 kg/head for the next 3 weeks. Thereafter, the pigs were fed 1.59 kg/head for 7 weeks and 1.82 kg/head for the remainder of the feeding trial. These feeding rates were slightly less than those suggested by Eusebio (1974): The feeding rates were adjusted because the animals were unable to consume the recommended daily quantities.

The largest weight gain, 64.55 kg live weight, was achieved by the pigs fed the diet that was 60% locally compounded feed and 40% imported feed. The smallest weight gain, 58.41 kg live weight, was recorded for the pigs fed the diet that was 40% locally compounded feed and 60% imported feed. This latter group also produced the smallest quantity of dressed pork. The largest quantity of dressed pork and the lowest average backfat thickness was produced by the pigs fed 100% imported feed, while the highest average backfat thickness was produced by the pigs fed 100% local feed. These results were all found to be statistically significant at the 5% level of significance (see table 6).

Each of the pigs was fed the same quantity of feed. Feed efficiency, calculated as the ratio of the weight of feed consumed to the average weight gained, was therefore greatest for the 60% locally compounded feed because it was associated with the largest average weight gain. The feed efficiency for dressed pork was greatest for the 100% imported-feed diet (see table 6).

The 100% local feed rated third in live-weight feed efficiency, behind the 60% and 40% locally derived feeds, but was found to be superior to the feed efficiencies

calculated for previous feeding trials conducted at CARI and the University of Liberia's College of Agriculture and Forestry (see table 6).

The 100% local feed also had the lowest feed cost per kilogram of pig meat produced, while the 100% imported feed had the highest feed cost per kilogram of pig meat produced (see table 7). The cost of the 100% local feed averaged $1.13 per kg of live weight and $1.54 per kg of dressed weight compared with $1.71 per kg live weight and $2.24 per kg dressed weight for the 100% imported feed. These differences were statistically significant at the 5% level of significance.

The lower cost of the locally derived feed contributed to higher gross margins for those pigs fed rations consisting of at least 60% local feed (see table 7). The 100% locally compounded feed had the highest gross margins of $63.57 per pig for live weight and $77.02 per pig for dressed weight. Pigs fed 100% imported feed ranked last in gross margin for live weight ($30.63 per pig) and fifth in gross margin for dressed weight ($50.28 per pig).

CONCLUSIONS AND RECOMMENDATIONS

The results of the feeding trials indicate that Liberia has the information and technology to ascertain the nutrient contents of local feedstuffs and to compound nutritionally balanced diets for pigs from these feedstuffs that are comparable in performance to imported commercial feeds.

In particular, the results show that weaner pigs can be raised on 100% locally compounded feed to a market weight of 73 kg without adverse health effects and can make a reasonable financial return within 20 weeks. Indeed, the results indicate that the lower cost of a nutritionally balanced, locally compounded feed can enhance the profit-making potential of the pig enterprise.

The locally compounded feed was lower in protein than imported commercial feeds and thus resulted in a greater backfat thickness in the pigs. Therefore, the 100% locally compounded feed should be used for finishing only. Grower pigs should be fed a ration of 60% locally compounded feed and 40% imported commercial feed for the first 8 wk to 10 wk to promote rapid growth.

Additional research is needed in Liberia to identify and perfect other feedstuffs that are appropriate for feeding pigs and plentiful enough to support a growing swine industry. While cassava and rice bran promise to be reliable energy sources in locally compounded pig feed, protein sources such as fish meal and brewer's spent malt are less available and are in demand for human consumption and export. Rubber seed is abundant in Liberia, but its high protein content cannot be

taken advantage of until further research determines appropriate measures to neutralize the hydrocyuanic acid in the seed.

As the price of imported feed escalates, feeds composed largely of locally available ingredients must be developed if the price of pork is to be kept within bounds on the Liberian market without damaging the domestic pork industry and resorting to importing more pig meat. The results of this study indicate that such feeds can be developed. Therefore, additional efforts should be made to identify, test, and improve feeds composed of local ingredients as part of an overall plan to improve pig production in Liberia.

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Table 1. Consumption of meat and meat products in Liberia, 1977 to 1984.

Meat or meat product	1977		1978		1979		1980		1981		1982		1983		1984	
	MT	%	MT	%	MT	%	MT	%	MT	%	MT	%	MT	%	MT	%
Pig meat	4,633	30.0	4,855	30.3	5,000	31.3	6,948	40.0	7,119	38.9	8,026	41.4	7,984	40.6	7,130	37.5
Beaf & veal	3,310	22.1	3,363	21.0	3,400	21.3	3,287	19.3	4,226	23.1	4,230	21.8	4,150	21.1	4,200	22.1
Sheep & goat meat	2,023	13.5	2,056	12.9	2,040	12.8	2,013	11.8	2,005	11.0	2,010	10.4	2,010	10.4	2,010	10.6
Poultry meat	3,025	20.2	3,015	18.8	3,125	18.8	3,125	18.4	4,127	22.6	4,130	21.3	4,100	20.9	4,000	21.1
Canned meat	302	2.0	290	1.9	860	5.3	610	3.6	729	3.9	886	4.6	1,350	6.9	1,100	5.8
Sausage	106	0.7	131	0.8	110	0.7	65	0.4	86	0.5	86	0.5	50	0.3	100	0.5
Other meat	1,599	10.0	2,290	14.3	1,575	9.8	952	5.6	--	0	--	0	--	0	--	0
Total	15,000	100	16,000	100	16,000	100	17,000	100	18,292	100	19,368	100	19,644	100	19,000	100

Source: FAO, n.d.
Notes: MT = metric ton; % = percentage of all meat consumed.
Units are US$ 1,000

Table 2. Value of livestock products imported by Liberia, 1977 to 1984.

Product	1977	1978	1979	1980	1981	1982	1983	1984
Cattle (live)	4,000	6,250	7,500	8,500	9,000	9,500	9,700	9,800
Sheep & goats (live)	880	1,070	1,200	820	665	660	838	800
Beef & veal (fresh & frozen)	874	738	900	749	646	680	420	550
Sheep & goat meat (frozen)	54	96	90	36	15	30	30	35
Pig meat (fresh and frozen)	27	17	150	12	26	75	90	60
Poultry (frozen)	58	36	37	235	200	200	150	--
Bacon, ham, salted pig meat products	1,312	1,595	1,800	3,396	3,462	3,500	3,792	3,000
Sausage	263	328	330	224	259	270	140	250
Canned meat	626	682	2,030	1,412	1,718	1,870	2,540	1,950
Edible meat	53	51	50	0	0	0	0	0
Total	8,147	10,863	14,087	15,384	15,891	16,785	17,700	16,443

Source: FAO, n.d.
Notes: Units are US$ 1,000

Table 3. Availability and prices of local feedstuffs in Liberia, 1986.

Feedstuff	Estimated quantity per year (metric ton)	Estimated number pigs it can support per year[a]	Time most readily available	Price per kilogram
Cassava flour[b]	300,000	3,788,000	Aug-Apr	11¢ - 24¢ fresh 32¢ - 58¢ dry milled
Rice bran[c]	73,500	337,466	year-round	9¢ - 11¢
Fish scraps[d]	4,544	11,475- 22,952	Aug-Dec	66¢ - $1.81
Brewer's spent malt[e]	675	11,363	year-round	4¢ - 9¢
Corn bran[f]	37	315	Jan-June	15¢ - 18¢
Wheat bran	--	--	--	20¢
Rubber seed[g]	109,954	469,014	July-Mar	8¢ - 9¢

Sources: MOA, 1987; FAO, n.d.

[a] Based on an estimated annual feed consumption rate of 300 kg/pig. Liberia had about 40,000 pigs in 1986.

[b] Quantities available based on MOA production estimates for 1986.

[c] Estimates based on actual production by the Liberian Produce Marketing Corporation's rice mills for 1986 and MOA estimates of milled rice for the same year.

[d] Estimate based on interviews with fish mongers and FAO estimates of fish consumption in Liberia.

[e] Estimates based on actual average quantities produced annually between 1980 and 1985 by the Monrovia Breweries LTD.

[f] Estimates hold good for Monrovia only and are based on actual production potential of three operating corn mills.

[g] Quantities available based on MOA estimates for 1985 and yield estimates of rubber seeds from CARI, 1984.

Table 4. Nutrient composition of selected feedstuffs.

	Crude protein %		Crude fat %		Sugar	
	Wet	Dry	Wet	Dry	Wet	Dry
Rice bran (parboiled)	4.98	5.39	1.35	1.45	0.102	0.11
Fish meal	46.38	49.73	13.59	13.60	0	0
Brewer's spent malt	16.24	17.08	10.10	10.64	0.62	0.65
Corn bran	7.13	9.50	8.85	11.64	6.10	8.10
Wheat bran	10.64	11.59	7.08	7.72	1.74	1.89

Source: Chemical Analysis by Department of Chemistry, College of Science and Technology, University of Liberia, Monrovia.

Table 5. Diet worksheet results: pig feed compounded of locally available ingredients, Liberia, 1986.

Feed ingredients	Quantity restriction	Feed comp. (%)	NUTRIENTS ME (MJ/kg) CON	ME (MJ/kg) SUP	Protein (%) CON	Protein (%) SUP	Crude fat (%) CON	Crude fat (%) SUP	Crude fiber (%) CON	Crude fiber (%) SUP	Ash (%) CON	Ash (%) SUP	Calcium (%) CON	Calcium (%) SUP	Phosphorus (%) CON	Phosphorus (%) SUP	Unit price ($)	Added cost per 100 kg ($)
Cassava flour	Max. 50%	20	13.8	2.76	1.70	.34							.26	.03	.32	.06	.45/kg	9.00
Rice bran	Max. 75%	55	12.80	7.04	10.20	5.61	1.35	.88	11.00	7.15	10.90	7.09	.06	.04	.22	.12	.10/kg	5.50
Fish meal	Max. 15%	10	10.90	1.09	48.00	4.80	13.59	1.36			10.80	1.1	2.94	.29	2.2	.22	1.24/kg	12.40
Brewer's spent malt	Max. 30%	15	5.88	.88	16.24	2.44	10.10	1.52	14.00	2.10	1.80	.27	.22	.03	.73	.11	.07/kg	1.05
Vitamin premix (Tetramix)	1 gm/2.2 kg feed																5.75/ 100 gm.	2.61
Salt	.33 kg/ 100 kg feed																1.10/kg	.36
Total		100	11.77		13.19		3.56		8.15		7.37		.40		.51			30.92
Nutrient Requirements			11.7-13.4		13-18		Max 7		Max 7		Max 5		Min. 85		Min. 69			

Notes: Max. = Maximum limit; Min. = Minimum limit; CON = nutrient content; SUP = nutrient supply.

Table 6. Physical results of 20-week pig-feeding trial, Liberia, 1987.

Feed type	Mean weight after 20 wk (kg)	Mean weight gain (kg)	Mean backfat thickness (mm)	Mean dressed percentage (%)	Mean dressed weight gain (kg)	Live weight feed efficiency	Dressed weight feed efficiency
100% local	72.74	59.56	31.16	73.51	43.78	3.67	4.99
80% local 20% imported	70.42	58.6	28.33	70.86	41.52	3.73	5.26
60% local 40% imported	75.01	64.55	25.50	71.32	46.03	3.38	4.74
40% local 60% imported	71.59	58.41	29.33	70.46	41.15	3.74	5.30
20% local 80% imported	75.00	63.41	29.33	71.44	45.30	3.44	4.82
100% imported	75.01	62.05	24.66	76.27	47.32	3.52	4.61

Notes: Each pig was fed a total of 218.30 kg of feed. Feed efficiency is the ratio of feed consumed (kg) to weight gained (live or dressed) (kg). Lower ratios reflect greater feed efficiencies. Weight gained was calculated as weight at slaughter minus initial weight.

Table 7. Economic results of 20-week pig-feeding trial, Liberia, 1987.

Feed type	Feed price (¢/kg)	Total feed cost ($)	Feed cost/ kg live wt. gain ($/kg)	Live wt. revenue ($)	Live Wt. gross margin ($)	Feed cost/ kg dressed wt. gain ($/kg)	Dressed wt. revenue ($)	Dressed wt. gross margin ($)
100% local	30.8	67.46	1.13	131.03	63.57	1.54	144.48	77.02
80% local 20% imported	34.4	75.10	1.28	128.92	53.82	1.81	137.02	61.92
60% local 40% imported	37.9	82.74	1.28	129.10	46.36	1.80	151.91	69.17
40% local 60% imported	41.4	90.38	1.55	128.50	38.12	2.20	135.80	45.42
20% local 80% imported	44.9	98.02	1.55	139.50	41.48	2.16	149.49	51.47
100% imported	48.4	105.88	1.70	136.51	30.63	2.24	156.16	50.28

Note: Pig meat prices were $2.20 per kilogram live weight and $3.30 per kilogram dressed weight.

A CASE STUDY OF TENANCY ARRANGEMENTS ON PRIVATE BURLEY TOBACCO ESTATES IN MALAWI

J. Sinoya Nankumba

SUMMARY

Tenant farming and tobacco production were introduced into Malawi by the British in the early 1900s while Malawi (then Nyasaland) was a British protectorate. Since independence in 1964, tobacco has continued to be one of Malawi's principal export crops and tenant farming has remained the predominant land-tenure system in tobacco-growing areas. Despite the importance of the tobacco subsector to the Malawian economy, little research has been conducted on the types of contractual arrangements in force on tobacco estates.

This paper investigates the nature of land-tenure arrangements on Malawian tobacco estates by analyzing the history of the tenant-farming system in Malawi and by surveying 330 tenant farmers and the estate managers of 17 privately owned, burley tobacco estates in Malawi's Kasungu Zone. Special attention is focused on (1) the reasons labor and management choose to enter into tenant-farming agreements, (2) the terms of contractual arrangements, and (3) tenant/management performance, to determine what improvements can be made in the tenant-farming system.

The tenant-farming system evolved in Malawi as a result of the over-privatization of land by the British and the need for cheap labor on British tobacco plantations. Africans with little or no land were encouraged, or forced by economic circumstances, to produce tobacco for plantation owners in return for a place to live, a small share in the sales value of the crop, and a plot on which to grow food.

Today, most of the socioeconomic and legal aspects of tenant farming are still patterned after the British system; the major differences are that most tobacco estates are now owned by native Malawians and managed by hired managers, and tobacco prices paid to tenants are now set by the government rather than estate owners.

It was found that tenant farming appeals principally to Malawians who have some farm background but who desire access to estate land, credit, and production inputs in an effort to raise their standard of living to subsistence level or above. Estate managers prefer tenant labor over wage labor because tenant farmers (1) bear most of the risk associated with crop

failure, (2) are assumed to be more dedicated and reliable workers than wage laborers, and (3) typically have wives and children who add to the labor force available to the estate.

Most tenant-farming contracts are oral; only one estate was found to use a written contract. In both cases, contracts were found to be vague and largely unenforceable by the tenant. No system of impartial arbitration of management/labor disputes is currently available to tenants.

In assessing tenant/management performance under the current system of contractual arrangements, it was found that tenants' 1987 net returns compared favorably with the estimated annual income of an unskilled laborer earning the minimum wage. Nevertheless, tenants surveyed voiced many grievances and their lengths of tenure indicated a high rate of tenant turnover on all but one of the estates surveyed. Notably, the Kanongo/Agra estate has a low rate of tenant turnover, the highest average 1987 tobacco yield, the best housing and provision of social services, and no record of complaints by either tenants or management.

Tenants at other estates complained of unfairness in the marketing of their tobacco, vagueness of contract provisions, and lack of social service amenities such as permanent housing and access to medical facilities and schools. Management at these estates complained principally of high tenant turnover rates which result in lower average tobacco yields and the need to spend more management time in recruitment and training efforts.

It is concluded that the basic terms of the tenant farming contract are beneficial to both tenants and landowners, but that the benefits are skewed in favor of the landowners. Tenants provide most of the labor and bear most of the risk in the production of the tobacco crop, and yet they receive only a fraction of the auction floor sale price, have no job security, are typically provided with poor housing and few social service amenities, and have little leverage in negotiating or enforcing their contracts.

Improving the provisions and enforceability of tenant contracts is justified in the interest of fairness alone, but it will also lower tenant turnover rates and increase yields and profits on burley tobacco estates. For these reasons, the Ministry of Agriculture, which licenses estates to produce specialty crops such as tobacco, is encouraged to pursue an active role in the regulation and oversight of contractual arrangements on tenant-farming estates in Malawi's burley tobacco sector.

It is specifically recommended that the form and content of tenant-farming contracts be improved by making contract provisions more complete, precise, equitable, and enforceable. These improvements will ensure that tenants are:

- charged fairly for necessary production inputs and consumer items provided by the estate (no more than cost incurred plus transportation)

- paid fairly for their crop and any other services they provide to the estate
- provided with adequate food, or land upon which to grow food, for family consumption
- provided with adequately sized, permanent housing; ideally iron roofed (financed through loans to the estate, if necessary)
- provided with the means to transport family members to medical facilities
- provided with other social services such as schools, recreation facilities, and on-site emergency medical assistance as practicable

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Tenant farming and tobacco production were introduced into Malawi by the British in the early 1900s while Malawi (then Nyasaland) was a British protectorate. Since independence in 1964, tobacco has continued to be one of Malawi's principal export crops and tenant farming has remained the predominant land-tenure system in tobacco-growing areas. Despite the importance of the tobacco subsector to the Malawian economy, little research has been conducted on the types of contractual arrangements in force on tobacco estates.

The predominance of tenant labor on private tobacco plantations suggests that this land-tenure arrangement is mutually beneficial to labor and management. Yet questions arise as to what motivates people to become tenant farmers and what motivates the managers of tobacco estates to rely so heavily on tenant labor, as opposed to wage-earning labor. Can improvements be made in estate management that will simultaneously boost production and improve the living conditions of the farm labor force? The establishment of the Estate Management Service Section within the Ministry of Agriculture in 1985 attests to the importance of finding answers to questions such as these.

This paper investigates the nature of land-tenure arrangements on Malawian tobacco estates by analyzing the history of the tenant-farming system in Malawi and by surveying tenant farmers and estate managers of privately owned burley tobacco estates in Malawi's Kasungu Zone. Special attention is focused on the motivations and socioeconomic characteristics of tenant farmers and on the terms of tenant-farming contracts to determine what improvements can be made in the management of burley tobacco estates.

EVOLUTION OF TENANT FARMING IN MALAWI

Malawi's private-property system is based upon English property law. Under English law, all rights to land are vested in the state and any rights which landowners enjoy with respect to the use and disposal of their lands are at the discretion of the state. Landowners, in turn, can retain all residual rights to their land (a freehold interest) or assign some or all of these rights to others through the transfer of property ownership or the granting of leasehold interests or easements.

During the middle ages, this hierarchical system of land tenure fostered the development of a class society in England where one's economic power and prestige was largely dependent on the land rights one held. Large blocks of land were granted to privileged individuals in return for their political patronage and military assistance. These landowners then set the terms under which the landless could live on their lands. Typically the landless were required to provide military service and farm labor for the landlord in exchange for military protection and the right to subsist on the land (Commissioner for Lands, Malawi Government, personal communication, November 2, 1987).

In the late 1800s the English system of property rights and social organization was introduced to Malawi (then Nyasaland), first through European settlements and later through the British colonial government which was established in 1891.

One of the official objectives of the British colonial government was to foster smallholder production of export crops. In practice, misunderstanding and distrust of African farmers often interfered with this goal. For example, in 1925 Colonial Secretary L. S. Amery issued a memorandum asserting, "All able-bodied men should be engaged in active work, either in or outside reserves. By active work is meant more than breaking the ground for women to till!" The 1926 Conference of East African Governors reformulated this statement, adding a distinctly racist bias. In their opinion, the typical African agriculturalist was irresponsible and therefore had to be carefully controlled by the state.

There is no case for prohibiting a native, just because he is a native, from growing any economic crop; but there is a very strong case for debarring from production any inefficient producer who endangers other producers, whatever his race. There is little doubt that for many years to come the majority of natives will be unable to grow certain crops with safety and efficiency (Malawi National Archives SI:2010:29, as cited in MacCracken, 1984).

The administration echoed these sentiments when it determined that European

plantation agriculture should be given first priority and Africans should be encouraged to work for the Europeans: "The educative values of natives who engage in this sort of work is great and for some time to come better results will on the whole be obtained from this than by production of natives working for themselves" (cited in Antill, 1945).

During this same period, a prominent European grower, A. F. Barron, bought some land northwest of Lilongwe for raising tobacco. Barron was so impressed with the tobacco he was able to grow using hired labor that he tried to increase his production by inviting Africans from the area to grow tobacco plots on his estate. He provided the Africans with seed and equipment, bought the crop, and resold it at the auction floors. This marked the beginning of the tenant farming system in Nyasaland (MacCracken, 1984).

The use of tenant labor on European plantations spread largely out of necessity. The success of the plantations depended on the availability of a large and inexpensive labor force. However, the extensive privatization of land by European settlers in Nyasaland's southern region resulted in a growing landless class of native Africans that began migrating to neighboring countries in search of new homes and better opportunities. Plantation labor shortages were averted by the institution of tenant farming and the passage of laws which set forth the conditions under which Africans were to be allowed to live on private estates.

Nyasaland achieved independence in 1964 and became the republic of Malawi in 1966. Today, most of the socioeconomic and legal aspects of tenant farming in Malawi are still patterned after the English system, and the laws which allowed Africans to reside on private estates have been preserved in the Africans on Private Estates Act (Chapter 33:01). One of the few differences between tenant farming before and after independence is that most of the estate land in Malawi's central region is now owned by native Malawians, including prominent business people and politicians.

Now that Malawi is an independent republic, it can be asked why the English system of tenant farming on large estates has been continued. What advantages does this system provide to estate owners and what advantages does it provide to farm laborers? Are there ways in which the system can be improved to benefit both landowners and tenants?

SURVEY METHODS

A survey of tenant farmers and estate managers on burley tobacco farms in the Kasungu Zone of Malawi was conducted in 1987 to identify

- the socioeconomic characteristics of tenants
- the reasons for becoming a tenant
- the reasons for estate owners to rely on tenants
- the forms and terms of tenant-farming contracts
- sources of tenant and management dissatisfaction

Kasungu Zone was selected as the survey area to limit the survey to one geographic and administrative zone and because most burley tobacco estates (both tenant and direct labor) are located in this zone.

Specially designed, pretested questionnaires were administered to a total of 330 tenants from 17 estates. Separate questionnaires were administered to an owner or manager from each estate and general managers of companies and policymakers in the ministries of agriculture and labor were interviewed using unstructured questionnaires. Six of the estates selected, including 3 Agricultural Development and Marketing Corporation (ADMARC) estates and 3 Press Farming estates, are corporate estates and the remaining 11 estates are privately owned by individuals. Random samples of 30 to 40 tenants were interviewed at each estate having more than 30 tenants and all tenants were interviewed at estates having less than 30 tenants. The estates were selected on the basis of owner/manager cooperation rather than random sampling.

BASIS FOR THE TENANT FARMING SYSTEM TODAY

To understand why people choose to become tenant farmers it is helpful to identify their socioeconomic characteristics and their incentives for becoming tenants. It is also helpful to identify why estates rely on tenant labor.

Socioeconomic Characteristics of Tenants

Only married men are permitted to enter into tenant-farming contracts at the estates surveyed. The rationale given is that this reduces turnover and desertions and provides a more stable labor force. A tenant's wife and older children are regarded as assistants to the tenant, and so by hiring a married man the estate is effectively hiring two or more farm laborers. The average family size of tenants surveyed ranged from five to seven among the estates,

with an overall average of six. Tenants' ages ranged from the late 20s to the late 60s, although most tenants were between 30 and 45. The average age was 40.

Tenants surveyed typically had little formal education. The average number of years of schooling on the different estates ranged from 1 to 5 years per tenant, with an overall average of 3 years per tenant. These figures suggest that most tenants are unable to read and write.

Prior to becoming tenant farmers, 56% of those surveyed had farmed crops other than tobacco, 19% had worked as hired laborers on burley tobacco farms, 6% had grown dark-fired tobacco, and the remaining 19% had not farmed before. Those tenants who started with no farming experience had diverse backgrounds, such as brick laying, running a grocery shop, selling fish and charcoal, tractor driving, tailoring, motor mechanics, office cleaning, and law enforcement. One tenant had worked under his father while his father was a tenant. These numbers indicate that while most tenants have had some prior farming experience, only about one-fourth of the tenants had any experience raising tobacco before becoming a tenant on a burley tobacco farm.

Seventy percent of the tenants surveyed are originally from the major tobacco growing areas of the Central Region: Dowa (22%), Kasungu (14%), Ntchisi (13%), Lilongwe (11%), and Dedza (10%). Another 15% of the tenants are originally from districts in the Southern Region where smallholder citizens are experiencing land shortages: Mangochi, Mulanje, and Chiradzulu. In summary, a composite description of the average tenant surveyed is a 40-year-old man with a wife and 4 children, who has had about 3 years of formal education and some farming experience in Malawi's central region prior to becoming a tenant.

Incentives for Becoming a Tenant

Ninety percent of the tenants surveyed said their principal reason for becoming a tenant was to earn more income. An additional 4.5% were attracted to tenant farming as a way to obtain easy access to farm production inputs (on credit) and 3% became tenants primarily to obtain access to land. Other reasons given included running away from village quarrels and locating near a school for the tenant's children.

While some of the tenants had no access to farmland at their district of origin, many of the tenants had been, or currently were, smallholders. Until recently, smallholders were not issued licenses to produce burley tobacco on their lands. Therefore, if they wanted a share in the profits of this relatively lucrative export crop they had to hire out as wage laborers or tenant farmers on burley tobacco estates.

Even now that smallholders can obtain licenses to produce their own burley tobacco, many still opt to enter into tenant farming contracts to have access to more land, or easier access to production inputs and credit, or both. In many cases the amount of land to which the smallholder has access in his home district is less than three hectares, which is generally insufficient to provide much more than the basic essentials of life. To obtain better housing, nutrition, and clothing, and improved access to medical care, transportation facilities, and educational opportunities for their children, these smallholders must earn more income.

Although 1987 net returns from tenant farming varied widely among the tenants surveyed, they were typically higher than the incomes of unskilled laborers working outside major cities in Malawi. While the statutory minimum wage rate for the unskilled laborers was K0.90 per day (about K259.00 per year), the average net returns of the tenants surveyed at 14 of the 17 estates was higher than this, ranging from K291.10 to K1052.78 per year (see table 1).

Incentives for Using Tenant Labor

All burley tobacco estates use tenant labor. A few estates use both tenant labor and wage labor. The principal advantage of relying on tenant labor is that most of the risk associated with the production and sale of the crop is borne by the tenant. If the crop fails or the sale price of tobacco falls, the tenant is still responsible for all costs incurred in the production of the crop. In addition to reducing landowner risk, the transfer of crop production risk to the tenant is advantageous to the landowner because it provides the tenant with added incentive to work hard to produce the best possible yields. The landowner doesn't lose under this system unless the tenant becomes highly indebted to the estate and leaves without paying.

Tenant farmers are also considered to be a more stable and reliable work force than are wage laborers. This is because tenant farmers live on the estate with their families, have a stake in the crop they are producing, and are therefore less apt to quit or be absent from work.

Another advantage of tenant labor is that, because only married men are hired as tenants, the estate is effectively hiring more than one farm laborer for the price of one. The tenant's family assists the tenant in the various phases of tobacco production and can be called upon as a ready source of wage labor by the estate when extra help is needed.

TENANT FARMING CONTRACTS

Both written and oral labor contracts are used in Malawi's agricultural sector; however, all but one of the estates surveyed rely solely upon oral contracts.

Oral Contracts

The advantages of an oral contract to estate owners and managers are the ease of negotiating such contracts, the lack of specificity required, and the difficulty a tenant would have in enforcing the contract should a dispute between landlord and tenant arise. Most of the estate managers surveyed indicated their belief that oral labor contracts are, for all practical purposes, unenforceable in a court of law.

Another explanation given for the use of oral contracts is that most of the tenants have had little formal schooling and would be unable to read the terms of a written contract. Despite a high illiteracy rate among the tenants surveyed, however, it was found that most tenants would prefer a written contract. Problems tenants cited with oral contracts include (1) the omission of important points, such as the provision of social services, (2) the tendency for tenants and estate managers to dispute details of the contract as time passes and memories fade, and (3) ambiguous provisions of the contract, particularly in the areas of housing and food security.

Although oral contracts varied in detail, they contained roughly the same basic provisions. The management is expected to provide the tenant with

- land, usually 2 plots of 1.5 acres (0.61 ha), one of which is to be used for burley tobacco and the other of which is to be used for maize to feed the tenant's family
- advances or credit for inputs such as fertilizer, food (maize), wage labor (if necessary), tools, seed, and poles and grass for home construction
- subsidized services such as insecticide spraying, use of storage barns and barn materials, tractor land preparation to ensure deep plowing, and transport of crops, fertilizer, and food
- technical advice and supervision
- payments in cash and credit for sale of tobacco, and bonuses for a high standard of work

In return for the above, the tenant is required to (1) repay all advances, (2) make full use of all subsidized services, (3) produce satisfactory yields of burley tobacco, and (4) sell all burley tobacco to the estate. In all cases, contracts were negotiated on a year-to-year basis.

In the production of tobacco, the tenant is responsible for all manual labor including preparing land and raising seedlings, and replanting, fertilizing, weeding, harvesting, curing, grading, and selling the crop to the estate. In addition, the tenants are responsible for the construction and maintenance of their own homes from materials, such as poles and grass, made available from the estate.

These basic contract terms have remained unaltered since the first tenant-farming system was established in Malawi in the 1920s. The only significant modifications in the tenant-farming system since the colonial period are that (1) crop prices are now set by the government instead of estate owners, (2) most contracts are oral instead of written, and (3) most estate owners are now absentee landlords who depend on employed farm managers. Prior to Malawi's independence, landowners typically determined crop prices and directly supervised tenant production.

Written Contracts

Of the estates surveyed, only Chilanga makes use of a written labor contract. This contract is referred to as a *memorandum of agreement* and requires the witnessed signature or thumb print of the tenant. The contract runs from year to year and contains 14 clauses stipulating conditions for the use of the land and the responsibilities of the tenant and landlord. Contracts automatically expire after the sale of the tobacco crop to the estate and must be renegotiated unless one of the parties to the contract has given notice at least 6 weeks prior to contract expiration.

The terms are similar to the terms of the oral contracts with a few significant exceptions. Prices for management services are specified in the written contract and the prices tenants must pay for production inputs are specified as the purchase price paid by the estate plus transportation costs. No land is made available to the tenant for maize production under this contract and only 1 acre (0.4 ha) is leased for tobacco production. Strict limits are placed on the availability of credit and cash advances to the tenant and the tenant must agree to abide by all orders of the estate manager concerning both crop production and personal discipline.

It is not clear how the tenant is to provide food for his family during the production season, given the small amount of food credit permitted and the lack

of provision of land for maize production. Furthermore, only maize and beans are supplied by the estate, and these are supplied only "when available." No method is given for determining the price tenants will be charged for maize and beans purchased from the estate.

The contract also specifies that the tenant will receive 10% of the value of the crop in cash. Presumably the remainder of the crop value is added to the tenant's account to offset debts accrued over the year, and any positive credit balance is carried forward. However, no terms are specified in the contract for paying more than 10% of the crop value in cash or for converting positive credit balances to cash.

Disputes over prices paid or the fulfillment of other terms of the contract must first be arbitrated by the owners of the estate and, if no agreement is reached, by the agricultural liason officer of the National Bank in Kasungu. It is not clear that the tenant has any counsel or leverage in these arbitrations or that the arbitrators are strictly impartial to the outcomes of the arbitration. Furthermore, the sample contract provided by Chilanga's management was not signed by a representative of the estate. This omission could cast the validity of the contract into doubt and make it even more difficult for the tenant to force the estate to abide by specific provisions in the contract should disagreements occur.

TENANT/MANAGEMENT PERFORMANCE

To evaluate the performance of tenants and management under the tenant-farming contract, tenants' net returns and length of tenancy were examined, and tenants and management were questioned to determine what, if any, grievances they had with contract terms or contract compliance.

Tenants' Net Returns

Tenants' net returns were examined as a measure of tenant-farming profitability. Annual net returns were calculated by subtracting the advances paid to tenants from the payments received by tenants for the tobacco crop. This is not the same as net income, which is a better measure of profitability, because

- It is net of some consumption (food) expenses as well as production expenses.

- It is only net of those production expenses for which the tenant received advances from the estate; it is not net of any production expenses for which the tenant paid cash.

- It does not take into account the rental value, if any, of the tenant's housing or maize plot.

These figures do show that the average net return for each tenant sample group was positive, suggesting that most, if not all, tenants were able to pay back their debts to management at the end of the crop year (see table 1). Average annual net returns varied by sample group, ranging from a low of K139.04 at Buwa Estate to a high of K1052.78 at Msaleka Estate. The overall tenant average was K475.92. To the extent that net returns approximate annual net income, they compare favorably with the annual incomes of unskilled laborers working outside major cities. All but three of the sample groups achieved an average net return higher than the approximately K260.00 the unskilled laborer is expected to earn in a year.

Length of Tenancy

The average number of years tenants remain on burley tobacco estates is one indication of the degree to which tenants and landowners are satisfied with tenant contracts and contract compliance. Assuming tenants have some reasonable employment options, their choice to remain tenant farmers would signal their general satisfaction with the operation of the tenant farming system. Similarly, assuming estate managers have access to an adequate labor supply, their willingness to renew tenant contracts would indicate their overall satisfaction with tenants' work.

All of the estates sampled have operated with tenant labor since at least 1969. Yet 70% of the tenants surveyed had been tenant farmers for 4 years or less and nearly 28% had been tenants for 1 year or less (see table 2). This high rate of tenant turnover suggests some dissatisfaction with contract provisions or contract compliance or both.

High turnover rates were not found on the Kanongo/Agra Estate. Nearly 70% of the tenants surveyed on this estate have worked there for 5 years or more, and over 37% have worked there for 11 years or more. The average length of tenancy in the Kanongo/Agra sample was 9.2 years, compared to an average length of tenancy of 3.5 years for all other tenants surveyed (see table 1). Notably, the Kanongo/Agra Estate is the only estate surveyed in which neither the management nor the tenants voiced complaints. This estate is also unusual because it is managed by the owner and provides a high level of social services. It also obtained the highest average yield of all estates surveyed.

Sources of Management Dissatisfaction

The most common complaint of owners and managers interviewed was the high rate of tenant turnover. This suggests that most tenants' decisions to drop out of tenant farming are voluntary rather than forced. Either they have not been able to farm profitably enough under the system or other needs have not been met. High turnover rates are a problem for estate management because it takes time to recruit and train new tenants, and because new tenants are more apt to produce low yields of quality tobacco. Apart from high turnover rates, estate management's major complaints were of some tenants' mishandling of tobacco and slowness in following technical advice, and of low yields (see table 3).

When asked to list serious offenses which could lead to a tenant's dismissal from the estate, most owners and managers agreed upon the following: (1) excessive absenteeism, (2) the selling of estate property, such as fertilizer issued to tenants on credit, (3) insubordination to estate management, and (4) failure to complete farm operations on time. Other offenses listed include credit default in more than two consecutive years, disturbing other tenants or their families, and smuggling tobacco off the estate.

Sources of Tenant Dissatisfaction

The most common tenant complaints were of management unfairness in the buying of tenants' tobacco crops, delays in receiving cash payments for their crops, and inadequate medical assistance (see table 3). Other grievances include vagueness of oral contracts, lack of schools for tenants' children, and poor housing. Tenants at Chilanga Estate also complained of having no land allocated to tenants for maize production (see table 3).

Marketing of crops. Since independence, tobacco estate management has been required to purchase tenants' tobacco at officially determined prices for each tobacco type and grade. This is generally considered to be an improvement over colonial days when tobacco prices were set at the discretion of each estate owner. However, some tenants complained that unfair pricing practices still occur, such as undergrading tobacco purchased from tenants and regrading it for sale at auction floors in Lilongwe. Some tenants also complained of receiving little training in the grading of tobacco, and being monetarily penalized for the poor job of grading they had done.

It was found that Press Farming and ADMARC estates stuck closely to officially set prices for tobacco and paid tenants promptly for their crops. Other estates typically offered slightly more or less than the official tobacco prices and waited

until after the tobacco had been auctioned to pay their tenants, sometimes paying them in installments.

Social services. Most privately owned tobacco estates are located beyond reasonable walking distances to schools and medical facilities. Some of the estates surveyed are more than 10 kilometers from the nearest hospital or clinic. Tenants in such remote locations voiced their great need for management cooperation in providing some medical care on site and in transporting tenants to medical facilities when necessary.

The Kanongo/Agra estate is the only estate surveyed that provides regular schooling for tenants' children. Children of other tenants do not attend school unless their estate happens to be near a government or mission school. Many tenants expressed concern about their children's education and proximity to a school was the overriding factor in some tenants' decisions to locate at a particular estate.

In almost all cases, tenants are expected to construct and maintain their own homes out of materials such as mud, thatch grass, and poles available on the estate. The average hut was found to occupy about 12 square meters. Tenants must live in these temporary structures because management will not or cannot provide permanent housing. Tenants have little incentive to upgrade their dwellings due to the uncertainty of their tenure and because they receive no compensation for their dwellings when they leave. Lack of good housing also limits tenants' acquisition of consumer goods to basic items that require little protection from the elements. The Kanongo/Agra estate is the only estate surveyed that provides tenants with permanent housing.

Vagueness of contracts. As mentioned in the description of oral contracts, tenants also expressed dissatisfaction with the vague and ambiguous provisions of contracts. General promises made concerning housing and food, for example, were subject to varying interpretations by tenants and management. In the example of Chilanga estate's written contract, no land is provided for the tenants' family food production, and the estate only promises to supply maize and beans "when available." It is not clear to what efforts estate management will go to make this food available, and it is not clear how the food will be priced. Oral contracts present the added difficulty of providing no record of the original wording of any promises made. Over time, tenants and management may come to completely different conclusions as to exactly what was promised to whom.

RECOMMENDATIONS FOR IMPROVING THE TENANT FARMING SYSTEM

The basic terms of the tenant-farming contract are clearly beneficial to both tenants and landowners. Tenants receive the use of land and production inputs on credit to produce a crop whose sales value is shared with landowners. However, as in the case of England's ancient feudal system, the benefits of the tenant-farming system are currently skewed in favor of the landowners. Tenants provide most of the labor and bear most of the risk in the production of the tobacco crop, and yet receive only a fraction of the auction-floor sale price, have no job (or home) security, are typically provided with few social services, and have little leverage in negotiating or enforcing contracts.

Tenant dissatisfaction with the current situation is evidenced by the high rate of tenant turnover experienced at most of the estates surveyed. Tenant farming appeals to those with inadequate access to land, credit, production inputs, training, or other resources and opportunities necessary to earn a comparable living. Tenants quit once access to these resources and opportunities is obtained or they find they have overestimated the benefits of tenant farming relative to other occupations.

Loss of experienced tenants is estate management's major complaint because it takes time and effort to recruit and train new tenants to produce comparable yields. To reduce tenant turnover, management must provide a better package of benefits to tenants This is borne out in the case of the Kanongo/Agra estate, where tenants are provided with better living conditions and social services and, in return, stay on longer and produce higher average yields than all other estates surveyed.

The form and content of tenant-farming contracts can be improved by making contract provisions more complete, precise, equitable, and enforceable. To eliminate confusion and disputes it is recommended that all provisions of a contract be clearly defined and specified, including provisions pertaining to

- the determination of prices for production inputs, consumption items, and the purchase of tenants' tobacco
- estate policy regarding credit limits, cash advances, and cash payments
- estate policy regarding the provision of housing, food, maize land, and other services
- tenant responsibilities

- grounds for tenant dismissal

- lease renewal and notification requirements

To improve contract enforceability, contracts should be written and dated, and signed or marked by both parties. If this is not practicable, tenants should at least have ready access to an official, complete, and precise written description of estate policies which will be in force over the contract year. In all cases, contract provisions should be clearly defined and explained to tenants prior to their acceptance of contract terms. Disputes over contract terms and contract compliance should be arbitrated by an impartial third party, such as a judge or a knowledgeable agent of the Ministry of Agriculture or the Ministry of Labor. The Ministry of Agriculture is already responsible for the issuance of licenses to owners of private estates to grow and sell special crops such as burley tobacco. It should interpret this responsibility, provisions of the Africans on Private Estates Act, and other relevant law, to include a responsibility to protect the rights and regulate the conditions of tenants on these estates.

The conditions of tenants can largely be improved by ensuring that they are

- charged fairly for necessary production inputs and consumer items provided by the estate (no more than cost incurred plus transportation)

- paid fairly for their crop and any other services they provide to the estate

- provided with adequate food, or land upon which to grow food, for family consumption

- provided with adequately sized, permanent housing; ideally iron roofed (financed through loans to the estate, if necessary)

- provided with the means to transport family members to medical facilities

- provided with other social services such as schools, recreation facilities, and on-site emergency medical assistance as practicable

In summary, improvements in the provisions and enforceability of tenant contracts are justified in the interests of fairness alone. But these same improvements will enhance tenant welfare, morale, and estate loyalty; reduce tenant turnover rates; and increase yields and profits on burley tobacco estates -

stimulating an overall improvement in the rural economy. For these reasons, the Ministry of Agriculture is encouraged to pursue an active role in the regulation and oversight of contractual arrangements on tenant farming estates in Malawi's burley tobacco sector.

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Table 1. Sampling means of selected characteristics of tenants, advances, yields, and returns (Kasungu Zone, 1986-87).

Estate	Sample size	Year estate was established	Averages: Years as tenant	Averages: Education[a] of tenant (years)	Averages: Family[a] size	Averages: Advances (Kwacha)	Averages: Yield (kg/ha)[a]	Gross return (Kwacha)	Net return (Kwacha)
Press Farming									
Katondo	40	1940	4.5	3	6	668.54	2107	1037.68	369.14
Kandaula	34	About 1940	5.4	3	7	528.77	1947	998.44	469.67
Mpale	40	About 1940	4.7	3	6	544.69	1932	1038.80	494.11
ADMARC									
Kasikidzi	8	1969	2.0	5	7	562.06	1682	804.80	242.74
Buwa	16	1969	2.0	5	5	645.32	1723	745.04	139.04
Chasato	6	1969	1.0	2	6	923.75	2807	1244.09	320.34
Privately Owned									
Chilanga	30	After 1964	3.0	3	5	437.97	1632	729.07	291.10
Salala	20	After 1964	4.6	3	6	669.58	2064	1118.21	448.63
Kamwankhuku	11	After 1964	2.8	2	6	404.65	1705	946.08	541.43
Lumbani	8	After 1964	2.6	4	5	323.08	1272	549.52	226.44
Sangwani	15	After 1964	1.8	3	5	427.93	1450	761.88	333.95
Mmanga 1	25	After 1964	2.6	2	6	486.77	1563	820.58	333.81
Nkhonde	7	After 1964	3.0	1	7	405.61	1934	829.99	424.38
Msaleka	15	After 1964	2.0	5	6	754.19	2119	1806.97	1052.78
Tithe	6	After 1964	1.0	1	7	682.67	2503	1336.67	654.00
Zuluma	9	After 1964	2.7	3	5	359.68	1747	840.07	480.39
Kanongo/Agra	40	1929	9.2	2	7	879.47	2814	1745.16	865.69
Total sample size	330								

[a]Rounded to whole numbers.

Table 2. Proportion of tenants by estate and by period of tenure (years) as a tenant (Kazungu Zone, 1986-87).

Estate	Sample size n	Period of tenure (years) as a tenant: 1 Freq.	1 %	2-4 Freq.	2-4 %	5-7 Freq.	5-7 %	8-10 Freq.	8-10 %	11+ Freq.	11+ %
Press Farming											
Katondo	40	9	22.5	13	32.5	11	27.5	1	2.5	6	15.0
Kandaula	34	5	14.7	15	44.1	6	17.6	2	5.9	6	17.6
Mpale	40	6	15.0	21	52.5	6	15.0	2	5.0	5	12.5
ADMARC											
Kasikidzi	8	2	25.0	6	75.0	0	0	0	0	0	0
Bua	16	10	62.5	4	25.0	2	12.5	0	0	0	0
Chasato	6	6	100.0	0	0	0	0	0	0	0	0
Privately Owned											
Chilanga	30	4	13.3	21	70.0	5	16.7	0	0	0	0
Salala	20	8	40.0	3	15.0	2	10.0	7	35.0	0	0
Kamwankhuku	11	2	18.2	9	81.8	0	0	0	0	0	0
Lumbani	8	2	25.0	5	62.5	1	12.5	0	0	0	0
Sangwani	15	9	60.0	4	26.7	2	13.3	0	0	0	0
Mmanga I	25	10	40.0	10	40.0	4	16.0	1	4.0	0	0
Nkhonde	7	4	57.1	1	14.3	1	14.3	1	14.3	0	0
Msaleka	15	6	40.0	8	53.3	1	6.7	0	0	0	0
Tithe	6	5	83.3	1	16.7	0	0	0	0	0	0
Zuluma	9	1	11.1	7	77.8	1	11.1	0	0	0	0
Kanongo/Agra	40	2	5.0	11	27.5	9	22.5	3	7.5	15	37.5
Total	330	91	27.6	139	42.1	51	15.4	17	5.2	32	9.7

Table 3. Summary of form and duration of tenant contract and of major tenant and management grievances by estate (Kasungu Zone, July 1987).

Estate	Form of contract	Duration of contract	Major tenant grievances	Major management grievances
Press Farming Estates (3 at Santhe, Kasungu)	Oral	Runs for 1 year term; renewable if management is satisfied with tenant performance	Unfairness in the buying of their tobacco	Slowness in following technical advice
ADMARC Estates (3 in Kasungu)	Oral	" " "	" " "	Tenant mishandling of tobacco
Privately Owned				
Mmanga	Oral	" " "	Delays in having their cash payment made; money paid in installments	
Salala	Oral	" " "	No payment made over the job done in raising seedlings in nursery	High tenant turnover
Chilanga	Written	" " "	No land allocated for maize	Few are lazy and noncomplying
Tithe	Oral	" " "	Inadequate medical assistance	
Lumbani	Oral	" " "		High tenant turnover
Sangwani	Oral	" " "	No medical facilities	Low yields
Kazumulo	Oral	" " "		High tenant turnover
Mfiti idzafanso	Oral	" " "	No medical assistance	High tenant turnover
Nkusha	Oral	" " "	No medical assistance	High tenant turnover
Kanongo/Agra	Oral	" " "		

AN ECONOMIC EVALUATION OF SMALLHOLDER FARMING SYSTEMS IN CHINGULUWE SETTLEMENT SCHEME, MALAWI

Chimimba David Phiri

SUMMARY

Agriculture is the backbone of Malawi's economy. Ninety percent of the rural population depends on smallholder agriculture for survival. Agriculture's share of Malawi's gross domestic product was 36% in 1987 (having declined from 55% in 1964 and 46% in 1976). Agriculture contributed 88% of Malawi's total export earnings, although smallholder agriculture contributed only about 30%.

Malawi is divided into eight Agricultural Development Divisions. Salima division has remained the second poorest despite a long history of development projects in the area.

The Chinguluwe settlement scheme in Salima is noteworthy because it includes settlers as well as local farmers. The settlers include Malawi Young Pioneers (MYPs), blind settlers, and migrant settlers. It has been assumed that the MYPs and the blind settlers, who received agricultural training prior to entering the settlement scheme, would act as examples to other farmers within and outside the scheme.

This study compared the performance of the four groups of farmers in the settlement scheme -- MYPs, blind settlers, migrant settlers, and local farmers -- with respect to resource-use efficiency for the three main crops of the area: maize, cotton, and groundnuts. Gross margins per hectare of land were the primary tool used to compare farmer efficiency. The gross margins were calculated as the total value of the crop minus the costs of variable inputs.

The blind settlers and local farmers were significantly more efficient than the MYPs and migrant settlers in maize production. During the survey year, rainfall was poor. However, the extremely poor performance of MYPs and migrant settlers could not be attributed entirely to poor rainfall. The use of expensive fertilizer needed to produce the improved varieties of maize reduced the gross margins. Both MYPs and migrant settlers emphasized cotton production, thus, investment in cotton might have taken resources away from other crops.

In cotton production, the gross margins of MYPs, blind settlers, and local farmers were not significantly different. However, the migrant settlers had a significantly higher gross margin than the other three groups. The high gross margins of the migrant settlers could be attributed to good management and to the fact that they favored cash crops (cotton) over subsistence crops (maize).

In producing groundnuts, each of the groups of farmers differed in its resource-use efficiency. It was surprising that the difference among farmers was so large considering that groundnuts require few inputs. However, competition for labor between cotton and groundnuts may have contributed to the poor performances, especially of MYPs and migrant settlers; as with maize, the groundnut crop might have been neglected by these two groups to concentrate on cotton production.

Overall, the gross margins of the blind settlers, migrant settlers, and local farmers did not differ significantly; however, the gross margins of the MYPs were significantly lower than those of the other groups. There was also no significant difference between the performance all of the settlers combined and the local farmers, whether measured by gross margin per variable capital or the gross margins per worker day.

The actual performance in Chinguluwe scheme was compared to the Agricultural Development Division estimates for the entire project of Salima. The blind farmers, migrant settlers, and local farmers matched or exceeded the estimates for groundnuts and cotton. The MYPs were consistently below the estimates, especially for maize and groundnuts.

Although the MYPs had the lowest performance of any farmers in the settlement scheme and surrounding area, the myth that they were excellent farmers remained. This myth may have worked to their disadvantage, since it may have prevented them from implementing extension advice. MYPs could improve their efficiency if extension workers worked closely with them to ensure that recommended practices were implemented.

Rising fertilizer prices and the eroding profitability of improved maize meant that farmers in the scheme would have been better off abandoning improved maize varieties and concentrating on local maize for subsistence and cotton and groundnuts for cash. Labor released from improved maize production could relieve the labor constraint in cotton and groundnut production. The area released from improved maize production could have been allocated to cotton for MYPs and migrant settlers, to groundnuts for blind settlers, and to both cotton and groundnuts for local farmers.

In Malawi, 90% of the population lives in rural areas where smallholder agriculture is the main occupation. The government's stated objective is to develop the rural sector to improve the standard of living of rural people and to distribute social and economic benefits equitably between urban and rural areas (Malawi Government, 1971). Agricultural development has been considered the appropriate tool to meet this objective.

An examination of the national accounts shows the central role of agriculture in Malawi's economy. Eighty-eight percent of national export earnings in 1987 originated from agriculture. Agriculture contributed 36% of the GDP in 1987, having declined from 55% in 1964 and 46% in 1964 (Malawi Government, 1987). Agriculture employed the greatest proportion of wage earners in the economy: 46% in 1985. In addition, many smallholder farmers were self-employed. The share of wage employment in agriculture fell from 51% in 1983 to 43% in 1986 (Malawi Government, 1987). The high but declining share of agricultural GDP and wage employment indicates GDP growth and job creation in other sectors. Whereas agricultural employment increased by 6.5% from 1984 to 1985, increases were about 22% in manufacturing and distribution.

Agriculture in Malawi is practiced on estates and smallholdings. Estates specialize in export crops such as tobacco, tea, and sugar. Their products account for 70% of Malawi's total export earnings. Although smallholders form the largest proportion of the population, less than 30% of export earnings come from their products. Not all smallholder efforts are reflected in national export earnings since much what they produce is consumed locally; but their production levels and incomes have remained lower than anticipated.

Smallholders receive only a small proportion of the national income. In 1980, annual smallholder income was K 137 (US$ 91) compared with a national average of K 315 (US$ 209) (Malawi Government, 1984).

RURAL DEVELOPMENT PROGRAMS IN MALAWI

Although Malawi encouraged smallholder agriculture before independence in 1964, agricultural development policy was first clearly spelled out in 1968 within the context of an integrated rural development program supported by the World Bank. It was aimed at increasing agricultural production and rural incomes through the intensive and coordinated supply of improved extension services, credit, infrastructure, storage and marketing facilities, health

services, housing, and rural water, and by promoting irrigation and land improvement.

The program led Malawi to establish four major rural development projects that covered 24,000 sq km and 279,000 farm families (about 20% of the rural population). Effects of improved living standards were expected to "trickle down" to families in the project areas and surrounding areas. However, by 1976, only 30% of households had benefited directly from the project policies (Ghai and Radwan, 1983): Production levels remained lower than anticipated, and the trickle-down, if any, seemed insignificant (Phiri, 1984).

The Malawi Rural Development Program was followed in 1978 by the National Rural Development Program, which was expected to reach more producers more quickly by extending and consolidating various development programs across the entire country. The programs were to receive less-intensive staffing and infrastructure than the major projects.

These seemingly concentrated efforts at agricultural and rural development emphasized persuading farmers to adopt improved technologies designed at research stations. Little effort was made to understand the farming systems within which the new technologies would operate, nor was a mere reorganization of resources considered worth investigating. Recently, doubts and frustrations about the effectiveness of the "bring-new-technology-to-the-farmer" philosophy have compelled technical and social researchers to base the development of new technology upon knowledge of existing farming systems, including knowledge of resource organization and farmers' objectives (Phiri, 1985). Until a substantial amount of basic research has been conducted and the results published, planners are unlikely to know the effects their policy decisions will have on rural people.

CHINGULUWE: A DESCRIPTIVE AND ANALYTIC OVERVIEW

Of Malawi's eight agricultural development divisions (ADDs), the Salima ADD is the second poorest. The average farm household in the Salima division had an income of K 121 (US$ 81) in 1980. Although development programs have operated in Salima since 1968, the division still has seasonal food shortages and low incomes.

The Salima project, one of three projects in the ADD, has four extension planning areas (EPAs). One of these areas is Chinguluwe EPA, which covers

40,000 ha and (in the 1986-87 crop season) the 5,360 farm families, or about 27,000 individuals, who live there.

Chinguluwe's tropical climate is typical of Malawi, with unimodal rainfall averaging 1,000 mm to 1,100 mm annually (although only 611 mm fell in 1986-87). Most of the rain falls from November to April. Temperatures range from 11°C in July to well over 30°C in October and November.

Most of Chinguluwe's soils are sandy clay. However, patches of heavy clay and latosols cause serious drainage problems that make cultivation impossible in some areas of the scheme.

In the 1986-87 season, just over 5,000 ha were cultivated in Chinguluwe. Of these, 3,443 ha (nearly 65%) were planted with maize and 1,100 ha (nearly 21%) were planted with cotton. Other crops grown included groundnuts (617 ha), rice (29 ha), cassava (28 ha), sweet potatoes (20 ha), sorghum (14 ha), cowpeas (12 ha), and pigeon peas (2 ha).

Only about 67% of the households harvested enough grain for food in 1986-87; 27% had an inadequate amount of grain; 6% had no food at all. Poor rainfall contributed to food shortages in 1986-87, but Salima has a long history of food shortages.

Chinguluwe Settlement Scheme

Chinguluwe EPA contains a unique settlement scheme that was established as part of the integrated rural development program. It is a dryland settlement scheme set aside by the government for Malawi Young Pioneer (MYP) settlers, blind settlers, and migrant settlers (people from other parts of the country which do not have enough land to absorb population growth). Local farmers continued to live in the area around the scheme.

MYP settlers were selected from a group that had taken a leadership-training course organized by the Department of Youth and Malawi Young Pioneers that included agricultural training. They were expected to serve as "spearheads for progress" exemplifying better farming methods. The blind farmers were selected from candidates who had also received extensive agricultural training. The government provided the MYPs and blind settlers with basic household and farming requirements -- such as pots and pans, hoes, axes, etc. -- and initial capital upon joining the scheme. Blind settlers were also provided with a house. The migrant settlers were selected by a committee from applicants

whose landholdings were insufficient for family subsistence and cash crop production.

Before this study, no research had been undertaken to establish the extent to which MYPs and other settlers were better farmers than local farmers, and to identify possible areas of improvement. Consequently, no empirical data existed on the levels of resource utilization among different categories of farmers.

A field survey was conducted in 1986-87. Four enumerators, who lived in the scheme during the 4 months of the survey, administered a partly structured questionnaire to 112 farmers:

- 30 migrant settlers, randomly selected from the registry kept at the headquarters of the extension planning area
- 22 blind settlers; that is, all of the blind participants
- 30 MYPs, randomly selected from a pool of 100
- 30 members of a control group of local farmers, randomly selected from villages outside the scheme

Household Characteristics

Of the 112 respondents, 106 (95%) were male heads of household; 6 were female heads of household -- two MYPs and four local farmers. This was an interesting departure from the norm; 28% of households in Salima ADD and 29% in the country as a whole were headed by women (Malawi Government, 1984). This suggests that female heads of households were less likely to participate in a settlement scheme than their male counterparts, for reasons beyond the scope of this paper.

The average age of respondents was 45 years. Most of the settlers had some primary education: 97% of MYPs, 82% of blind settlers, and 83% of migrant settlers. Only about half of the local farmers had any primary education. Most of the settlers were literate: 93% of MYPs, 73% of blind settlers (farmer knew braille or wife was literate), and 70% of migrant settlers. Only one-third of the local farmers were literate.

All of the migrant and MYP respondents were married. Twenty of the 22 blind settlers were married. Of the 30 local farmers, 26 were married; the four

unmarried farmers were the female heads of household. Most of the marriages were monogamous; one MYP and two local farmers had two wives each.

All MYP respondents were married. Twenty of the 22 blind settlers were married. Normally blind male farmers were allowed to enter the scheme only if they were married to sighted wives, but in special circumstances, well-trained single blind settlers were allowed. All thirty migrant settlers were married. Of the 30 local farmers, 26 were married; the four unmarried farmers were the female household heads. Most of the marriages were monogamous; one MYP and two local farmers had two wives each.

Cropping Systems

The most popular crops grown in the Chinguluwe area were maize, cotton, and groundnuts. Sorghum, cassava, pumpkins, rice, groundbeans, sweet potatoes, cowpeas, millet, and bananas were also grown. All farmers grew maize, 97% grew cotton, and 91% grew groundnuts (see table 1). Maize was the staple food; cotton and groundnuts were the major cash crops. Cotton was grown exclusively for cash, but some groundnuts were retained by the households for subsistence. The fact that all other crops were grown by only a minority of households indicates a low level of diversification. Local farmers diversified more than settlers. The low incidence of diversification among the settlers could be due to the widespread attitude that settler agriculture is cash agriculture. It is well documented in economic and business literature that the more commercially oriented a firm is, the more it will concentrate on a few products.

A greater proportion of households produced cash crops (cotton and groundnuts) in the settlement scheme and the survey area in general than in Salima ADD as a whole.

Cropping Patterns

Virtually all settler households grew crops in pure stands. Two local farmers intercropped maize and cowpeas or pumpkins. Thus, mixed cropping was not important in the survey area. This finding contrasted sharply with the data collected in the 1980-81 National Sample Survey of Agriculture, which showed that 47% of the smallholders in Malawi and 15% in Salima ADD practiced mixed cropping (Malawi Government, 1984). (However, the land used for mixed cropped was only 16% of the total area under cultivation in Malawi and 15% of that in Salima division.) The high incidence of monoculture in the settlement scheme may have been due to the influence of the extension service, which encouraged farmers to grow pure stands.

Based on the amount of land allocated, cotton, maize, and groundnuts were the most important crops. Farmers allocated an average of 1.2 ha to maize, 1.4 ha to cotton, and 0.4 ha to groundnuts.

More farmers grew local varieties of maize than grew improved varieties, with blind settlers growing the smallest proportion of improved varieties. Local farmers allocated more land to improved maize varieties than blind settlers and migrant settlers, primarily because two local farmers grew the imported variety NSCM41 on a large scale. Farmers grew most of their maize for subsistence, and local varieties were preferred for consumption. Varieties such as NSCM, Bantam, and MH12 were grown for sale. The MYPs experimented more with the newer varieties, NSCM41 and Bantam. Only 2 MYPs grew MH12, a well-established hybrid maize variety. This might be explained by the eroding profitability of hybrid maize as a result of increasing fertilizer prices associated with the removal of fertilizer subsidies under the the World Bank Structural Adjustment Loan Program. Whereas local maize can be grown without fertilizer, MH12 requires heavy fertilization. Profits from hybrid maize were receding as fertilizer prices increased. Farmers were quick to react; they have abandoned MH12 in favor of more rewarding cash crops.

MYPs allocated more land to cotton (1.8 ha) than did migrant settlers. Local farmers allocated the least land to cotton. (The averages have been calculated based on the households that grew the crop.)

Farmers in Salima seem to have shifted from growing manipintar groundnuts, which they were historically advised to grow, to the new SAC58 variety. This shift is surprising as the two varieties have the same yield expectations and agronomic requirements.

Livestock Management Systems

Livestock was a small but important component of the farming system in Chinguluwe. Of the 112 respondents, 102 (91%) owned livestock. No significant difference in livestock ownership occurred between settlers and local farmers. A much lower proportion of livestock ownership was expected among blind settlers because of potential management problems; however, 82% of blind settlers owned livestock -- a smaller proportion than other groups of farmers, but not significantly so. Poultry was the most abundant form of livestock, although local farmers owned more goats than chickens.

The primary motive for people to join the settlement scheme was to engage in small-scale commercial agriculture. In Malawi, small-scale commercial agriculture has been associated with cash-crop production rather than food-crop or livestock production. Traditionally, livestock have been kept as a means of savings and sold in times of need for food, taxes, weddings, and school fees. Keeping livestock as a form of savings was more visible in the largely subsistence-sector of local farmers in Chinguluwe, as opposed to the more commercially-oriented settler community.

Most livestock-owning households used a free-range management system. High levels of labor and capital were required for intensive systems of livestock management and these inputs were scarce in Chinguluwe. It seemed imprudent to invest resources in intensive livestock systems, especially since only cattle were well incorporated into the farming system. Farmers who practiced intensive or semi-intensive livestock management systems said that the primary reason that they did so was to prevent the animals from eating other farmers' crops. Other households stated that they used intensive systems because of the lack of herd boys. Thus, while shortage of labor for indoor feeding prevented some farmers from using intensive management, the shortage of labor for herding caused others to use it.

MEASURING RESOURCE-USE EFFICIENCY: A REVIEW OF METHODS

The debate regarding the best method to measure farm performance and resource-use efficiency predates the subjects of farm management and agricultural economics as we know them today. Following the principles of production economics exemplified in the theory of the firm, maximizing profit has been regarded as the primary objective of the farm business. An entire discipline of farm business management has evolved. For example, Barnard and Nix (1979) said that the objective of farm management is to arrive at the particular output that gives greater profit than any other level of output. Similarly, Drucker (1968) said that management must always, in every decision and action, put economic performance first. Thus, the theory of the firm implies that a farm is performing well if it organizes its resources so it maximizes profit.

However, the assumption of perfect competition that is implicit in this approach has been criticized by many economists. They argue that, because knowledge about the future is imperfect, agricultural production decision-making takes place in an environment of uncertainty Dillon (1979) noted that this is especially true in underdeveloped agricultural systems where underdevelopment itself compounds

the uncertainty, regardless of whether the decision-maker is a subsistence farmer, landlord, commercial producer, technician, or politician. Economists argue that, in the face of risk and uncertainty, smallholder farmers consciously select crop combinations that facilitate sufficient food income for the family's needs. This situation was described by Simon (1955) and Cyert and March (1963) as "satisfying" and by Lipton (1968) as a "survival algorithm."

Farmers are willing to live with just enough risk and uncertainty to attain their sufficiency objective and deliberately avoid all higher risk and uncertainty levels. For example, the results of Farrington's empirical study in Malawi (1975) indicated that, because farmers could not predict whether the impending season would have good rainfall, they selected crop combinations that were likely to produce good returns in either a good or poor year.

Game theories and decision theories have been developed to explain decision-making under risk and uncertainty. However, the theories do not serve as complete expositions of decision-making unless combined with utility analysis as described by Von Neumann and Morgenstern (1955) and modified by Ramsey (Officer and Halter, 1968). Game theory, which assumes pure-risk situations in which a probability can be attached to a future outcome and active competition, is not applicable in farm decision-making. Decision theory is more appropriate because it assumes uncertain and passive opponents and farmers compete with nature -- an uncertain, passive opponent. Utility analysis states that it is necessary to determine people's utility curves before predicting the decisions they will reach. Decision theory combined with utility analysis is known as the household objectives approach.

Where the profit maximization and household objectives approaches have been applied to small-scale agriculture, the results have almost always been at odds with each other. Measures of farmer performance based on the profit maximization approach invariably lead to conclusions that small-scale farmers allocate resources inefficiently and that they are lazy and irrational decision-makers. Measures based on the household objectives approach lead to conclusions that farmers allocate resources efficiently according to their subjective judgement of future outcomes.

Whether or not uncertainty is incorporated into the analysis, the use of gross margins and linear programming (modified to Minimization of Total Absolute Deviation, taking uncertainty into consideration) is helpful in comparisons and farm modeling, especially in traditional agriculture.

The gross margin is calculated by subtracting the variable costs of the inputs from the total value of production. Although the gross margin is not an absolute measure of profitability (in the neoclassical economics sense), it remains the most satisfactory measure of resource efficiency available in small-scale agriculture because it is impossible to value and allocate fixed costs to each enterprise (Richards, 1978). In small-scale agriculture, the use of family and commercial labor, which do not have costs attached, suggests that gross margins need to be used instead of profit per se for means of comparison.

Linear programming is widely recognized as a method for developing a combination of farm enterprises that maximizes profits and is feasible with respect to linear fixed farm constraints. Research on the resource-use efficiency of Malawian smallholder production system has used either gross margin or linear programming.

Catt (1970) examined progressive farmers' model farms and demonstrated that the planning methods used by advisory officers were not enabling farmers to make full use of their resources. He found that land and capital were less limiting than labor on the farms.

Chirwa (1976) identified the major constraints in Malawi's development projects and determined that farmers opted for crops that were feasible given resource constraints. Farmers in the Salima project area, for example, opted for groundnuts rather than cotton. Although cotton gave higher returns than groundnuts, its demand on scarce labor made it unfeasible.

Makumba (1979) noted that, among the major factors affecting the levels of gross margins in South West Mzimba, cropping patterns, improved farm inputs, and farmers' personal characteristics were potential sources of progress in modernizing small-scale agriculture.

According to Shaba (1980), agricultural systems in Malawi combine a large number of farm activities in each household. The farmers' decision-making process concerning what crops to grow, how much to grow, and how to grow them is therefore complex. The cropping patterns found in agricultural systems in Malawi reflect farmers' attempts to evolve production systems with maximum utility.

GROSS MARGIN ANALYSIS

The value of the crop obtained per unit of land and per unit of labor used in the production process were compared for four groups of farmers in Chinguluwe.

Emphasis was on the value of the enterprises as opposed to the volume produced. Efficiency was defined as a relative measurement, rather than the neoclassical economics definition where marginal factor costs are equated with marginal revenue products. Gross margin analysis forms the basis of the comparisons. Since most households depended entirely on family labor, which was very difficult to measure accurately, family labor was not included in the calculation of gross margins per hectare. No distortions were expected because the family size for each farmer group was similar. However, when hired labor was used, it constituted a variable cost that had to be deducted from the gross value -- using hired labor implies a real out-of-pocket cost for the farmer. Farmer groups varied widely in use of hired labor.

The three most important crops, maize, cotton, and groundnuts were used in comparisons. In traditional agriculture, farmers normally divide their crops into food crops and cash crops. While cash crops are grown entirely for the market, food crops are grown for subsistence, with only the surplus being marketed. Other crops are grown for both subsistence and sale. In Salima, groundnuts and improved maize varieties belonged to this latter category. A portion of groundnuts is reserved for subsistence while the remainder is sold. Improved maize is primarily a cash crop in many parts of Malawi, but it serves dual purposes in food-deficient Salima. It is a cash crop when local maize yields are sufficient for subsistence needs and a food crop when the local maize yields are inadequate.

Comparisons in this study were made on the basis of total yield. Because only a portion of the entire harvest entered the market, valuing the crops based on marketed yield could grossly underestimate the returns to individual resources. Also, it was never known in advance what hectarage of food crops would constitute marketed surplus, thus it became methodologically impossible to compare resource-use efficiency based only on the marketed crop.

Gross Output

Migrant settlers obtained higher overall gross output per hectare than the MYPs, blind settlers, or local farmers (see table 2). With an average yield valued at K 350 per hectare for maize, cotton, and groundnuts, migrant settlers were at least K 65 per hectare above the local farmers who had an average yield of K 285 per hectare. MYPs had the lowest yields at K 227 per hectare. When the three crops were considered separately, local farmers obtained the highest yield (though only marginally above MYPs) from maize, migrant settlers from cotton, and blind settlers from groundnuts.

When only marketed output was considered, maize did not enter the picture because virtually no maize was sold by sampled households. Only one farmer -- a migrant settler -- sold any maize (1,800 kg) to the marketing parastatal, the Agricultural Development and Marketing Corporation (ADMARC) in the 1986-87 season. Thus, in 1987, maize was not a cash crop. All cotton output was sold to ADMARC; thus, gross output was equal to gross marketed output. Part of the groundnut harvest was retained by households for family use. MYPs sold 79% of their groundnut harvests, blind settlers 95%, and migrant settlers 90%. No local farmer sold any groundnuts, perhaps because traditionally groundnuts are grown for subsistence.

Migrant settlers had the highest marketed output (K 208 per hectare), local farmers had the lowest marketed output (K 132 per hectare). However, gross output does not indicate efficiency because costs are ignored. Therefore, gross margins were used to compare efficiency among farmer categories.

Maize

When costs were taken into consideration, the net output (gross margin per hectare) was so greatly reduced that gross output figures were rendered almost meaningless. Farmers did well with local varieties of maize with gross margins of K 69 per hectare for MYPs, K 84 per hectare for blind settlers, K 77 per hectare for migrant settlers, and K 101 per hectare for local farmers. They did poorly with composite varieties, although they managed to recover their costs, with gross margins of K 17 per hectare for MYPs, K 62 per hectare for blind settlers, K 18 per hectare for migrant settlers, and K 56 per hectare for local farmers. However, most did catastrophically with hybrid maize. The gross margins were K -4 per hectare for MYPs, K -138 per hectare for migrant settlers, and K 55 per hectare for local farmers (see table 3). Blind settlers did not grow any hybrid maize.

The large differences in gross margins can be explained in part by varieties' differing fertilizer requirements. Local varieties did not require fertilizer. The World Bank-sponsored Structural Adjustment Program was phasing out fertilizer subsidies and fertilizer prices were rising. In the 1986-87 season, fertilizer costs were K 141 per hectare for composite and K 162 per hectare for hybrid maize. Improved varieties, of course, had higher yields, but maize prices were lagging behind the pace of subsidy removal, so net returns were low. The low and negative gross margins could be attributable to the negative returns from hybrid maize.

In addition to heavy fertilizer costs, the 1986-87 growing season had unusually low rainfall and, therefore, the response of hybrid maize to fertilizer was disappointing. Optimal moisture conditions must prevail for maximum response.

Thus, it seems that the fertilizer used by MYPs and migrant settlers was wasted. Local farmers used appreciably less fertilizer and so prevented losses due to low rainfall.

MYPs and migrant settlers planted a larger area with cotton than either blind settlers or local farmers. Their concentration on managing cotton fields may have adversely affected their management of other crops, including maize.

With respect to gross margins per unit of variable capital, MYPs, migrant settlers, and local farmers had zero returns. Blind settlers had a return of just over K 1 per hectare.

The high variable costs incurred by MYPs and migrant settlers reduced their gross margins (see table 4). Blind settlers emerged as the best maize producers, followed by local farmers.

Cotton

Cotton was the most important cash crop for all farmers. Salima has an ideal climate for producing cotton with soils of low to medium fertility, low rainfall, and a hot dry season. Ninety-seven percent of all farmers in Salima grew cotton, including all of the MYPs, blind settlers, and local farmers.

Farmers did not use fertilizer on cotton because they believed that it might cause excessive vegetative growth and prevent good boll formation. Gross margins could be high in a season with low rainfall and low incidence of pests. Pests were the biggest menace to cotton production, so all farmers bought pesticides and sprayers which were provided on credit. Variable costs for cotton were much lower than for maize.

Gross margins for migrant settlers were much higher than for the other three groups (see table 5). Gross margins among MYPs, blind settlers, and local farmers were not significantly different from each other, but they were all significantly lower than those of migrant settlers. Total variable costs were not different among farmer categories so differences were due to gross output.

Migrant settlers' significantly higher gross margins made their return to variable capital significantly higher. Gross margins per kwacha were about K 4 for MYPs and blind settlers, K 7 for migrant settlers, and K 5 for local farmers. Thus, migrant settlers were more efficient than other farmers in their use of land and capital for cotton production.

The performance of MYPs and blind settlers was disappointing because both had received intensive agricultural training before joining the scheme. MYPs, in particular, were expected to excel in cotton production since they had the most training.

Groundnuts

Data on groundnuts production was disaggregated by variety. Three varieties were produced: manipintar (an oil nut), SAC58 (an oil nut), and chalimbana (a confectionery nut). Only one farmer, an MYP, grew chalimbana, which is not surprising because extension workers recommended the production of oil nuts which could be sold to ADMARC unshelled. The rationale seems to have been that cotton competed with groundnuts for labor since shelling is a labor-intensive exercise. Thus, cotton growers were well advised to grow manipintar and SAC58.

For manipintar groundnuts, blind settlers had a significantly higher gross margin than local farmers, followed by migrant settlers and MYPs (see table 6). Blind settlers also had a higher return to variable capital than other farmers, but the difference was not statistically significant.

Blind settlers also performed well with SAC58, but local farmers had a higher, but not significantly higher, gross margin (see table 7). The gross margins of MYPs and migrant settlers were not significantly different. However, the gross margins of blind settlers and local farmers were significantly higher than those of MYPs and migrant settlers. There does not appear to be a satisfactory explanation for the blind settlers' poor performance with SAC58, since they performed well with manipintar and management regimes for the varieties are the same.

SAC58 had appreciably lower gross margins than manipintar, even though a Salima ADD working paper indicated that similar yields were expected from the two varieties. SAC58 was a new variety in the area and farmers' lack of experience with it might partly explain the yield difference. But this does not explain why local farmers performed better than other farmers, especially as variable costs were similar across farmer categories.

Gross margins per kwacha for SAC58 were also lower than for manipintar. The gross margins of blind settlers and local farmers were not different from each other, but they were significantly higher than those of MYPs and migrant settlers.

The farmer who grew chalimbana had a gross margin of K 204 per hectare and a gross margin per kwacha of K 51 (see table 8).

Summary of Returns to Land

No group of farmers excelled in all crops simultaneously. When the gross margins per hectare were considered, migrant settlers performed best, but their performance was not significantly different from that of blind settlers or local farmers (see table 9). When each of the means of the blind settlers, local farmers, and migrant settlers was compared to that of MYPs, the difference was significant in each case. This implies that the performance of MYPs was significantly lower than that of every other group.

Summary of Returns to Variable Capital

Returns to capital were difficult to measure since land was under public control: No monetary value was attached to it so there was no basis for attaching any particular price to land. Rental fees for nearby private estates could not be used as a proxy as they were heavily subsidized. In any case, there was no land market, so there was no reason to regard land as priced capital.

Except for blind settlers, farmers built their own houses, using family labor and locally obtained materials. Neither the house nor the labor and the materials could be adequately priced.

Since those fixed items could not be evaluated satisfactorily, gross margins per unit of variable capital were compared. Because fixed capital costs were not included, performance was probably biased upward; however, since the system was applied equally across farmer groups, any distortions should be minimal, at least for the sake of comparison.

While gross margins per kwacha for maize were extremely low, they were often high for groundnuts. The major reason for the difference was the lower input requirement for groundnuts. In spite of the high gross yields obtainable from groundnuts, farmers could not concentrate capital or labor on them. Because maize was produced primarily for subsistence, farmers continued to produce it despite its relatively low gross margins. This implies that where food security is a prime objective, farmers may be less sensitive to returns to inputs.

The conclusion for returns to variable capital was the same as that for returns to land. There were no differences in performance per variable capital for blind settlers, local farmers, and migrant settlers; but each of these groups performed significantly better than MYPs (see table 10).

Returns to Labor

Like capital, labor is notoriously difficult to measure in subsistence economies. In Chinguluwe, no records were kept; however, an attempt was made to calculate worker hours for each activity based on farmers' own estimates and enumerators' periodic observations.

For gross margins per worker day, there are striking differences in the performance of farmer groups among crops and varieties. As in the case of land-use efficiency and variable-capital-use efficiency, there were no significant differences among blind settlers, local farmers, and migrant settlers, but MYPs performed significantly worse than the others (see table 11).

MYPs were the only farmers who did not earn more (calculated as overall gross margin per worker day) than the official rural wage of K 1 a day. There was no significant difference between the earnings of all other farmer groups and the official wage rate. Thus, smallholder farming did not pay better than rural wage employment.

ACTUAL vs EXPECTED PERFORMANCE

The actual performance of farmers in Chinguluwe was compared with that of farmers unaffected by the scheme. A linear programming theoretical model construct could be useful in this exercise. In the absence of such a model, actual data was compared to data on expected performances for Salima ADD that was calculated in an evaluation study (Salima ADD, 1986).

In producing local maize each of the farmer groups performed significantly below ADD estimates (see table 12). Local farmers in Chinguluwe performed better than settlers in the scheme, but even they performed worse than ADD estimates. Low rainfall might partly explain the difference, since the estimates were based on normal rainfall. However, it is not likely that MYPs with a gross margin of only K 69.05 per hectare and migrant settlers with a gross margin of only K 76.66 per hectare could have approached the estimated production, even in a year with better rainfall.

In producing composite varieties of maize, blind settlers performance was slightly above the estimate at K 61.85 per hectare, and local farmers performed near to the estimate at K 56.11 per hectare. However, the MYPs and migrant settlers performed far below expectations, which suggests that they were inefficient in growing composite maize as well.

All farmer groups had much lower than anticipated yields for hybrid maize. Although their large investments in fertilizer were unrewarded due to the low rainfall, the negative gross margins for MYPs and migrant settlers were extraordinary. Local farmers received K 55.28 per hectare in the same micro-environment. The MYPs and migrant settlers did not produce hybrid maize efficiently, perhaps because they were lax in following extension advice for maize and concentrated on other crops.

Generally, all farmer groups performed well in cotton production. In fact, migrant settlers performed much better than the expectations: Their gross margin of K 471.27 per hectare was nearly double the estimate. Perhaps it was because they concentrated on cotton that they performed so poorly with maize. The other farmers performed close to the estimate.

Blind settlers performed much better than the estimate in producing manipintar groundnuts, as did local farmers. Migrant settlers were slightly above the estimate; MYPs were slightly below the estimate.

In producing SAC58 groundnuts, MYPs and migrant settlers fell significantly below the estimate while other farmers performed near the estimate. The explanation for this is problematic. One can not blame the season in a case where other groups performed well. The fact that SAC58 was a new crop and farmers did not know how to manage it can be disregarded for the same reason. The migrant settlers may have performed poorly in producing some crops because they concentrated on cotton. However, the MYPs produced below the estimates in all crops, including cotton.

MYPs performed below the expectations, especially in maize and groundnut production, despite agricultural training prior to joining the scheme and constant extension advice. Perhaps because they received training they may have developed the attitude that they could disregard extension worker's advice. MYPs seemed to receive adequate advice, but it is questionable whether that advice was utilized. Extension workers may also have assumed that the MYPs were excellent farmers. The extension workers should follow-up extensively with the MYPs to ensure that the recommended procedures are followed.

CONCLUSION AND RECOMMENDATIONS

The resource-use efficiency of the farmer groups differed among varieties and among crops. However, at an aggregate level, the performances of the blind settlers, migrant settlers, and local farmers were not significantly different.

Though the MYPs were widely believed to be excellent farmers, their performance was significantly worse than that of the other groups. The efficiency of the MYPs could be improved if they followed the advice of the extension service more closely.

Generally, the rising fertilizer prices and eroding profitability of improved maize indicated that farmers in the scheme should have grown only enough local maize for subsistence and allocated the land used for composites and hybrids to cotton and groundnuts. In doing this, they would have also released the labor inefficiently used on improved maize for cotton and groundnut production. The extra area released from improved maize varieties could be allocated to cotton for MYPs and migrant settlers, to groundnuts for blind settlers, and to both cotton and groundnuts for local farmers.

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Table 1. Crops grown by households in Chinguluwe settlement scheme, Malawi, 1986-87.

Crop	MYPs		Blind settlers		Migrant settlers		Local farmers		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Maize	30	100.0	22	100.0	30	100.0	30	100.0	112	100.0
Cotton	30	100.0	22	100.0	27	90.0	30	100.0	109	97.3
Groundnuts	30	100.0	21	95.5	27	90.0	24	80.0	102	91.1
Cassava	20	66.7	2	9.1	9	30.0	3	10.0	34	30.4
Sorghum	1	3.3	1	4.5	4	13.3	2	6.7	8	7.1
Pumpkins	8	26.7	0	0.0	3	10.0	15	50.0	26	23.2
Groundbeans	1	3.3	0	0.0	2	6.7	5	16.7	8	7.1
Cow peas	1	3.3	0	0.0	3	10.0	4	13.3	8	7.1
Sweet potatoes	9	20.0	1	4.5	4	13.3	10	33.3	24	21.4
Millet	0	0.0	0	0.0	0	0.0	1	3.3	1	0.1
Rice	1	3.3	0	0.0	0	0.0	0	0.0	1	0.1
Bananas	1	3.3	0	0.0	0	0.0	0	0.0	1	0.1

Table 2. Average gross output by major crop and farmer group in kwacha per hectare, Chinguluwe settlement scheme, Malawi, 1986-87.

Crop	MYPs	Blind settlers	Migrant settlers	Local farmers
Maize	204	130	177	205
Cotton	320	323	543	347
Groundnuts	225	375	261	333
All	227	247	350	285

Table 3. Average gross margins for maize by variety and farmer group in kwacha per hectare, Chinguluwe settlement scheme, Malawi, 1986-87.

Variety	MYPs	Blind settlers	Migrant settlers	Local farmers
Local	69.05	84.47	76.66	101.04
Composite[a]	17.00	61.85	18.31	56.11
Hybrid[b]	-98.28		-137.93	55.23
All maize	-4.08	73.16	-14.32	70.81

[a]Ukiriguru composite A.
[b]National Seed Company of Malawi (NSCM41) and Malawi Hybrid (MH12).

Table 4. Calculation of gross margins for maize by farmer group in kwacha per hectare, Chinguluwe settlement scheme, Malawi, 1986-87.

	MYPs	Blind settlers	Migrant settlers	Local farmers
Value of gross output	204.42	130.0	176.85	204.70
Variable costs:				
Fertilizer[a]	162.73	37.59	143.13	107.28
Seed	10.00	1.70	9.50	6.21
Transport	8.00	2.50	6.40	4.57
Credit charge[b]	16.27	3.76	14.31	10.72
Hired labor	3.50	5.91	9.33	2.67
Miscellaneous	8.00	5.38	8.50	2.44
Gross margin	-4.08	73.16	-14.32	70.81

[a]MYPs and migrant settlers used recommended rates of fertilizer for composites and hybrids. Local farmers and blind settlers used less-than-recommended rates for composites and hybrids.
[b]All farmers obtained fertilizer on credit from the Agricultural Development and Marketing Corporation; a 10% credit charge was levied.

Table 5. Average gross margins for cotton by farmer group in kwacha per hectare, Chinguluwe settlement scheme, Malawi, 1986-87.

	MYPs	Blind settlers	Migrant settlers	Local farmers
Gross output	320	323	543	347
Variable costs:				
Insecticides[a]	43	41	46	41
Sprayer	13	13	13	13
Transport	4	4	5	3
Hired labor	5	8	6	4
Miscellaneous	2	3	2	1
Gross margin	254	255	471	286

Note: Seed was provided free by the Agricultural Development and Marketing Corporation.
[a]Includes 10% interest charge on loan to purchase insecticide.

Table 6. Average gross margins for manipintar variety of groundnuts by farmer group in kwacha per hectare, Chinguluwe settlement scheme, Malawi, 1986-87.

	MYPs	Blind settlers	Migrant settlers	Local farmers
Gross output	251	462	283	338
Variable costs:				
Transport	4	7	3	5
Miscellaneous	1	1	2	1
Gross margin	246	454	278	332

Note: Farmers used seed stored from the previous season. No farmer used hired labor to produce or market groundnuts.

Table 7. Average gross margins for SAC58 variety of groundnuts by farmer group in kwacha per hectare, Chinguluwe settlement scheme, Malawi, 1986-87.

	MYPs	Blind settlers	Migrant settlers	Local farmers
Gross output	217	289	239	327
Variable costs:				
Seed[a]	42	42	42	42
Transport	6	10	7	8
Miscellaneous	1	1	4	1
Gross margin	167	236	187	276

Note: Hired labor was not used.
[a]Includes seed obtained on loan and 10% interest charge.

Table 8. Summary of average gross margins per hectare for groundnuts by variety and farmer group in kwacha per hectare, Chinguluwe settlement scheme, Malawi, 1986-87.

Variety	MYPs	Blind settlers	Migrant settlers	Local farmers
Manipintar	246	454	278	332
SAC58	167	236	187	276
Chalimbana	204			
All	206	345	233	304

Table 9. Overall gross margins by crop and farmer group in kwacha per hectare, Chinguluwe settlement scheme, Malawi, 1986-87.

Crop	MYPs	Blind settlers	Migrant settlers	Local settlers
Maize	-4	73	-14	71
Cotton	254	255	471	286
Groundnuts	206	345	232	304
All	152	224	230	220

Table 10. Overall gross margins per variable capital, by crop and farmer group in kwacha per hectare, Chinguluwe settlement scheme, Malawi, 1986-87.

Crop	MYPs	Blind settlers	Migrant settlers	Local settlers
Maize	0	1	0	1
Cotton	4	4	7	5
Groundnuts	27	31	27	30
All	10	12	11	12

Table 11. Gross margins per hectare by crop and variety in kwacha per worker day, Chinguluwe settlement scheme, Malawi, 1986-87.

Crop	MYPs	Blind settlers	Migrant settlers	Local farmers
Maize	-0.03	0.56	-0.11	0.54
Local	0.63	0.77	0.70	0.92
Composite	0.13	0.48	0.14	0.43
Hybrid	-0.66		-0.92	0.37
Cotton	1.27	1.28	2.36	1.43
Groundnuts	0.91	1.53	1.03	1.35
Manipintar	1.09	2.02	1.24	1.48
SAC58	0.74	1.05	0.83	1.23
Chalimbana	0.91			
All 0.72	1.12	1.09	1.11	

Table 12. Indicative gross margins and returns to labor for Salima Agricultural Development Division, 1986-87.

Crop/variety	Gross margin (K/ha)	Gross margin (K/worker)
Local maize	132.48	1.20
Composite maize	56.17	0.43
Hybrid maize	138.03	0.92
Cotton	278.56	1.39
Manipintar groundnuts	268.40	1.34
SAC58 groundnuts	264.55	1.32
Chalimbana groundnuts	370.35	1.65

Source: Salima ADD, 1986.

FARM ENTERPRISE COMBINATION AND RESOURCE USE AMONG SMALLHOLDER FARMERS IN IJEBU, NIGERIA

A. A. Adesimi

SUMMARY

Policy makers need a better understanding of the technical and managerial constraints facing smallholder farmers if they are to achieve the crucial objective of increasing the production and sales of staple food crops in Nigeria. Toward this end, survey information was obtained over the course of the 1987 crop year from a total of 60 smallholder farmers who were randomly selected from 4 villages in Ijebu North Local Government Area of Ogun State, Nigeria.

All of the farmers surveyed were married men with children. Most were over the age of 50 and had little or no formal schooling. Farmers relied on traditional tools and cropping practices to produce subsistence food crops on farms which ranged from 0.1 ha to 4.0 ha in size, with a mean farm size of 1.5 ha. Farming practices did not include the use of hired labor, borrowed capital, or mechanized farm equipment.

Farmland cultivated during the study period was devoted to 10 different combinations of 5 staple food crops: cassava, maize, melon, yam, and cocoyam. About 69% of the cropland was intercropped, while the remainder was devoted to segregated stands of cassava or maize. Maize, cassava, or both were planted solely or in combination with other crops on all but 4% of the land cultivated.

A budgetary analysis of per-hectare crop yields, costs, and revenues reveals that enterprises which included melon, yam, or both, required the highest fixed and variable cost outlays and provided the highest gross returns and gross margins. Conversely, whether intercropped or grown in segregated stands, maize and cassava required the lowest-cost outlays and provided the lowest gross returns, per hectare. The lowest gross and net returns per hectare resulted from the sole cropping of maize. The fact that farmers did not devote proportionately more of their land to the crops that resulted in the highest per-hectare profits suggests that other considerations, such as food security and the availability and cost of inputs, play a significant role in production decisions.

Linear programming results suggest that one of the most critical constraints to increased farm production is a seasonal shortage of farm labor. Such shortages could be averted by programs which enable smallholder farmers to hire seasonal workers or which facilitate the adoption of labor-saving technologies.

Current farm policy encouraging farmers to adopt sole-cropping practices appears to be misdirected. This study's survey results and budgetary and linear programming analyses add to the growing body of evidence that suggests the intercropping of subsistence food crops is more profitable, efficient, and practical than the cultivation of food crops in segregated stands. It follows that agricultural research should be refocused to center on improving the efficiency and output of mixed cropping practices.

Finally, least-squares analysis of smallholder farmers' allocation of crop output between home consumption and market sales reveals that household income and product prices are key policy variables that could be used to elicit an increased marketed surplus of staple food crops.

Annual food shortages have grown dramatically in Nigeria over the last 20 years. The food crisis has intensified even though most of the nation's land and labor force is employed in the agricultural sector. To meet the shortfall between domestic production and demand, the government has imported massive quantities of food, the cost of which the Central Bank of Nigeria (1974, 1976, 1981) estimated to be ₦ 57.7 million (57.7 million naira) in 1970, ₦ 126.3 million in 1973, ₦ 441.7 million in 1976, and ₦ 1,105.3 million in 1979; a nominal increase of 1,816% in 9 years. The food import bill continued to rise rapidly until the end of 1985, when the government imposed drastic restrictions on food imports to check the rapid drain on foreign reserves and arrest the mounting burden of foreign debt.

Many regard the Nigerian food problem as a paradoxical situation because Nigeria appears to have the human and physical resources necessary to provide ample food and fiber for its domestic population and the export market. For example, referring to human resources, Johnson, Scoville, Dike, and Eicher (1969, p.1) observe that the thousands of Nigerian smallholder farmers can be relied upon as a driving force for the transformation of Nigeria's agriculture because they are willing to accept new crops and management practices, and are responsive to price and income incentives. Similarly, the Third National

Development Plan, 1975-1980 (Federal Republic of Nigeria, 1975, p.63), indicates that of the 71.2 million ha of cultivable land in Nigeria, only 34 million ha (47.7%) were under cultivation. If these human and land resources were fully used, it follows that the agricultural sector could be the major source of growth and stability for the economy as a whole.

THE NEED FOR SMALLHOLDER FARM RESEARCH

The Nigerian government has not relented in its efforts to embark on a bold program of agricultural transformation. Under the current Structural Adjustment Program, government policy is to develop the agricultural sector as quickly as possible so that it can (1) feed the rapidly growing population without the need for massive food imports, (2) provide raw materials for industrial production, (3) diversify the economic base, (4) increase non-oil exports, and (5) reduce Nigeria's dependence on oil exports for foreign exchange.

The government has rightly focused its current agricultural development policy on smallholder farmers. Priority must be given to smallholder farmers because they constitute about 95% of farming households in Nigeria and produce most of the food crops consumed in the country. Although medium-scale and large-scale holdings are gradually emerging, Nigeria will continue to depend largely on smallholder farmers for its food supply and economic stability for many years to come.

To achieve its policy objectives, the government must obtain technical and managerial knowledge of food-crop production at the farm level -- both to understand why past efforts have had little effect on individual farm operations and output and to plan well for the future.

Toward this end, this paper examines the farm organization and decision-making of smallholder farmers. In particular, 1987 survey results of farmers' (1) household characteristics, (2) farm management concerns and techniques, (3) use of inputs, (4) planted hectarage, (5) yields, (6) income, and (7) subsistence requirements are used to

- analyze enterprise yields, costs, and returns using budgetary techniques

- specify linear programming models to determine the optimal enterprise mix under alternative household goal assumptions

- estimate the price and income elasticities of home consumption and market sales of subsistence crops

- determine policy implications

Linear Programming and Optimal Enterprise Combinations

Farm-level input-output studies are of recent origin in Nigeria. Research which has been conducted, however, supports the use of linear programming techniques to determine optimal enterprise combinations and suggests that mixed cropping practices tend to be preferable to sole-cropping practices in smallholder farming. Benchmark information provided by the pioneer studies of Norman (1973) clearly reveals the relative merit of mixed cropping as compared with sole cropping in smallholder farming systems. Experience gained in conducting these pioneer studies also led Norman to write effectively about the methodology and problems of farm management investigations (1973b). Studies by Spencer (1977) and Zuckerman (1979) suggested ways to handle methodological issues such as survey methods, sample selection, enumerator selection and training, and input-output measurements.

Desai (1962) demonstrated the advantage of using linear programming techniques over marginal analysis by applying both techniques to data collected through farm-management inquiry in Bombay. Using land and capital as the two resource constraints, marginal analysis suggested that the sorghum crop yielded the highest farm income from among the alternative enterprises. The linear programming technique, however, revealed that a higher farm income could be generated by growing a particular combination of crops.

Olayide and Olowude (1972) used linear programming techniques to examine crop and livestock production possibilities in the savannah belt of Oyo State in Nigeria. Farm products considered in the analysis include maize, rice, tobacco, cotton, kenaf, cassava, yams, peas, beans, melons, other vegetables, beef, poultry, and pigs. The aim was to develop standard, enterprise combination levels that would maximize a farm's net income given a minimum tobacco-hectarage allotment and assumed soil and climatic restrictions. The linear-programming result shows that the farmer could profitably produce a combination of laying hens, early maize, rice, and cassava, with a sufficient amount of labor time remaining to devote to other enterprises, such as yams, cowpeas, or other supplementary crops. Under the assumptions of the study, the optimal combinations of enterprises yielded net farm incomes between ₦ 1,087 and ₦ 1,649.

Using linear programming techniques, Ogunfowora and Norman (1973) found that the scarcity of financial resources on traditional farms also tends to support the practice of mixed cropping. According to their findings, sole cropping using modern technologies should be encouraged only if the required, additional financial resources are provided.

Norman (1973a) also shows that, in Northern Nigeria, mixed cropping is a more rational and profitable choice than sole cropping. His study found this to be true for traditional agricultural systems as well as for experimental production systems that use improved practices. Mixed cropping reduces the risk inherent in traditional production systems, permits greater flexibility in labor use, economizes on the use of land and labor resources, and provides less variability in annual returns compared with sole cropping.

Based on their findings, Osuji and Olayemi (1978) assert that the system of mixed cropping in traditional agriculture has stood the test of time and has, over the years, guaranteed a subsistence to the farm household. Finally, in a recent study, Okuneye (1985) found that the intercropping of maize with yams was 60% more profitable than the sole cropping of local rice -- despite government efforts to encourage domestic rice production as a substitute for rice imports.

Smallholder Responsiveness to Price and Income Changes

Information on farmers' responsiveness to price and income changes is crucial in determining optimal farm policy. In particular, it is important to be able to predict how farm output will change with changes in agricultural prices and income, and how farmers will allocate any surplus production between household consumption, market sales, and other distributions.

Useful insights are found in studies by Bardhan (1970), Haessel (1975), and Adesimi and Awoyomi (1983). Each uses multiple regression analysis to specify models that postulate how the subsistence farmer allocates total food crop production between household consumption, market sales, and other end uses. In these studies, it is hypothesized that consumption is determined by the price of the food crop, total household income, and household size. Marketable surplus is postulated to be a residual, influenced by crop price, household income, household size, and the quantity of food crops available after necessary allocations to other end uses. Using two-stage least squares estimation procedures, the relevant equations are estimated and price and income elasticities with respect to consumption and marketed surplus are derived. Although the studies obtain different estimates of the relevant parameters, they all show the surveyed farmers to be price and income responsive in deciding how to allocate their output between household consumption and market sales.

DATA COLLECTION AND PRELIMINARY ANALYSIS

Survey information was obtained from Ijebu North Local Government Area (LGA) of Ogun State, from April through December of 1987. This particular sample area was chosen because of its unique importance in the food-crops economy of the old Ijebu Province. It is often called the food basket of Ijebu Province.

Four villages were randomly selected from a list of villages in the LGA. Ten percent of the farm households from each of the four villages were randomly selected for study, resulting in a total sample size of 60 farm households: 20 from Oke-Arowa, 15 from Aredi, 13 from Oru, and 12 from Ilaporu.

It is unusual for smallholder farmers to keep written farm records. Therefore, data was collected from the selected households through a series of structured, pretested questionnaires, which were personally administered over multiple visits during the course of the growing season.

Two major problems were encountered during the field work. The most critical was the disruption of farming activities due to the unusually late commencement and irregular pattern of rainfall. Several farmers had to plant their crops two or three times due to the bad weather. Consequently, harvested output and data collection concerning planting operations were adversely affected. Seed and labor inputs for plantings that resulted in crop failure were disregarded; only those inputs that contributed to crop successes were considered in the computation of input costs.

The second problem was that some farmers had not harvested all their 1987 cassava crop by the end of the study period. In these instances, cassava output was estimated on a pro-rata basis.

Household Characteristics

Many agricultural analysts have expressed great concern over the existing age structure of Nigeria's farmers. The average age of the farm population is increasing due to the scarcity of young people interested in farming. Survey results support the claim that the average age of smallholder farmers is increasing. Seventy-five percent of the farmers surveyed were over 50 years old, only 5% were less than 41 years old, and none were less than 31 years of age.

Most of the farmers surveyed were not literate. Fully 60% had received no formal education, 15% had received up to 3 years of formal schooling, 22% had acquired 4 to 6 years of formal schooling, and 3% had received 10 or 11 years of formal schooling.

All farmers surveyed were men, and all were married and had children. Most of the field work was done by the men. Although 53% of the farmers received some farming assistance from their wives, only 30% received such help from their male children and only 10% received help from their female children. Women assisted primarily with harvesting operations, although some women assisted their husbands with processing, weeding, and, more rarely, planting operations. Male children helped with planting, weeding, and(or) harvesting, and female children helped only with harvesting.

Farm Management

All farms studied were between 0.1 ha and 4.0 ha in size. The mean farm size was 1.5 ha, with most farms being from 1 ha to 2.5 ha in size. Approximately 19% of the farms consisted of single plots. The remaining 83% of the farms were divided into two, three, or four plots; the mode was two.

Farmland cultivated during the study period was devoted to 10 different combinations of 5 staple food crops: cassava, maize, melon, yam, and cocoyam (see table 1). About 69% of the total cultivated land area was devoted to mixed plantings and the remainder was devoted to segregated plantings of cassava or maize. Maize, cassava, or both, were planted solely or in combination with other crops on all but 4% of the cropland cultivated. Of the land devoted to mixed cropping, 54% was planted to combinations of two crops, such as cassava and maize, and the remainder was planted to combinations of three crops, such as cassava, melon, and maize.

Farmers gave several reasons for intercropping. The most commonly cited reason, given by over half of the farmers, was that it reduced labor and operating costs. A third of the farmers mentioned that intercropping provided security against crop failure. Other reasons given were that intercropping was in accordance with tradition and helped to prevent soil erosion.

Risks inherent in farming were readily identified by the farmers. Every farmer named drought and fire as serious farming risks. Over half of the farmers also mentioned the risk of snake bites, personal accidents, and crop destruction by animals, and a third of the farmers mentioned crop destruction by rodents and insects. All risks cited involved injury to either crops or farmers. Management techniques for these types of risks were given as (1) prayer, in the case of fire and drought, (2) carefulness and native medicine, in the case of personal injuries, (3) perimeter fencing and traps, in the case of crop destruction by animals, and (4) rat poison and insecticide use, in the case of rodents and pests.

A characteristic feature of traditional agriculture is its low level of technology, as manifested by the set of farming implements used by farmers. On average, surveyed farming households had 4.3 cutlasses, 2.1 hoes, 0.3 shovels, 2.7 knives, 1 axe, 5.4 sacks, 4.9 baskets, and 0.4 headpans. The average life span of each of these items is relatively short -- between 1 and 5 years. No mechanized farm equipment was in use. This set of farming implements underscores the fact that, among farmers sampled, agriculture is anchored largely on traditional and conventional inputs, most of which have not been improved for decades.

BUDGETARY ANALYSIS OF FARM ENTERPRISES

Crop yield, cost, and revenue figures were obtained from farmer surveys (see table 2). Per hectare, the cassava/melon crop enterprise yielded the highest gross revenue, gross margin, and net revenue. The second highest net revenue per hectare was obtained from cassava/cocoyam/maize, which ranked seventh among the 10 crop enterprises in both total costs and gross revenues. This was closely followed by melon/maize, cassava/melon/maize and cocoyam/melon, each of which had much higher per-hectare costs and gross revenues than did the cassava/cocoyam/maize enterprise.

Enterprises which included melon, yam, or both, required the highest fixed and variable cost outlays, and provided the highest gross returns and gross margins. Conversely, whether intercropped or grown in segregated stands, maize and cassava required the lowest cost outlays and provided the lowest gross returns. The lowest net revenue, per hectare, resulted from the sole cropping of maize.

Interestingly, a comparison of table 1 and table 2 indicates that farmers did not devote proportionately more of their land to the enterprises that resulted in the highest gross margins or net revenues. For example, the cassava/melon enterprise, which received the highest gross margin and net revenue per hectare, ranked fifth in total planted hectarage, accounting for only 10.4% of total land area planted. Similarly, the crop mixes resulting in the second and third highest net revenues per hectare ranked sixth and seventh, respectively, in total planted hectarage. The most land area (24%) was devoted to the cassava/melon/maize enterprise, which ranked fourth in net revenue and gross margin per hectare. The second and third highest hectarage figures were associated with cassava and cassava/maize, which earned low per-hectare net revenues and the second and third lowest, per-hectare gross margins. Maize, which ranked tenth in all cost and revenue categories, ranked fourth in planted hectarage, accounting for about 12% of total land area planted. These results suggest that either farmers were poor estimators of per-hectare returns, or that other considerations such as food

security, input cost and availability, and relative crop risks played a significant role in crop hectarage determinations.

OPTIMAL ENTERPRISE COMBINATIONS

A linear programming framework was used to determine the optimal enterprise mix for the sample of farmers studied. Two programs were specified. The first program was designed to determine the enterprise mix which maximized gross margin per hectare, given the land, labor, and capital resource constraints of the typical farm household surveyed. The second program differed from the first by the addition of a requirement that the farm household produce a sufficient amount of each crop for household subsistence. The objective function for both linear programs is mathematically stated as follows:

$$\text{Maximize } Z = \sum_{i=1}^{m} C_i X_i$$

The function is subject to the following constraints:

$$\sum_{i=1}^{m} a_{ik} X_i \leq b_k \qquad \text{(linear programs 1 and 2)}$$

$$\sum_{j=1}^{n} Y_{ji} X_j \geq d_j \qquad \text{(linear program 2 only)}$$

where

Z is the sum of the various gross margins of the activities in the 1987 crop year

C_i is the gross margin per hectare of the ith activity in the 1987 crop year

X_i is the hectarage devoted to the ith activity in the 1987 crop year

m is the number of activities

a_{ik} is the per-hectare requirement of the kth resource by the ith activity in the 1987 crop year

b_k is the level of the kth resource available in the 1987 crop year

Y_{ji} is the yield per hectare of crop j in the ith activity in the 1987 crop year

X_j is the hectarage of the activity in which crop j appears in the 1987 crop year

n is the total number of activities in which crop j appears

d_j is the minimum amount of crop j required for subsistence per household per year

The first set of constraints puts a maximum limit on the resources available to the farm household represented in the linear program. Land is limited to 2.52 ha to allow for possible expansion of farm size if factors permit. Capital is limited to ₦ 500, and labor is limited to the work days furnished by the household. None of the surveyed households was observed using borrowed capital or hired labor; therefore, these resources were not included in the program.

The second set of constraints places a minimum crop production requirement of subsistence level or above on the objective function. This requirement could not be specified in hectares due to the intercropping of the various crops. Information on annual, subsistence-level crop requirements was obtained from each household surveyed, and per-household averages were used to set the minimum production constraints.

Optimal Farm Plan I

The first linear-programming problem assumes that production decisions are based solely on the desire to maximize profits, as is frequently postulated by economic theorists. Given the resource constraints described above, the optimal solution for this linear-programming problem is for the farmer to devote 1.8 ha to the cassava/melon enterprise and 0.43 ha to the cassava/melon/maize enterprise, which would have resulted in a 1987 income of ₦ 2,399.

Two resources are found to be limiting: operating capital and June/July/August labor availability. This finding is consistent with what is known of the local smallholder farming situation. The June/July/August period requires the greatest input of farm labor to combat the rapid weed growth, soil erosion, and lodging of plants that result from the heavy rains characteristic of this season. Labor is also required during this period for the construction and maintenance of perimeter fences to reduce the incidence of crop destruction by animals. Similarly, limited operating capital is a serious problem among traditional farmers, due to low incomes and a lack of ready access to credit or loan facilities. This solution leaves a farmland surplus of 0.29 ha and a labor surplus during all but the June/July/August period.

Optimal Farm Plan II

Survey results, as well as the existing literature cited, suggest that the production decisions of smallholder farmers are not influenced by the profit

motive alone. They also incorporate the objective of obtaining food security for the family. Therefore, the second linear-programming problem assumes the smallholder farmer has the more complicated goal of maximizing profit subject to producing the annual, subsistence food requirements for the farm household.

The solution to this linear-programming problem is for the farmer to allocate 1.03 ha to the cassava/melon/maize enterprise, 0.96 ha to the cassava/melon enterprise, 0.3 ha to the cocoyam/melon enterprise, and 0.19 ha to the maize/yam enterprise. This allocation would have met the minimum food requirements of the average household in the survey and produced a 1987 income of ₦ 2,379. According to this solution, cassava, maize, and melon should be produced in quantities exceeding minimum family requirements, whereas cocoyam and yam should be grown for home consumption only (see table 3).

The limiting resources in this case are February/March labor (for land preparation) and June/July/August labor (for control of weeds, lodging, and soil erosion). There would be some unused labor resources during all other periods of the year. The solution leaves a surplus of 0.04 ha of farmland and ₦ 130 of operating capital. A comparison of optimal plans I and II shows that plan II is less capital intensive, but also less profitable than plan I. It also incorporates a greater number of enterprises and more land in the farm production plan, and requires greater use of labor throughout the year.

Neither plan incorporates either of the sole-cropping activities, despite the fact that sole cropping was practiced by 38% of the farmers and accounted for 30% of total land cultivated in the 1987 survey. This is an important result because maize and cassava have been the subject of intensive research efforts by national and international agencies, and are being recommended to farmers for cultivation as segregated crops. The linear-programming results indicate that, given the technical and economic relationships and subsistence requirements found in the survey, sole cropping is actually far less competitive with mixed cropping systems. As a further example, if maize and cassava were forced into plan II, income would be reduced by ₦ 504 and ₦ 571, respectively, whereas melon/maize and cocoyam/yam would reduce income by only ₦ 123 and ₦ 99, respectively, if they were forced into the plan.

HOME CONSUMPTION AND MARKET SALES ALLOCATIONS

The previous section sought estimates of the optimal allocation of resources given specified objectives and constraints. This section focuses on estimating the factors that actually have influenced smallholder farmers in allocating their food crop output between home consumption and market sales.

In keeping with the literature cited earlier, it is postulated that in a subsistence village community such as those surveyed, the farm household allocates its total food-crop output (F) between home consumption (C), market sales (M), and net disposals to others (D) such as rent in kind, gifts, and festival rituals. This accounting identity is represented by the following equation:

$$F = C + M + D$$

Because D represents contractual and traditional obligations, it is considered to be exogenously determined. The farmer's short-run decision, therefore, is how to allocate $F - D$ between C and M. By defining M as a residual amount, dependent on $F - D$ and C, the analysis can focus on the determination of C.

The household consumption function for subsistence food crops (C) is hypothesized to be determined by the price of the food crop (P), total household income (Y), and household size (H), where Y is the sum of the value of the food crops produced ($P \times [F-D]$) and any off-farm income, which is assumed to be exogenously determined. In linear form, this consumption function is expressed as follows:

$$C = a_0 + a_1P + a_2Y + a_3H + U$$

where U is a statistical error term with a mean of zero, and the a's are coefficients to be estimated.

Least-squares estimates were obtained for the coefficients in this equation so that the relevant price and income elasticities could be calculated for each subsistence crop among all villages surveyed. One reason for the price variations among villages is that some of the markets are primary while others are secondary. Because P is endogenously determined in the system, a two-stage least-squares technique was used. The first stage estimated P as a function of M using ordinary least squares. The second stage estimated the original regression equation by ordinary least squares, using the series of prices derived from stage one.

As shown in table 4, the standard errors of the estimated coefficients are each significant at the 5% or 10% level, and the signs of the coefficients are consistent with standard economic theory. Ranging from 0.32 to 0.61, the adjusted multiple correlation coefficients (R^2s) suggest that the explanatory variables explain a modest, but reasonable percentage of the variations in the independent variables, and therefore adequately characterize the principle factors which govern the allocation of smallholder farm output between home consumption and market sales.

The estimated coefficients and the average prices, output, consumption, and market sales (see table 5) were used to calculate the short-run (1) price elasticity of demand, (2) income elasticity of demand, (3) price elasticity of market sales, (4) income elasticity of market sales, and (5) total price elasticity of market sales (which includes the income effect of a price change) for each subsistence food crop.

The results indicate that farmers' allocations of subsistence food-crop output are responsive to changes in price and income (see table 6). The income elasticities of both market sales and home consumption were found to be greater than unity for all crops analyzed. That is, a 1% increase in income would elicit a greater than 1% increase in market sales (or home consumption) if all other variables were held constant.

The pure price elasticities of home consumption and market sales were found to be greater than unity for all crops except cassava, which exhibited a price inelastic demand for home consumption. A more realistic estimate of the price elasticity of market sales is derived by including in the calculation both the price and income effects of a change in crop price. Using this measure of elasticity, the data suggests that for four of the five crops studied farmers would respond to an increase in crop price by offering more of their crop for sale. Figures representing total price elasticities show market sales to be extremely price elastic for melon (55.35), unitary price elastic for yams (1.01), and slightly price inelastic for maize (0.75) and cocoyams (0.83).

The exception was cassava, which exhibited a negative, total price elasticity of market sales. The study found that a 1% increase in the price of cassava was associated with a .87% drop in the amount of cassava marketed, when both price and income effects were considered. This implies that there is a backward-bending supply curve, wherein producers either produce less or consume a greater share of their cassava production as cassava prices increase (for example, because the household's preference for additional food outweighs its preference for additional income). Because cassava is a favorite dish of people in the survey area, the latter may explain this particular situation.

POLICY IMPLICATIONS

The urgent need to increase the production and sales of staple food crops in Nigeria manifests the need of policy makers to obtain a better understanding of the technical and managerial constraints facing Nigeria's smallholder farmers. The results of the linear programming analysis suggest that one of the most critical constraints to increased farm production is a seasonal shortage of farm

labor. Such shortages could be averted by programs which enable smallholder farmers to hire seasonal workers (for example, through the provision of low-cost loans) or which facilitate the adoption of labor-saving technologies, such as improved farm tools, herbicides for weed control, and intermediate mechanized technology.

Current farm policy encourages farmers to adopt sole-cropping practices. This approach appears to be misdirected in light of this study and the growing body of evidence that suggests the intercropping of subsistence food crops is more profitable, efficient, and practical than the cultivation of food crops in segregated stands. It follows that agricultural research should be refocused to center on improving the efficiency and output of mixed cropping practices. For example, fertilizers, herbicides, and mechanical weed harvesters should be developed with mixed-crop farming requirements in mind.

Finally, analysis of smallholder farmers' allocation of crop output between home consumption and market sales indicates household income and product prices are key policy variables that could be used to elicit an increased marketed surplus of staple food crops. Farm income could be augmented, for example, by assisting farmers to increase yields through the efficient application of fertilizer, pesticides, and improved seeds. Similarly, producer prices could be raised as part of a deliberate policy to guarantee prices at remunerative levels.

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Table 1. Farm enterprises by number of farmers and total hectarage planted.

Farm enterprise	Farmers Participating			Total hectares planted		
	Number	%	Rank	Number	%	Rank
Cassava	23	38.3	2	17.45	19.0	2
Maize	23	38.3	2	10.83	11.8	4
Cassava/maize	22	36.6	4	12.53	13.6	3
Cassava/melon	13	21.7	5	9.58	10.4	5
Cocoyam/melon	5	8.3	8	2.31	2.5	9
Melon/maize	13	21.7	5	6.60	7.2	7
Cocoyam/yam	2	3.3	10	1.01	1.1	10
Maize/yam	6	10.0	7	2.55	2.8	8
Cassava/melon/maize	27	45.0	1	22.05	24.0	1
Cassava/cocoyam/maize	5	8.3	8	6.89	7.5	6
Total	60			91.80	100.0	

Source: Field study, 1987.
Note: Most farmers participated in more than one enterprise.

Table 2. Enterprise yields, costs, and returns per hectare.

Enterprise	Yield (metric tons)	Total crop revenue (₦)	Total enterprise revenue (₦)	Total variable cost (₦)	Total fixed cost (₦)	Total cost (₦)	Gross margin (₦)	Net revenue (₦)
Cassava	5.82	698.4	698.4	192	234	426	506.4	272.4
Maize	0.85	425.0	425.0	88	210	298	337.0	127.0
Cassava	4.02	482.4						
Maize	0.76	380.0	862.4	198	358	556	664.4	306.4
Cassava	4.64	556.8						
Melon	0.4	884.0	1,440.8	309	591	900	1,131.8	540.8
Cocoyam	1.52	425.6						
Melon	0.44	972.4	1,398.0	522	548	1,070	876.0	328.0
Melon	0.41	906.1						
Maize	0.81	405.0	1,311.1	560	418	978	751.1	333.1
Cocoyam	1.01	282.8						
Yam	2.5	1,000.0	1,282.8	408	613	1,021	874.8	261.8
Maize	0.78	390.0						
Yam	2.23	892.0	1,282.0	480	587	1,067	802.0	215.0
Cassava	3.86	463.2						
Melon	0.3	663.0						
Maize	0.62	310.0	1,436.2	584[a]	522	1,106	852.0	330.0
Cassava	3.15	378.0						
Cocoyam	0.65	182.8						
Maize	0.68	340.0	900.0	204	362	566	696.0	334.0

Source: Field Study, 1987.
Note: ₦ = Naira (Nigerian currency).
[a]Variable costs for cassava/melon/maize enterprises are disproportionately higher than those of cassava/melon and maize enterpirses combined. This is not uncommon on farms that have multiple-crop enterprises and is probably due to increased labor requirements and longer planting times.

Table 3. Comparison of optimal plan II output with average household subsistence requirements (metric tons).

Food crop	Optimal output	Household subsistence requirements	Output remainder[a]
Cassava	8.43	1.7	6.73
Cocoyam	0.45	0.45	0
Maize	0.79	0.42	0.37
Melon	0.82	0.17	0.65
Yam	0.43	0.43	0

Source: 1987 survey results and linear programming solution.
[a]Optimal output minus household subsistence requirements.

Table 4. Two-stage least-squares estimates of regression equation (household consumption of crop output as a function of crop price [P], household income [Y], and household size [H]).

Crop	Intercept	Coefficients of independent variables P	Y	H	R^2	Sample size
Cassava	1.321	-0.008**	0.016**	1.101**	0.51	23
		(0.003)	(0.007)	(0.311)		
Maize	6.234	-0.004**	0.010**	0.583**	0.42	23
		(0.002)	(0.004)	(0.102)		
Melon	19.114	-0.002**	0.005**	0.704**	0.61	58
		(0.001)	(0.002)	(0.219)		
Cocoyam	8.626	-0.002**	0.003*	0.450**	0.44	12
		(0.001)	(0.002)	(0.222)		
Yam	11.411	-0.003*	0.002**	0.613*	0.32	8
		(0.002)	(0.001)	(0.436)		

Source: Regression results.
Note: Numbers in brackets are asymptotic standard errors.
*$p < 0.10$ **$p < 0.05$

Table 5. Average price, output, consumption, and sales of food crops.

Crop	Price per metric ton (₦)[a]	Gross output	Miscellaneous allocations	Home consumption	Market sales	Ratio of consumption to sales
		----------metric tons per household----------				
Cassava	120	3.52	0	1.70	1.82	0.93
Maize	500	0.50	0.03	0.42	0.05	8.40
Melon	2,210	0.23	0.01	0.17	0.05	3.40
Cocoyam	280	0.70	0.04	0.45	0.21	2.14
Yam	400	1.10	0.05	0.43	0.62	0.69

Source: Field study, 1987.
[a]₦ = Naira (Nigerian currency)

Table 6. Price and income elasticities of household consumption and market sales of staple food crops.

Crop	Household consumption		Market Sales		
	$E_{pure\ price}$	E_{income}	$E_{pure\ price}$	E_{income}	$E_{total\ price}$
Cassava	-0.56	3.98	0.53	3.71	-1.87
Maize	-4.76	5.95	40.0	50.0	7.5
Melon	-26.0	14.95	88.4	50.83	55.35
Cocoyam	-1.24	1.31	2.67	2.8	0.83
Yam	-2.79	2.05	1.94	1.47	1.01

Source: Regression results.

Table 5. Diet worksheet results: pig feed compounded of locally available ingredients, Liberia, 1986.

Feed ingredients	Quantity restriction	Feed comp. (%)	NUTRIENTS ME (MJ/kg) CON	ME (MJ/kg) SUP	Protein (%) CON	Protein (%) SUP	Crude fat (%) CON	Crude fat (%) SUP	Crude fiber (%) CON	Crude fiber (%) SUP	Ash (%) CON	Ash (%) SUP	Calcium (%) CON	Calcium (%) SUP	Phosphorus (%) CON	Phosphorus (%) SUP	Unit price ($)	Added cost per 100 kg ($)
Cassava flour	Max. 50%	20	13.8	2.76	1.70	0.34							0.26	0.03	0.32	0.06	0.45/kg	9.00
Rice bran	Max. 75%	55	12.80	7.04	10.20	5.61	1.35	0.88	11.00	7.15	10.90	7.09	0.06	0.04	0.22	0.12	0.10/kg	5.50
Fish meal	Max. 15%	10	10.90	1.09	48.00	4.80	13.59	1.36			10.80	1.1	2.94	0.29	2.2	0.22	1.24/kg	12.40
Brewer's spent malt	Max. 30%	15	5.88	0.88	16.24	2.44	10.10	1.52	14.00	2.10	1.80	0.27	0.22	0.03	0.73	0.11	0.07/kg	1.05
Vitamin premix (Tetramix)	1gm/2.2 kg feed																5.75/ 100.0 gm	2.61
Salt	0.33 kg/ 100 kg feed																1.10/kg	0.36
Total		100		11.77		13.19		3.56		8.15		7.37		0.40		0.51		30.92
Nutrient Requirements			11.7-13.4		13-18			Max 7		Max 7		Max 5		Min. 85		Min. 69		

Notes: Max. = Maximum limit; Min. = Minimum limit; CON = nutrient content; SUP = nutrient supply.

HIRED LABOR ON SMALLHOLDER FARMS IN SOUTHEASTERN NIGERIA

S. A. N. D. Chidebelu

SUMMARY

Nigeria has set the goal of becoming self-sufficient in food production by the year 2000. However, the demand for food has been increasing at a rate of 4% to 5% since the 1970s, while agricultural output has been increasing by only about 2%. Thus, agricultural output must be significantly increased to meet Nigeria's goal.

Lack of labor is the most important constraint to increased agricultural output in southeastern Nigeria. Smallholder farmers used to rely on family members and other unpaid laborers. However, due to the increasing monetization of the economy, decreasing family size, increasing rural-to-urban migration, and increasing schooling of children, smallholder farmers have become dependent upon hired labor.

This study surveyed smallholder farmers and hired laborers. Their socioeconomic characteristics were compared; the current labor situation on the farms with respect to the types of labor used and managerial concerns was determined; and the welfare and living conditions of hired laborers were investigated.

At the time of the survey, 90% of the smallholder farmers that were interviewed used hired labor. Most said they would increase the size of their farms if more laborers were available for hire.

Many hired laborers were working part time while they attended school or a training program. The hired laborers were younger than the smallholders, on the average. The most important reasons people gave for working as hired laborers were that no other jobs were available and they wanted to earn additional money. All of the hired laborers owned farms on which they produced food for subsistence; however, they said their farms were too small to supply all of the food and cash needs of their families. Working as a hired laborer was a means of earning cash. The vast majority of hired laborers said they would rather neither themselves nor their children had to work as hired laborers.

The hired laborers walked long distances to the fields, shared rooms with others, and bought most of their meals from itinerant food vendors. Their wages varied according to the type of work they

were doing. Building mounds for yam-based crop mixtures paid more than twice as much as building mounds for cocoyam-based crop mixtures. The laborers complained that the wages were too low, whereas smallholder farmers claimed that they had to pay high wages to hired laborers.

The division between men's jobs and women's jobs has been eroding in Nigeria. Some tasks, such as mound making, still are generally done by men, just as some jobs, such as carrying and harvesting, continue to be done primarily by women. However, many tasks that were formerly considered men's jobs, such as yam tying and yam-barn building, are now being done by both men and women.

Many of the new technologies being introduced into Nigerian agriculture are labor intensive. For example, applying fertilizer not only requires labor to apply the fertilizer but also results in additional labor being needed for weeding. These technologies are being evaluated on the basis of their ability to increase output per hectare. However, since more land is available than labor, these technologies should be evaluated on the basis of output per worker hour.

Nigeria has set a goal of becoming self-sufficient in food production by the year 2000. This is an ambitious undertaking since the country's demand for food has been growing at a rate of about 4% to 5% since the 1970s, while agricultural output has been increasing by only about 2% (Peres and Mahapatra, 1976). Moreover, about 80% of Nigeria's farmers are smallholders, with an average farm size of less than 2 ha. Although the use of irrigation, tractors, and fertilizers is gradually being introduced into crop production systems, most of the current growth in output is coming from small-scale farmers who still rely on traditional technology and rudimentary capital in a rainfed system but who have increased the amounts of land and labor they use (Oyejide, 1986).

The contribution of agriculture to Nigeria's gross domestic product has declined from a high of 64% in 1960 to 24% in 1984, at the 1973-74 factor cost (Federal Office of Statistics, n.d.). Nevertheless, the agricultural sector still employs more than 70% of Nigeria's labor force either directly or indirectly. In the past, family laborers were believed to outnumber hired laborers on smallholder farms (Johnson, 1982). Theories suggested that underemployment and disguised unemployment existed in smallholder farming systems and, therefore, family size was the constraint to increased agricultural production. Since Nigeria now farms an estimated 32 million ha of the available 72 million ha (Oyejide, 1986), only 44% of the available land is under cultivation. Recent studies suggest that farmers can obtain additional land (Nweke and Winch, 1980). A consensus is emerging that labor shortages and the corresponding high cost of labor have

played a central role in agriculture's poor performance (Eicher and Baker, 1982; Oyejide, 1986).

Several factors acting singly and in concert have reduced the amount and quality of agricultural labor supplied by farm families: a decrease in the number of wives and children per family (Nweke and Winch, 1980; Chidebelu and Ezeronye, 1985; Pat-Mbano, 1986), an increase in schooling of children, an increase in the average age of farmers, and an increase in rural-to-urban migration. Other sources of unpaid labor, such as work gangs, age grades, and in-laws have vanished in most areas following the increased monetization of the economy and the loosening of social ties. The reduction in labor supply is significant because, in many parts of Nigeria, including the southeastern states, agriculture is highly labor intensive: Both mixed cropping and cultivating root crops are labor-intensive processes. All of these factors have led to smallholders' increased dependence on hired labor.

In the rural areas of southeastern Nigeria, the demand for hired labor is high (Kolawole, 1972; Nweke and Winch, 1980; Chidebelu and Ezeronye, 1985; Okorji, 1986). Farmers complain that hired labor is scarce, expensive, and generally unreliable. But farm families are unable to provide the labor required during seasonal peaks and hired laborers will perform farm operations that require physical exertion beyond that which the farm operator is willing or able to supply. Farm tasks such as making mounds, weeding, and transplanting rice must be done quickly or yields are reduced.

If farmers adopt improved technologies (improved seeds and planting materials, fertilizer, irrigation, and agro-chemicals), Nigeria can achieve its goal of food self-sufficiency. However, research in Nigeria and elsewhere in Africa has shown that labor availability determines whether farmers adopt the recommended practices (Norman, 1970; Byerlee and Eicher, 1972; Mellor, 1976; Clark, 1985; Van Tienhoven, 1985).

LABOR USE IN NIGERIA

The development economics literature provides several views of labor. Lewis (1954) and his supporters hypothesized that many developing countries have surplus labor and disguised unemployment in agriculture. Lewis defined disguised unemployment as a situation in which an elastic supply of labor from the agricultural sector is provided to the industrial sector at a constant real wage -- a process that might involve zero, or close to zero, opportunity cost in terms of output foregone. This view assumes that a large part of the labor force in agriculture is redundant -- its marginal physical product is zero. A variant of this model states that surplus agricultural labor is seasonal -- the marginal physical

product of agricultural labor is positive at some times and zero or around zero at other times.

Another view is that there is no surplus agricultural labor and the movement of labor from agriculture to the non-agricultural sectors will cause a decrease production unless this movement is accompanied by increased productivity on the farm. Nigerian policy appears to be based on this model. A variant of this model argues that, in many African countries, land is in surplus and the lack of labor is the constraint to increased production.

All of these models are relevant to the situation in southeastern Nigeria, but none of them fully reflects the situation. Most researchers have questioned the applicability of the labor-surplus model to contemporary developing economies. The land-surplus model is regarded by many as an oversimplification. The current balance of the argument suggests labor has a small but positive marginal value product over the entire year, since the marginal value product of labor is definitely positive during the work peaks. The marginal value product of agricultural labor could be close to zero, zero, or even negative seasonally.

Unpaid Workers

Workers on smallholder farms may be unpaid or paid workers. The unpaid farm workers are family members, friends, age-grade members, and exchange laborers. Except for family members, unpaid farm workers actually are paid in kind -- that is, in food and drinks. The cost of feeding and entertaining them may equal or exceed the wages they would have earned as hired laborers (Upton, 1978).

The farm family is the most important source of unpaid labor. The family head supervises farming activities and allocates jobs to family members based on ability, gender, age, the nature of farm operations, and custom. Okorji (1985) showed that women contributed more labor than men to arable crop production. This role of women enabled many male farmers to earn cash in nonfarm jobs.

Johnson (1982) suggested that family workers outnumbered hired laborers on smallholder farms. However, Johnson also noted that the decline in polygyny and the increase in the number of children attending school were reducing the availability of family labor and thus making it necessary for smallholders to hire laborers so the optimum farm size could be maintained.

Hired Laborers

Hired laborers work in return for payment in cash, in kind, or both. Farmers hire workers primarily during periods of high labor demand when family labor is

insufficient. Sometimes hired laborers perform the work of the farm operator, who then can participate in off-farm employment. Norman (1970) reported that, in parts of northern Nigeria, laborers were occasionally hired during slack periods, especially at the beginning of the dry season, while the farmer relaxed in the compound. This practice conferred prestige on the farmer because only those who had large amounts of money from cotton and groundnut sales could afford to hire labor while relaxing at home.

Hired laborers can be categorized as regular, contract, and casual workers (Johnson, 1982). Regular workers are employed year-round and are usually unskilled or semi-skilled. Contract workers usually are used for short capital-development projects such as stumping and felling trees. Casual workers are often used to cope with short, seasonal work peaks during weeding and harvesting. In Anambra State, each laborer surveyed performed many farm operations, and none was hired year-round.

Hired laborers can also be categorized as migrant or resident workers. The migrant worker comes from a neighboring or distant village and takes up residence in a new village to work for a brief period. Resident workers are natives of the villages where they work. Both types were encountered in this research. Most migrant workers were men. Women hired laborers tended to work near their permanent residences.

Dependence on Hired Labor

Agricultural production in Nigeria is labor intensive. More than 90% of the output is produced by smallholders cultivating an average of less than 2 ha (Olayide and Atobatele, 1980). There is little or no mechanization in most areas of southeastern Nigeria, and production follows the dictates of the weather. For these reasons, all farmers in an area tend to perform the same farm operations at approximately the same time. Critical operations such as making mounds, planting, weeding, and harvesting are closely tied to the seasons and must be completed quickly. In the past, farm families relied on work gangs, age-grades, in-laws, and communal laborers for supplementary labor when needed. Polygyny, the lack of formal schooling for children, and low rural-to-urban migration helped to keep the family labor force large and the need for hired labor low.

Most of these factors have changed in Anambra State. Recent studies have shown that the average smallholder is a man more than 50 years old, with fewer than two wives, and fewer than seven children (Flinn and Zuckerman, 1981; Chidebelu and Ezeronye, 1985; Pat-Mbano, 1986). In most areas, other sources of unpaid labor have vanished as the economy has become more monetized. Consequently, smallholders have come to rely increasingly on hired laborers to supplement

depleted family labor. This increased use of hired labor has been confirmed by many researchers. Nweke (1980) found that, in parts of southeastern Nigeria, hired labor accounted for 65% of the total expenditure of Ogboji and Nubia farmers. Furthermore, 55% of the rice farmers and 87% of the yam farmers employed laborers. In Nsukka Local Government Area of Anambra State, 81% of the farmers surveyed by Chidebelu and Ezeronye (1985) hired labor, whereas in the Uzo-Uwani area of the Nsukka zone, Obiechina and Otti (1985) found that labor accounted for 77% to 83% of the total cost of rice production. This calculation includes the farmers' opportunity cost, if any; however, most rice-production activities are carried out by hired laborers. Similar high use of hired labor has been noted in western Nigeria by Kolawole (1972).

The shortage of agricultural labor, especially hired labor, is the major constraint to increasing agricultural production in Nigeria. Nigeria's population density in 1985 was 103 persons per square kilometer (World Resources Institute, 1986), and researchers in various parts of Nigeria have found that most farmers can rent or buy additional land. In northern Nigeria, Norman (1970, 1974) found that the amount of land a family could cultivate was not limited by the availability of land but, instead, by the amount of labor they could supply. For example, 70% of Ogboji farmers and 60% of Nubia farmers did not require additional land, and all of those who required extra land said they could get it easily. Norman stressed that, for many farmers, a lack of labor, particularly seasonal labor, was the major constraint to increased production. Unavailability of land may be a constraint in certain areas; however, the shortage of labor is the most significant constraint.

Divisions of Labor by Gender

Some farm operations are performed predominantly by men, by women, or by children. Spencer (1976), for example, found that, in Sierra Leone, men provided 70% of the labor input for export crops while women provided the majority of the labor for food crops. The type of farm operation, as well as the type of crop, plays a role in determining whether men, women, or children provide the labor.

Clark (1985) concluded that women have managed the farms in most parts of Africa because men have migrated to urban areas. Thus, a lack of labor for the farm operations dominated by women was the factor limiting farm expansion under existing technologies. Clark supported Spencer's position that 90% of food crop production depended on women because the men concentrated on export and nonfood crops. Clark further contended that most of the improved farming methods proposed by researchers would increase the demand for women's labor. For example, applying fertilizer makes extra weeding necessary, and women do most of the weeding. In contrast, traditionally male tasks, such as clearing land, felling trees, and making ridges are being mechanized.

Okorji (1986) concluded that, in southeastern Nigeria, certain crops (such as yams) were men's crops while others (such as cocoyams) were women's crops. However, in Okorji's study of the distribution of labor input in the production of yams -- a man's crop -- women contributed slightly more than half of the total labor input. While men predominated in preparing land and making mounds, women predominated in weeding.

SURVEY METHOD

Studies have revealed the importance of hired laborers, but little research has been done on the hired laborers themselves. If policies are to be effective in increasing agricultural output, they will have to be based on an understanding of the hired laborers and their working conditions.

To increase this understanding, a survey of 200 hired laborers and 400 smallholder farmers was conducted in Anambra state in 1988 with the following objectives:

- to ascertain the socioeconomic characteristics of the hired laborers and compare these with the characteristics of the smallholder employers
- to describe the current labor situation on smallholder farms, including the types of labor used, farm operations performed, and types of crops grown
- to investigate the welfare of hired laborers, especially their living and working conditions, the problems they encounter, and their major goals and expectations
- to determine gender patterns of labor use by crops and farm operations
- to examine managerial aspects of hired labor use, especially recruitment, supervision, job assignment, and wage determination

Anambra State was chosen for study as being representative of the southeastern region of Nigeria. The major arable crops grown in Anambra State are yams, cassava, cocoyams, maize, rice, legumes, and vegetables. Rice is usually cropped alone because of the soil requirements and because of the need to flood the rice at some stages of its growth. Cassava, cocoyams, and yams are sometimes cropped alone, but they are usually grown in crop mixtures. The three primary crop mixtures are yam based (yam, cassava/cocoyam, maize, and vegetables),

cassava based (cassava, cocoyams, maize, and vegetables), and cocoyam based (cocoyam, maize, and vegetables) (APMEPU, 1982).

The four major food-producing zones of Anambra State were selected for study. From each zone, one local government area (LGA) was selected based on its importance in food production.

From each LGA, 50 hired laborers were selected; thus, 200 hired laborers were interviewed. An attempt was made to include both men and women hired laborers in the sample. Of the 200 questionnaries obtained, 196 (98%) were usable.

From each LGA, the owners of 25 yam-based farms, 25 cassava-based farms, 25 rice farms, and 25 cocoyam-based farms were selected and interviewed. Consequently, 100 smallholders were interviewed in each LGA, for a total of 400 smallholders. This survey yielded 397 usable questionnaires (95%).

SOCIOECONOMIC CHARACTERISTICS OF HIRED LABORERS AND SMALLHOLDER FARMERS

The socioeconomic characteristics of the hired laborers were compared with those of the smallholder farmers who employed them. Conscious efforts were made to include women in the sample of hired laborers; therefore, the distribution of 66% men and 34% women was not random. However, usually more men than women are hired as laborers. The majority of the farmers -- 73% -- were men.

About 52% of the hired laborers considered themselves full-time laborers, while 73% of the smallholders considered themselves full-time farmers. The hired laborers, with a mean age of 31 years, were relatively younger than the smallholders, with a mean age of 40 years (see table 1).

A higher percentage of hired laborers than of smallholders had primary or higher levels of formal education (see table 2). It also appeared that more laborers than smallholders had no formal education. However, since many of the farmers did not respond to this question, the results were skewed, and many of the farmers who did not respond appeared to be illiterate. Therefore, it is reasonable to assume that hired laborers tended to have more education than smallholder farmers. It was expected that hired laborers would have little education since educated youths usually migrate to urban areas in search of nonfarm employment. However, many of the hired laborers, especially those who worked part time, were students in secondary schools or teacher-training

colleges and used their income as hired laborers to pay for their education. These students worked mostly during weekends and holiday periods. Other hired laborers were unemployed school leavers and former auxiliary teachers and civil servants. The high level of education among hired laborers was more pronounced in the Uzo-Uwani area than in the Abakaliki area, where most of the hired laborers had no formal education.

About 62% of the hired laborers were not married. This includes a minority who were widowed or divorced. The remaining 38% were married, with 33% having one wife; 5%, two wives; 2%, four wives; and less than 1%, five wives.

Over half of the hired laborers had children; 46% had one to five children, while 11% had six children or more. The average was 2.4 children per hired laborer. This contrasts with the average of 5.2 children per smallholder farmer.

The average family size for hired laborers was 5.4 people comprising a husband and wife, 2.4 children, and 1 other relation. The average family size of the smallholder was 10.4 people, comprising a husband and wife, 5.2 children, and 3.2 other relations.

In 1987, the average hired laborer reported earnings of ₦ 559 (4 Nigerian Naira = US$ 1) from farm labor and ₦ 419 from nonfarm activities. The average smallholder earned ₦ 1,642 from farm activities and ₦ 655 from nonfarm activities. The total income earned by the average hired laborer was ₦ 978, which is only 65% of the official government minimum wage of ₦ 1,500, excluding transport and housing allowance. The average smallholder earned ₦ 2,297, which is 153% of the minimum wage. Thus, on average, hired laborers would be better off financially if they were able to find employment that paid the official minimum wage, whereas smallholders are better off in their present occupation. The income of hired laborers is less static than the minimum wage; wages for hired laborers tend to increase with inflation.

people worked as hired laborers as a stop-gap measure in the absence of other jobs; they moved on to other jobs when they became available. When questioned about how long they intended to continue as hired laborers, 44% said they would stop working as hired laborers when the economy improved, 48% did not give an answer, and only 8% hoped to work as hired laborers for up to 4 years.

The average smallholder farmer had 16 years of experience. Only 20% had farmed for 5 years or less, while some had been farming for more than 40 years. This suggests that smallholder farming is a permanent feature of the agricultural scene.

WELFARE OF HIRED LABORERS

Despite the importance of hired laborers to smallholder farms, little information is available on their living and working conditions, their goals, their expectations, and their problems.

Reasons for Working as Hired Laborers

The three most common reasons people gave for working as hired laborers were that no other jobs were available (49%), they wanted to earn additional money (39%), and they wanted to get seed yams for planting on their own farms (13%).

Contrary to the general belief, only 12% of those surveyed said they worked as hired laborers because their farms were too small to generate adequate income. Hired laborers' farms provide food for their families but are not sources of cash. So these farmers work as hired laborers and at other nonfarm employment to generate cash.

The goal of 53% of the hired laborers was to become full-time farmers; 34% hoped to move into nonfarm activities; only 9% wanted to continue working as hired laborers. (Only 6% of the respondents claimed to like working as hired laborers.) These goals, if achieved, would affect the future labor supply to the agricultural sector and, thus, could result in a reduction of hectarage under cultivation.

When the respondents were not working as hired laborers, 57% worked on their own farms, 31% carried out petty trading, and 15% harvested palm fruits for other people. Thus, over half of the hired laborers (57%) interviewed were also smallholder farmers; but none of the smallholder farmers interviewed worked as hired laborers.

All of the hired laborers owned farms where they grew staple crops. The two most common crops grown were cassava (76%) and yams (72%); cocoyams were grown by 22% of the respondents. All used multiple cropping systems for all crops except rice.

When asked how they viewed the size of their farms, 60% of hired laborers complained that their farms were too small to supply all the food and cash needs of the family, and 33% saw their farms as being "just okay." When asked why they had not increased their farms, 60% said they lacked money and only 8% said no land was available for rent or purchase.

Living Quarters

About 62% of the hired laborers migrated to a town near where they worked; the rest lived at home. The hired laborers were mobile, tending to change their residential addresses frequently. The mean number of years spent in a town was 4, and the mean number of years spent at the current address was 2.5. The majority did not know where they would live in the future. Those who expected to remain at their present locations for more than 36 months usually owned their own homes. The three most important considerations when choosing a location were the availability of jobs (44%), the presence of relations and friends (31%), and the availability of free accommodations (31%).

Because most hired laborers were migrants, finding living quarters was an important concern for them. The influence of the extended family system was evident -- 32% obtained their residence through the help of relations and friends. Once away from home, the first point of contact was usually relations or friends. In 16% of the cases, the farmer provided accommodation with the employment.

Rooms were shared by as many as 12 hired laborers, the mean being 3.8 persons per room. Most of those who lived alone or shared a room with only one other person lived in their own homes. The structures varied from cement block houses with zinc roofs to mud houses with thatched roofs. Normally, the migrant hired laborer had minimal furniture: a mat and, sometimes, a wooden bed made with raffia palm poles (popularly called *anaba aghara,* meaning "leave behind while going," because it is usually not carried from town to town).

Because of the lack of motorized transportation and poor roads, 79% of the hired laborers had to walk long distances to get to the farms where they worked. Most of the farms are far from the main residential areas, and the roads leading to them are impassable to vehicles for all or part of the year. The Nigerian government is tackling the lack of roads and other infrastructure in the rural areas through the recently launched Directorate for Foods, Roads and Rural Infrastructure aimed at providing good rural roads, especially for the food producing areas of the country. Even where transportation is available, the cost may be prohibitive if the hired laborer must pay the fee. In 38% of the cases where the laborer took public transportation to the farm, the laborer paid the fee; in 38% of the cases, the farmer paid; and in 13% of the cases, the cost was shared.

Meals

When working, laborers often left their rooms early in the morning and returned late in the evening. Their employers usually provided at least one good meal in the afternoon, and some employers also provided a morning meal.

Most of the hired laborers who lived on their own depended on itinerant food vendors for their other meals. These meals consisted mostly of starches such as yams and cassava, which the laborers say provide them with the necessary energy for their jobs. Laborers were asked about the meals they had eaten the previous day. Cassava was the dominant food during breakfast (55%) and supper (55%), whereas yams dominated lunch (55%). Cassava -- which is processed into *gari* or *fufu* -- is usually dipped in a sauce before eating. This meat or fish and vegetable sauce is a source of vitamins and protein. Yams are prepared with vegetables and no meat, or pounded and dipped in a sauce, similar to cassava.

Wages and Expenses

Wages received by hired laborers varied according to

- The type of farm and the specific operation (see table 3). In yam-based crop mixtures, the payment to hired laborers per day varied from ₦ 2.9 for tying yams in the barn to ₦ 6.3 for preparing land. However, the wage for land preparation varied from ₦ 6.3 for yam-based crop mixtures to ₦ 3.0 for cocoyam-based crop mixtures. Hired laborers received the least pay for work on cocoyam enterprises, while work on rice and yam enterprises had the highest pay.

- The social and economic importance of the crop. Rice is primarily a cash crop; yams are a food-security crop and a "man's" or prestige crop. Cocoyams are grown mostly by women.

- The difficulty of the work. For example, yams require large mounds, cassava smaller mounds, and cocoyams the smallest mounds.

Of the hired laborers, 7% preferred to work for women, 30% preferred to work for men, and 61% had no preference. The men that preferred women as employers said women paid promptly upon completion of the job and tended to pay slightly higher wages. Some women laborers did not like working for men because they said that they were harassed by the wives of their employers.

On the average, laborers worked 9 hours a day, including the time spent walking to and from the place of work. In general, 21% worked from 4 to 8 hours and 78% from 9 to 12 hours. The hours of work in the field were usually from 7:00 or 8:00 a.m. to 4:00 or 5:00 p.m. with one or two breaks for meals and for snuff.

The average hired laborer's reported monthly spending was ₦ 8.0 for a room, ₦ 8.3 on transportation to and from the place of work, ₦ 11 on transportation home, ₦ 20.8 on medicine, ₦ 79.7 on food, ₦ 12.5 on drinks and snuff, and ₦ 7.6 on entertainment, for a total of ₦ 147.9 per month. Food and drinks accounted for 62% of the total expenditure, followed by medicine at 14%.

Hired laborers generally took care of their own medical expenses. According to the survey, 79% always took care of their own expenses when sick, 9% always were cared for by their employers, and 11% shared their medical bills with their employers. With the high cost of medical services, medical bills represented significant cost items to hired laborers.

The vast majority of hired laborers, 81%, said they would not want any of their children to work as hired laborers because of the indignity suffered. Only 8% said they would recommend the job to their children. Only 8% intended to put in 1 to 4 years more as hired laborers. Although intention is not the same as performance, this response gives insight into the respondent's hopes.

Problems

The four most important complaints of the hired laborers were the low pay, (68%), the long walk to the farms (55%), the difficulty in getting regular jobs (42%), and the fact that they had to leave their families behind (33%). While hired laborers complained of low pay, the smallholder farmers complained about the high cost of hired labor. The average hired laborer earned ₦ 5 to ₦ 10 per day, in addition to at least one meal valued at about ₦ 2.50. Thus, the average hired laborer earned ₦ 7.5 to ₦ 12.5 per day, when working. This can hardly be regarded as low pay because unskilled government workers earn less than ₦ 6.00 per day. However, laborers complained that the wage was low relative to the amount of energy expended and the tediousness of the job.

Although 42% of the respondents said they had problems in obtaining regular jobs, most of the respondents worked virtually year-round (see table 4). However, many of them said they were not able to find work every day that they wanted to work.

MANAGERIAL ASPECTS OF USING HIRED LABOR

Smallholder farmers considered a number of factors when deciding who to hire. The four most important factors were the laborer's past farming experience (74%), the farmer's prior knowledge of the laborer (46%), the laborer's age (45%), and the laborer's gender (41%). In many areas, unemployed laborers congregate at specified locations early in the morning. Prospective employers go to these locations and negotiate work and wages with laborers. The laborers are transported or walk to their working places. In some instances, a senior laborer or foreman is hired who visits the site, negotiates the wages, and is then responsible for hiring other laborers. In other cases, laborers are contacted and an agreement struck in advance.

It was expected that the laborer's age, the type of job to be done, the amount of time to be spent on the job, and the laborer's gender would determine the wage rate. However, the most important determinants were education (73%) and the farmer's bargaining ability (70%). Employers also considered the going wage rate (41%) and the gender of the laborer (26%).

The ages of the surveyed laborers were fairly uniform. Payment was not scaled according to age, except that children were paid less than adults because they did less work. While smallholders usually did not hire highly educated laborers, those they did hire usually received slightly higher wages than uneducated workers because the farmers realized that the educated laborers were misemployed and performing jobs beneath their status. The farmers said the laborer's gender was important only in jobs such as making mounds, in which men were superior. It appeared that wages were usually determined on the basis of the job performed, rather than on the person who performed the job.

The farmers said laborers did not specialize in specific farm operations. The same laborer could be hired for a variety of tasks, including making mounds, weeding, and harvesting. The three most common methods of job assignment were daily work, task work, and piece work.

Supervision took a substantial amount of the farmers' time. Most farmers -- 60% -- rarely left their laborers unsupervised, and 36% never left their laborers unsupervised. The extent of the supervision varied depending on the farm operation. Only clearing land and stumping trees were supervised by less than 50% of the farmers. In the case of clearing land, close supervision was deemed unnecessary because bad work could be detected easily on inspection. Farm operations like transplanting rice, sowing seed, and harvesting are more difficult to assess after completion and have more disastrous consequences if badly done. The farmers reported some problems in the work done by hired laborers. The

number one problem was bad mound making due to lack of skill. Weeding and harvesting also were problem areas. This partially explains why farmers closely supervised these operations. Farmers occasionally provided informal education to hired laborers, such as demonstrations of farm operations like making mounds, weeding, and harvesting.

At the time of the survey, 90% of the farmers interviewed used hired labor (see table 5). The farmers were questioned on their probable response to changes in the supply of hired labor. The majority, 83%, said they would increase the size of their farms if more hired laborers were available. This implies that lack of hired labor is a major constraint to increasing farm size and production. A majority of 72% said they would reduce the size of their farms if the supply of hired laborers declined. Nweke and Winch (1980) reported that different crop enterprises would be differently affected by a reduced labor supply; for example, in rice production, preparing land and harvesting would be limited by a decrease in hired labor, whereas in yam-based crop mixtures, making mounds and weeding would be limited.

GENDER DISTRIBUTION AND IMPLICATIONS

The operations required in smallholder farming varied according to the cropping system used: The sizes of the mounds required by the different enterprises varied. Preparing land for rice production did not involve making mounds but sometimes included puddling. The gender distribution of labor also varied according to the cropping system.

The importance of different types of labor differed. The farmers reported the number of people hired for each farm operation. Some people worked more than one day or took part in more than one farm operation. The nearest equivalents to these figures are man days, woman days, and child days. The average yam farmer hired 106 men, 71 women, and 68 children. On farms with cocoyam-based crop mixtures, an average of 44 men, 47 women, and 19 children were hired. Smallholders using cassava-based crop mixtures hired an average of 65 men, 49 women, and 44 children, while those producing rice hired an average of 106 men, 110 women, and 60 children. The enterprise that demanded the highest number of hired laborers was rice (306), followed by yams (245), cassava (158), and cocoyams (110). This order of demand closely follows the order of perceived importance. Rice is the most important cash crop since most of the output is sold. Yams are a prestige crop and are the most important food crop, followed by cassava, and cocoyams.

It can be debated whether the number of laborers is a direct measure of the labor input. Different people have tried to convert women's and children's labor into man-day equivalents. Yang (cited in Brown, 1979) used a formula whereby 2 child days equaled 1.25 woman days, which equaled 1 man day. Spencer (cited in Brown, 1979) thought otherwise and proposed a formula whereby children from 7 to 15 years were assigned 0.5 and women and men 1.0. Brown also reported that Tollens, following his Zaire research, said that any conversion of female and child labor units to male labor units was arbitrary. An earlier study by Edwards in Jamaica, also reported by Brown, concluded that conversion from children and female into adult male equivalent was not very useful because, among other things, the capacity for work differed even between two people of the same sex. On this issue of conversion of women and children's labor into men's equivalents, there is no consensus. Thus, in this study, separate figures are provided for men, women, and children.

Male and female hired laborers participated in all farm operations. In a few farm operations, one gender predominated because experience has shown them to be the most efficient or because of habit or social norms. For example, in yam-based cropping mixtures, clearing land and making mounds were done primarily by men because the jobs require strength. However, men predominated in preparing yam barns and sowing yam seed mainly by custom. Children predominated in bird scaring because this task requires little skill and offers minimal pay. In all cropping systems, women predominated in harvesting. Farmers believe that women are better than men in weeding because they are more painstaking and can bend down for hours. Women are usually preferred for carrying tasks because women are accustomed to fetching water and carrying farm produce to the market.

However, many of the gender divisions are eroding. Operations like making yam barns and tying yams in the barns, which used to be done exclusively by men, are now also done by women. Women began to take over these tasks as young men migrated to the urban areas on apprenticeships and nonfarm jobs.

POLICY IMPLICATIONS

Although family labor is still important on smallholder farms, the scarcity of hired labor has become the constraint to farm expansion. New technologies that indirectly require additional labor may be resisted by farmers because of this labor constraint. Recent technologies in cassava and grain production require two fertilizer applications. These induce excessive weed growth, thereby necessitating more frequent weeding and, hence, more labor. Because of the high cost of labor, many smallholder cassava and maize fields tend to be

overgrown by weeds, which reduces yields. Furthermore, when improved technologies result in increased output, more labor is required for harvesting and transportation. Thus, the labor constraint must be recognized and new technologies must be assessed on the basis of increase in output per worker hour as well as on increase in output per hectare.

The aging of the farming population will worsen the labor situation on farms. Thus, policies must seek to attract able-bodied youths back to the farms. In the meantime, the drudgery of farming must be reduced by mechanizing farm operations that require heavy hired-labor input, including clearing land and making mounds. The labor constraint may also be eased by making the work less difficult. For example, the traditional African hoe could be improved to reduce the extent of bending necessary for its use.

In southeastern Nigeria, the staple crops are roots and tubers such as cassava, yams, and cocoyams. Research on cassava has emphasized breeding improved high-yielding and disease-resistant varieties. Little research has been done on yams and cocoyams. Government policies should be established that encourage greater and more appropriate research on the production of these crops. Yam varieties should be developed where tendrils do not need to be staked, thereby eliminating the need for the farmer to collect stakes, stake the yams, and tend the vines. Yam and cassava varieties should be developed that can be harvested mechanically, thereby reducing the amount of labor required for harvest.

If such developments are not possible, a consumer-education campaign should be mounted to change the diets of southeastern Nigerians from roots and tubers to grains. All aspects of grain production have been mechanized, making them less tedious and labor intensive to produce.

The government should assist smallholders in reducing their production costs by subsidizing some farm inputs such as planting materials, fertilizer, and other agrochemicals and by implementing price-support schemes that will enable farmers to earn a reasonable income. Many farmers have responded to labor constraints by reducing their farm sizes. This action has tended to further reduce the available food supply, thereby frustrating the federal government's aim of self-sufficiency by the year 2000. Ajayi (1988) reported that food crops grown in many parts of Nigeria were left unharvested because of the high cost of hiring labor. Furthermore, with more of the labor being supplied by women and with increasing emphasis on girls' education, the supply of agricultural labor will continue to diminish unless the government takes steps to reverse these trends.

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Table 1. Age distribution of agricultural workers in southeastern Nigeria, 1987.

Age	Hired laborers		Small farmers	
	Number	%	Number	%
16 or less	8	4	0	0
17 - 27	64	33	56	15
28 - 38	83	42	85	22
39 - 49	33	17	128	34
50 or more	8	4	97	26
No response	0	0	13	3
Total	196	100	379	100

Table 2. Educational attainment of agricultural workers in southeastern Nigeria, 1987.

Education	Hired laborers		Small farmers	
	Number	%	Number	%
None	51	26	63	17
Primary	87	44	147	38
Secondary/Teacher training	54	28	88	23
Higher institution	4	2	7	2
No response	0	0	74	20
Total	196	100	379	100

Table 3. Average wages received by hired laborers in southeastern Nigeria, 1987 (₦ per day).

Farm operation	Farm enterprise			
	Yams	Cassava	Cocoyams	Rice
Clearing land	6.3	6.2	3	6.1
Making mounds/preparing fields	5.9	5.7	3.1	5.5
Sowing seeds/planting stems/ transplanting	3.4	28	1.9	4.5
Weeding	4	3.5	2.4	4.2
Staking yams	3.4			
Applying fertilizer		2.2		3.4
Spraying chemicals		1.6		3.3
Harvesting	4	3	1.5	5.3
Carrying seed yams/ planting materials to the farm	1.7		0.7	
Carrying harvested crop	2.5	1.8	0.9	
Preparing yam barn	3.4			
Tying yams in the barn	2.9			
Preparing nursery bed				4.8
Scaring birds				2
Threshing rice				7.3
Winnowing rice				

Table 4. Number of hired laborers working each month, southeastern Nigeria, 1987.

Month	Hired laborers	
	Number (N=196)	%
January	147	75
February	143	73
March	146	75
April	162	83
May	161	82
June	158	81
July	158	81
August	150	76
September	138	70
October	137	70
November	145	74
December	143	73

Table 5. Sources of labor to smallholders, southeastern Nigeria, 1987.

Source of labor	Farmers using this source of labor	
	Number (N = 379)	%
Farmer	296	79
Family members	263	69
Hired laborers	342	90
Age grades	20	5
Friends	60	16
Tractor	48	13

EFFICIENCY OF AGRICULTURAL PRODUCTION IN SMALL- AND MEDIUM-SCALE IRRIGATION IN NIGERIA

Saa Dittoh

SUMMARY

Irrigated agriculture has the potential to relieve many of Nigeria's constraints to agricultural production. Past attempts to develop irrigation have generally been unsuccessful in Nigeria and in most parts of sub-Saharan Africa. Therefore, a deeper understanding of irrigated agriculture is called for. This study compared irrigation systems in two middle-belt states of Nigeria to identify opportunities to increase agricultural production and the productivity of irrigation projects.

Survey data was collected from irrigators -- some who were not participating in formal, government schemes and some who were -- in seven areas of the two Nigerian states. From each irrigator, information was collected on general socioeconomic characteristics; production activities, including resource use, costs, output, and returns; receipt of technical and credit assistance; and marketing practices and problems.

The results of the study showed that horticultural crops were grown on small irrigated farms, averaging 0.82 ha in informal systems and 0.44 ha in formal systems. The area under informal irrigation in Niger and Kaduna states of Nigeria appeared to be at least 12 times greater than that under formal irrigation: The area under informal irrigation during the 1987-88 season was about 22,200 ha, while the area under formal irrigation was about 1,846 ha. The main problem in informal systems was that they had access only to small pumps that could be used only along the banks of rivers; thus, the area that could be irrigated was limited. Problems in the formal systems included frequent breakdowns of water pumps, farmers' lack of freedom to choose which crops to cultivate, and discrimination by government officials.

The relative economic efficiency of the systems was analyzed using a restricted unit profit function approach, which made it possible to determine the relative efficiencies of different farm sizes, technologies, and scales of operation. The study also examined variations in farmers'

success in maximizing profits. Input and output prices also differed in the study area because sources of input procurement, transportation costs, and times of purchase and sale varied.

The estimates of the Cobb-Douglas profit function for the four sets of farm groups indicated that

- Small and large farms were economically efficient to the same degree.
- Informal irrigation systems were more economically efficient than formal irrigation systems.
- Economic efficiency did not differ for small-scale and medium-scale irrigation technologies (as distinct from farm size) in the study area.

Factor demand functions were used to test for relative price efficiencies. There was a significant difference in the price efficiency of hired labor between the small and large farm groups using informal irrigation. Small farms were relatively more wage price efficient than the larger farms. There were, however, no significant differences in price efficiency for irrigation water and fertilizer.

In comparing small and large farm groups using formal irrigation, small farms were more wage price efficient, while large farms were more fertilizer price efficient.

In comparing informal and formal irrigation farm groups, all of the variable factor price efficiencies were significantly different. Wage price and irrigation water price efficiencies were higher in informal irrigation; fertilizer price efficiency was higher in formal irrigation.

In comparing small-scale and medium-scale formal farm groups, the variable factor price efficiencies were not significantly different. All three factors were equally price efficient, irrespective of the scale of the irrigation scheme.

Absolute price efficiencies were determined by testing whether the calculated coefficients for the factors were equal to the factor prices. Separate calculations were made for small and large farm groups. Both sets of hypotheses were rejected at the 5% level of significance. This implied that neither small farms nor large farms were maximizing profits.

The conclusions were similar for the informal farm group, the formal farm group, the small-scale farm group, and the medium-scale farm group. None of the groups equated the marginal value products of all variable factors to the marginal factor costs (prices). This implied that, if the goal of production is profit, resources could and would have to be used more efficiently.

One approach to addressing Nigeria's irrigation needs would be to integrate formal and informal irrigation systems. The relative price efficiency analysis indicated that labor was being used inefficiently on large farms and fertilizer was being used inefficiently on small farms. It also indicated that labor and irrigation water were used more judiciously by informal irrigators than

by formal irrigators. These indications support the need to integrate informal and formal irrigation to take advantage of the strengths of each system.

African agriculture is in crisis. The abundant natural resources of the continent must be harnessed to increase food and fiber production. One limiting factor in crop and livestock production in Africa is rainfall. The distribution of rainfall over time and space and the undependability of rain are major nonhuman constraints in African agricultural production. In fact, the 1988 floods in Sudan, Nigeria, Burkina Faso, Mali, and other areas in the Sahel have shown the distribution of rainfall to be more important than quantity. Drought and floods can occur on the same lands.

Irrigation harnesses surface and ground water for agricultural production. Irrigation offers a means of overcoming the limitations imposed on agricultural production by unreliable, erratic, and unpredictable rainfall.

Research on irrigated agriculture in some developing countries, especially those of South Asia, has shown that properly functioning irrigation systems or schemes can benefit farmers, especially in situations where other inputs, such as high-yielding crop varieties, fertilizers, and pest- and disease-control chemicals are also used (Herrington, 1972; Griffin, 1979; Singh, 1982).

Although some parts of Africa have practiced water control for centuries, irrigation is not yet widely used on the continent as a whole. According to Brown and Wolfe (1985), Africa has 11% of the world's population but only 4% of its irrigated area (4.7% according to FAO estimates, 1986). Irrigation is concentrated in a few countries, notably Egypt and the Sudan. Sub-Saharan Africa has few successful irrigation schemes. Many irrigation projects seem to have wasted efforts and funds (World Bank, 1979; Club du Sahel, 1983; Kamuanga, 1983; Adams and Grove, 1984). However, the potential of irrigation requires that it receive further consideration.

PROBLEM DEFINITION AND OBJECTIVES OF STUDY

More than half the land area of Nigeria is arid or semiarid and can support crop production for only 3 to 6 months a year under rainfed conditions. This situation is partly responsible for the overall low production of food and fiber in the country. The rainfall pattern prevents efficient use of land, labor, and other

resources and makes adoption of improved technology difficult. Agricultural production could be expanded in the arid and semiarid areas if irrigation were used more widely and efficiently.

Nigeria has spent large sums to build infrastructure for irrigation, especially in the central and northern parts of the country, but the contribution of irrigation to agricultural production remains low (Adams and Grove, 1984; Adeniji, 1985). The production and productivity of irrigation projects must be increased, and as future irrigation structures and methods are planned, they must avoid mistakes made in current schemes and projects.

The Nigerian government's efforts to develop water resources have shifted in recent years from large-scale to medium- and small-scale irrigation projects. Following Nwa (1987), a large-scale formal irrigation scheme includes at least 500 ha, a medium-scale scheme has 50 ha to 500 ha, and a small-scale scheme has less than 50 ha. Little information is available on the relative economic efficiencies of small-, medium-, and large-scale irrigation schemes. The current policy shift seems to be based on intuition rather than on empirical evidence. The common belief is that the success or failure of an irrigation project is not determined by size but by the degree of private-sector involvement in the project. While almost all government-controlled irrigation projects in Nigeria are considered failures, informal irrigators -- those not in government-owned schemes -- using 2-in. and 3-in. petrol pumps continue to throng the valley bottoms of streams and rivers to produce horticultural crops during the dry season.

Informal irrigation systems have grown phenomenally in the last few years, which suggests that they are profitable. However, informal systems cannot meet all of Nigeria's irrigation needs. As Fotzo (1983) asked: Can informal small-scale irrigation, which depends only on rainfall, run-off, and natural storage, achieve the major objectives of irrigated agriculture? Carter and Kay (1984) claimed that intensifying small-scale irrigation in the Nigerian river bottoms would lead to pumping problems in the future, while Erhabor (1982) pointed out that the lack of water constrains the expansion of irrigated area.

Identifying the constraints to irrigated agriculture in Nigeria requires the empirical determination of the relative efficiency of agricultural production in informal and formal irrigation systems as well as the relative efficiency of irrigated systems based on their size. Irrigated agriculture involves limited land and is labor intensive; hence, farm-size efficiency considerations are important in irrigation research. Both the size of the farm and the size of the irrigation system must be considered.

This study compared informal irrigation systems with small- or medium-scale formal irrigation systems in two middle-belt states of Nigeria to identify factors that could increase agricultural production and the productivity of irrigation projects in the country.

The objectives of the study were

- to study the socioeconomic characteristics of informal and formal irrigators
- to determine the relative economic efficiency of small and large irrigated farms
- to determine the relative economic efficiency of agricultural production in informal and formal irrigation systems
- to determine the relative economic efficiency of agricultural production in small- and medium-scale formal irrigation systems
- to identify the factors causing differences in efficiency among the different types and scales of irrigation systems

SAMPLING AND DATA-COLLECTION PROCEDURES

Primary data was collected by administering structured questionnaires to selected farmers -- some who did not participate in formal irrigation schemes and some who did -- in Niger and Kaduna states of Nigeria. Secondary data was obtained through informal interviews with irrigation authorities and technical staff.

After a pilot survey of six middle-belt states, seven irrigation areas were selected: Agaie, Bida, Chinchanga-Minna, and Wushishi in Niger State and Bagoma, Kaduna Gardens, and Galma-Shika in Kaduna State.

Sampling frames of farmers were difficult to obtain, even in formal irrigation schemes, so the numbers of irrigators in the various areas were estimated with the help of field workers. Then, through systematic random sampling, a sample of farmers was selected for study.

Informal and formal irrigators were sampled separately. For each area, 11 to 16 informal irrigators and 7 to 18 formal irrigators were chosen, based on the estimated number of irrigators in the area.

Three vehicles were used to collect primary data, a comprehensive survey, cost-route data collection, and output data collection and measurement. The comprehensive survey was conducted in January and February 1988. The informal irrigators had started preparing land in November 1987. Due to a variety of problems, irrigation activities in the formal irrigation schemes did not start until February 1988.

Separate questionnaires were developed for informal and formal irrigators. Information was collected on each irrigator's general socioeconomic characteristics; production activities, including resource use, costs, output, and returns; receipt of technical and credit assistance; and marketing practices and problems.

The general survey was followed immediately by a limited cost-route data collection, which aimed to strengthen the reliability of the data collected in the general survey. Because of the large sample size, the farmers were divided into two groups, and the cost-route data was collected from each group in alternate weeks for one month. In effect, therefore, this data was collected twice a week from each farmer for 2 weeks. However, the data was collected at the peak of irrigation activities, in March and April, which improved the reliability of the survey data and helped to clarify responses to the general survey. Other activities of irrigators also were observed.

Some output from two farms in each irrigation area was measured. It was difficult to measure harvests of each farmer throughout the irrigation season. Prices varied daily -- often they varied widely within the same day -- so output could not be translated into revenue received. However, most farmers kept records of their total income, particularly when requested to do so.

The 14 farmers from whom detailed output data was sought were chosen on the basis of their willingness to cooperate and their variety of crop combinations. They were requested to keep accounts of all harvests. The study team then recorded the harvests as they visited the farmers. A few baskets, bags, and bales of the crops were bought and weighed to determine the output in standard units.

CHARACTERISTICS OF IRRIGATION IN THE STUDY AREA

Informal small-pump irrigation is used in many of the valley bottoms of rivers and streams, called *fadama*, in the study area. No attempt has yet been made to determine the number of informal irrigators or the area covered by informal

irrigation in any part of the country. The results of this survey suggested that the area under informal irrigation in Niger and Kaduna states was at least 12 times greater than that under formal irrigation. During the 1987-88 season, the area under formal irrigation was estimated at about 834 ha for Niger State and 1,012 ha for Kaduna State, for a total of 1,846 ha. The estimates were for area under irrigation and not "developed" area or potential area for irrigation -- some areas reported as developed were yet to be developed enough for irrigation. The above estimates implied that the area under informal irrigation was about 22,200 ha. Since the average area per informal irrigator was about 0.82 ha, the two states had about 27,000 informal irrigators.

One of the effects of irrigation is that it increases the gross area under crop production. Thus, the impact of irrigation in an economy can be measured by the intensity of cropping -- the ratio of gross cropped area to net cropped area, expressed as a percentage. For example, if a piece of land is cropped twice in a year, the intensity of cropping is 200%. If half the land is flooded during the rainy season and only half is cultivated, but the whole area is cultivated in the dry season, the intensity of cropping is 150%. The measurement can be applied to a whole state or country. The intensity of cropping in irrigated lands in Nigeria is less than 150% because most of the *fadama* are not cultivated during the rainy season. This is one of the greatest constraints to informal irrigation. Most of the formal irrigated lands are cultivated at least twice a year. The possibility of cultivating irrigated land twice a year is an important factor in assessing relative efficiency and profits as well as the desirability of irrigation projects or systems. However, this study did not have adequate information to take these factors into account.

Informal irrigators use mainly 2-in. (about 3.5-hp) and 3-in. (about 5-hp) petrol pumps. The pumps may be individually or jointly owned or they may be hired. Few irrigators still use the traditional *shaduf* system, a simple lever system to take a limited amount of water from small streams using calabashes and small buckets to irrigate limited areas on the banks of streams.

Formal irrigation takes place along valley bottoms where dams are built across rivers or streams. Wherever formal schemes are found on one bank of a river, informal irrigation will be found on the other bank or close upstream or downstream.

All the formal irrigation schemes in this study had pump problems. Pumps frequently broke down, especially in the state government schemes. When farmers were asked about the problems of the irrigation schemes, almost all of them said frequent pump breakdowns were the most serious problem. Other problems in formal irrigation schemes included the limited amount of irrigable

area, farmers' lack of freedom to choose which crops to cultivate, and discrimination by officials of the schemes (see table 1).

The location, soil type, and microclimate of farms and the preferences and expectations of farmers determined which crops were grown. During the 1987-88 season, the primary crops grown in Niger State were peppers and leafy vegetables; the primary crops grown in Kaduna State were tomatoes, garden eggs, maize, peppers, and onions (see table 2).

Irrigated farms in Nigeria were generally much smaller than rainfed farms. Also, farms in formal irrigation schemes were much smaller than farms using informal irrigation. The distribution of farm size was not uniform between locations.

Four of the areas chosen for study -- Bida, Chichanga-Minna, Galma-Shika, and Kaduna Gardens -- are within or very near towns and cities. Two areas -- Agaie and Bagoma -- are close to main trunk roads. Wushishi is in a relatively rural area, far from a major town or trunk road. Most of the produce from Wushishi is sold to marketers who travel from the towns and cities. Since the crops grown under irrigation are usually sold, the location of the farm in relation to roads and towns may affect its profitability.

RESTRICTED PROFIT FUNCTION APPROACH TO DETERMINING EFFICIENCY

The restricted unit profit function approach to determining relative economic efficiency was used to analyze the data. The unit profit function has been used extensively in determining relative economic efficiencies in agriculture, including irrigated agriculture, in developing countries (Lau and Yotopoulos, 1972; Yotopoulos, Lau, and Lin, 1976; Kalirajan, 1981a, 1981b). Though the approach has advantages over the traditional neoclassical production function, the frontier production function, linear programming, and other methods, it also has limitations. The approach was modified for this study to accommodate the nature of irrigated agriculture in Nigeria and the type of data collected.

A neoclassical production function might be stated as

$$Q = f(X, Z) \tag{1}$$

where Q is the total quantity of output of a crop or crops, X is the vector of quantity of variable inputs, and Z is a vector of quantities of fixed inputs.

Profit (π') can therefore be stated as

$$\pi' = PQ - \sum_{i=1}^{m} r_i X_i \tag{2}$$

where P is the price (or weighted price) of output, r_i is the price of the ith variable input, and m is the number of variable inputs.

For profit maximization,

$$\frac{\partial f}{\partial X_i} = \frac{r_i}{P} = q_i \tag{3}$$

which implies that $r_i = Pq_i$ where q_i is the normalized price of the ith variable input. The normalized price is nominal price divided by the price of the output.

The demand for the ith variable input may be given as

$$X_i^* = f_i(q,Z) \quad i = 1 \ldots m \tag{4}$$

where X_i^* denotes the optimum quantity of the ith input and q is the vector of normalized prices of variable inputs. The optimum quantity gives the maximum profit.

From equations (2) and (3), a restricted profit function may be defined as

$$\pi = P(Q - \sum_{i=1}^{m} q_i x_i) \tag{5}$$

It is the total value of output minus the total cost of the variable inputs of production. It is a gross margin or the "surplus" appropriated by the fixed inputs of production, according to Yotopoulos and Lau.

When equations (1) and (4) are substituted into (5), the normalized restricted profit (π^*) function is obtained.

$$\pi^* = \frac{\pi}{P} = f_i(q,Z) - \sum_{i=1}^{m} q_i f_i(q, Z) \tag{6}$$

Thus

$$\pi^* = G(q, Z).$$

Thus, the normalized restricted profit function is a function of the normalized prices of variable inputs and the physical quantities of fixed inputs. It follows that the restricted profit function (π) -- not normalized -- is a function of a vector of variable input prices -- not normalized -- and the quantities of the fixed inputs as indicated.

$$\pi = \phi(r, Z). \tag{7}$$

In the restricted profit function, the independent variables are truly independent or exogenous; thus estimation of the function will not result in simultaneous equation bias.

Variable factor demand functions are usually obtained and estimated jointly with the restricted-unit profit function. The factor demand functions are obtained by directly differentiating the normalized restricted profit function with respect to the normalized prices for the various factors and by invoking Shepherd's lemma, which states that the negative of the first derivative of the normalized unit profit function, with respect to the normalized input price, is the optimal variable input quantity or the factor demand function. The demand function for a factor, for labor for example, may be given as

$$-\frac{Wx_1}{\pi^*} = b_1^* \text{ or } -\frac{Wx_1}{\pi} = b_1 \tag{8}$$

where x_1 is total labor used, π^* is the normalized profits, π is the nonnormalized profits, and b_1^* and b_1 are the corresponding regression coefficients of the price of the factor. The factor demand functions allow the components of technical and price efficiencies to be identified separately.

Jointly estimating the restricted unit profit function and the factor demand function raises the problem that the equations might be related through their error terms. If the errors of the equations are correlated, using ordinary least-squares estimation will result in inefficient, though consistent, regression coefficients. In such cases, Zellner's method (Zellner, 1962) can be used.

The restricted profit function is appropriate for determining relative efficiencies as a result of different farm sizes, technologies, and scales of operation. These differences also result in differences in farmers' abilities to maximize profits. Input and output prices also differed in the study area because sources of input procurement, transportation costs, and the times of purchase and sale varied.

The variable inputs used in irrigated agriculture include labor, seeds and seedlings, fertilizers, pesticides, and irrigation water. Farmers usually obtained vegetable seeds from the previous year's crops or from friends and relatives at no cost. Seedlings were usually produced by the farmers -- the only cost was that of their labor. Pest- and disease-control chemicals were used by few of the surveyed farmers, and those who used chemicals used small quantities, so pesticides were ignored in estimating the profit functions. Frequency of irrigation was considered an important variable in the analysis.

Using the Cobb-Douglas function, the following restricted profit functions and their corresponding factor demand functions were estimated. The restricted profit and the factor prices were not normalized.

Equations (9) to (12) were estimated to determine the relative economic efficiency of small and large irrigated farms.

$$\ln \pi = \ln A + a_s D_s + b_1 \ln W + b_2 \ln I + b_3 \ln R + a_1 \ln H + a_2 \ln FAL + a_3 \ln FIX + \sum_{j=1}^{6} d_j D_j \quad (9)$$

$$-\frac{WL}{\pi} = b_1^s D_s + b_1^L D_L \quad (10)$$

$$-\frac{IG}{\pi} = b_2^s D_s + b_2^L D_L \quad (11)$$

$$-\frac{RF}{\pi} = b_3^s D_s + b_3^L D_L \quad (12)$$

where

π = restricted profit per farm (₦), calculated as revenue from output minus hired labor costs and variable costs

W = daily wage rate for hired labor, including expenditure on food provided (₦)

I = unit variable cost of irrigating the farm (₦), calculated as expenditure on the variable cost items (excluding labor) for irrigation divided by the number of irrigations during the season

R = price per bag of fertilizer, including the cost of transporting the bag from point of purchase to point of use (₦)

H = irrigated area (ha)

FAL = family labor, including farmer's own labor, used on the farm during the irrigation season (worker days)

FIX = value of fixed assets used exclusively for irrigation, such as irrigation pumps (₦)

D_S = small-farm dummy variable (1 for small farms, 0 otherwise)

D_L = large-farm dummy variable (1 for large farms, 0 otherwise)

D_j = irrigation area (location) dummy variables; seven irrigation areas were studied; six dummies have been specified; Galma-Shika was excluded; $D_1 = 1$ and 0 otherwise for Agaie; $D_2 = 1$ and 0 otherwise for Bida; $D_3 = 1$ and 0 otherwise for Chinchanga-Minna; $D_4 = 1$ and 0 otherwise for Wushishi; $D_5 = 1$ and 0 otherwise for Bagoma, and $D_6 = 1$ and 0 otherwise for Kaduna Gardens.

L = total labor hired (worker days)

G = total number of irrigations in an irrigation season

F = total bags of fertilizer used

All other notations in the equations are regression coefficients or constants.

The average area irrigated by the 102 informal irrigators was 0.82 ha (see table 3). Thus, all farms with more than 0.8 ha were designated as large; all others were designated as small. The average area cultivated by the 75 formal irrigators was 0.44 ha. Thus, all farms with more than 0.4 ha in the formal schemes were designated as large; all others were designated as small. The relative efficiencies of small and large farms were therefore treated separately for formal and informal irrigation.

A model specification similar to equations (9) through (12) was used to estimate the relative economic efficiencies of informal and formal irrigation. However, the small- and large-farm dummies, D_S and D_L, were replaced with informal- and formal-irrigation dummies, D_I and D_F.

Agaie, Bida, Chinchanga-Minna, Wushishi, and Kaduna Gardens were small-scale formal schemes; Bagoma and Galma-Shika were medium-scale schemes. The relative economic efficiency of small-scale and medium-scale formal irrigation schemes was determined. The model specification was similar to those mentioned above, but scale dummies replaced the size dummies: $D_N = 1$ if farmer was operating a medium-scale scheme, 0 otherwise.

The seven irrigation areas studied differed in soil type, microclimate, rurality, market structure, and other factors. All of these factors affect farm output and profitability. Any economic efficiency comparisons should be devoid of these influences; hence, the location dummies were used to capture influences that arose solely because of the location. The location dummies were necessary since the

profit function was not normalized by the price of output. The dummies removed any output price influences on the efficiency parameters since prices, especially output prices, tend to be location specific.

The restricted profit functions used for this study differed from the versions usually used:

- The profit and input prices were not normalized in this study because prices of output could not be determined adequately due to wide variations in price over short periods of time.

- Family labor was regarded as a fixed input. The farmers make decisions based on availability of family labor, which does not vary with the level of output.

- Capital stock, rather than capital flow (interest on capital) was regarded as fixed capital. If land (not rent) and family labor (not the opportunity cost of labor) are regarded as fixed inputs, then capital stock (not interest on capital) should be regarded as the fixed capital input.

- The ordinary least-squares method, rather than Zellner's or Kalirajan's application of Aitkins generalized least-squares methods, was used due to technical constraints.

ANALYSIS OF RELATIVE EFFICIENCIES IN IRRIGATED AGRICULTURE

Using the formulas explained above, the relative economic and price efficiencies were calculated. In addition, the absolute price efficiencies were calculated.

Relative Economic Efficiency

The estimates of the Cobb-Douglas profit function for the four sets of farm groups (see table 4) indicated that

- Small and large farms were economically efficient to the same degree.

- The coefficient of the irrigation system dummy variable (D_I) was statistically significant; thus, informal and formal irrigation systems differed in economic efficiencies. The positive sign of a_I indicated that informal irrigation was more economically efficient.

- The parameter a_N could not be estimated due to the insignificance of the influence of the irrigation scale dummy variable D_N on unit profit. This implied economic efficiencies of small-scale and medium-scale irrigation in the study area did not differ.

Except in the comparison of informal and formal systems, some independent variables -- wage rate, fertilizer price, and family labor -- that were considered important did not have any significant explanatory power, as indicated by their t-ratios, in spite of the high R^2 values. This finding suggested high multicollinearity, probably with respect to the fixed inputs: land, family labor, and fixed assets. The equations could be reestimated using the generalized least-squares method to see if better estimates would be obtained. However, the emphasis of this estimation was on the variables that indicated relative economic efficiencies -- D_S, D_I, and D_N, and those variables were not affected by any multicollinearity problem.

Relative Price Efficiency

Factor demand functions were used to test for relative price efficiencies (see table 5). In comparing small and large farm groups using informal irrigation, the price efficiencies of hired labor differed significantly. The small farms were relatively more wage price efficient than the larger farms. The wages paid by farmers with small hectarages were closer to the marginal value products of the hired labor than those paid by farmers with large hectarages. Even if the same wages were paid, price efficiencies could differ because of differences in the marginal value products of labor. There were no significant differences in irrigation water price efficiency and fertilizer price efficiency.

In comparing small and large farm groups using formal irrigation, price efficiencies of hired labor and fertilizer differed significantly, but price efficiencies of irrigation water did not. Small farms were more wage price efficient, while large farms were more fertilizer price efficient. This implies that either labor resources were wasted on large farms and fertilizer was wasted on small farms or too little labor was used on large farms and too little fertilizer was used on small farms. The latter situation is more probable.

In comparing informal and formal irrigation farm groups, all of the variable factor price efficiencies were significantly different. Wage price and irrigation water price efficiencies were higher in informal irrigation; fertilizer price efficiency was higher in formal irrigation. This means labor and irrigation water were used more judiciously by informal irrigators; however, informal irrigators tended to apply either too much or too little fertilizer. Again, it is more likely that they used

too little fertilizer because fertilizer is generally unavailable at the right time, especially to informal irrigators.

In comparing small-scale and medium-scale formal farm groups, all of the variable factor price efficiencies were not significantly different. That means all three factors were equally price efficient, irrespective of the scale of the irrigation scheme.

Absolute Price Efficiencies and Profit Maximization Objective

Absolute price efficiencies were determined by testing whether the calculated coefficients for the factors were equal to the factor prices. Separate calculations were made for small and large farm groups. Both sets of hypotheses were rejected at the 5% level of significance, implying that neither small farms nor large farms were maximizing profits.

The conclusions were similar for the informal farm group, the formal farm group, the small-scale farm group, and the medium-scale farm group. None of the farm groups equated the marginal value products of all variable factors to their marginal factor costs (prices). Therefore, if the goal of production is profit, resources could and would have to be used more efficiently. Profit maximization appears to be a main goal of production in irrigated agriculture in Nigeria because negligible amounts of produce are consumed by the farmers' households and horticultural crops cannot be stored for future use. The other goal of irrigated agriculture, from the farmers' perspective, is to gainful employ farmers during the dry season. These two goals reinforce each other. Hence, efforts should be made to improve efficiencies in the use of resources.

A MODEL FOR INTEGRATING INFORMAL AND FORMAL IRRIGATION

The need for irrigated agriculture in Nigeria is no longer being debated. Now the debate concerns how to execute programs and projects successfully. Past attempts to develop irrigation have generally failed in Nigeria and in most parts of sub-Saharan Africa. Therefore, a deeper understanding of irrigated agriculture is called for. This study concentrated on determining the relative efficiencies of different farmer groups participating in irrigated agriculture to identify opportunities for improving production and productivity.

The results of the study showed that horticultural crops were grown on irrigated farms that averaged only 0.82 ha in informal systems and 0.44 ha in formal systems. The primary problem for informal systems was that the small pumps

used could pump water only to the banks of rivers, thus limiting the area that could be irrigated. Problems in the formal systems included frequent breakdowns of irrigation water pumps, farmers' lack of freedom to choose which crops to cultivate, and discrimination by government officials.

The relative efficiency analysis indicated that current irrigated farm sizes were equally efficient in economic terms, which implies that irrigators could be encouraged to increase their areas under irrigation without any significant loss in efficiency. Comparing formal and informal irrigation, the analysis clearly showed that informal irrigation was more economically efficient, which suggests a need for less government control of irrigation projects. The government should continue to play a role in irrigation development, however, because the potential for expanding the area under informal irrigation is limited. Basic irrigation infrastructure, such as dams, canals, and even pumps, have to be provided partly by government.

One approach to addressing Nigeria's irrigation needs would be to integrate formal and informal irrigation systems (see figure 1). Each stage of integration could take up to 5 years to accomplish. Successful irrigated agriculture will only develop through a well-guided evolutionary process.

In the first stage, an irrigation commission would be established. It would encourage cooperative spirit among irrigators, provide extension services to both formal and informal irrigators, and provide loans to informal irrigators for purchasing larger pumps.

During the second stage, irrigation and agricultural extension services would be intensified, and farmers would be encouraged to form irrigation communes.

The third stage would involve constant interaction between the commission and the communes to develop proposals for building infrastructure for new irrigation schemes and for rehabilitating the existing infrastructure. The commission and communes also would negotiate with landowners on land-use matters. Irrigation infrastructure would be built in suitable areas, and informal and formal systems of irrigation would be integrated.

Finally, the commission's agroindustrial and food policies and its market-intervention strategies would affect the market, and the farmers would shift to producing the desired crops.

The relative price efficiency analysis indicated that labor was used inefficiently on large farms and fertilizers were used inefficiently on small farms. It also indicated that labor and irrigation water were used more judiciously by informal irrigators

than by formal irrigators. These indications support the need to integrate informal and formal irrigation to take advantage of the strengths of each system.

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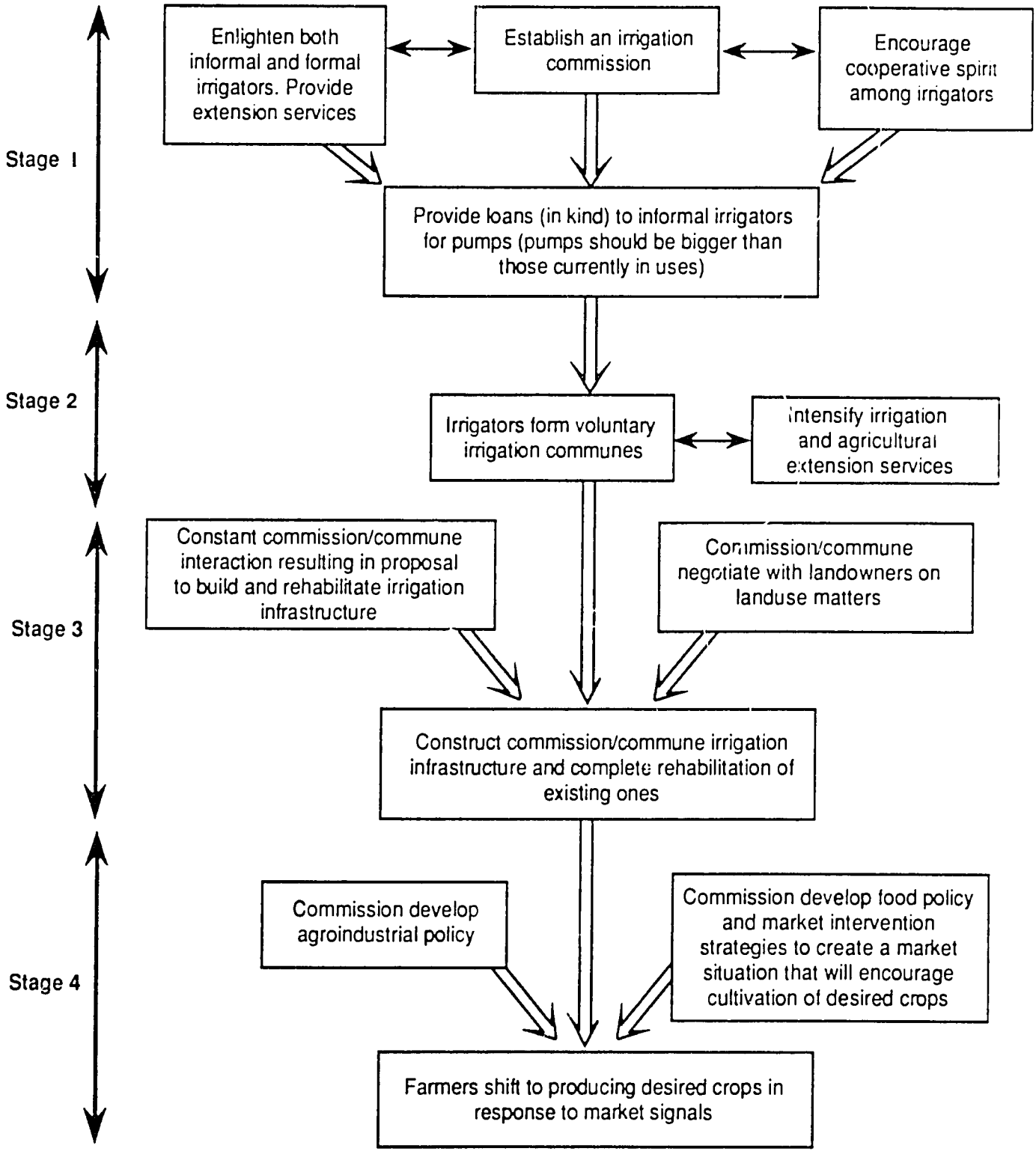

Figure 1: Informal/formal irrigation integration model

Table 1. Major problems of formal irrigation schemes reported by informal and formal irrigators, Nigeria, 1987-88.

Area	Frequent pump breakdowns		Plots too small		Difficulty getting plots		Lack of freedom to choose crops		Discrimination by officials	
	informal	formal	informal	formal	informal	formal	informal	formal	informal	formal
Agaie	4	0	5	11	8	4	9	5	4	0
Bida	16	10	8	6	3	4	2	0	3	0
Chinchanga-Minna	11	10	11	8	4	2	0	0	4	0
Wushishi	2	0	9	7	10	6	4	5	5	2
Bagoma	9	6	3	6	6	7	3	1	1	0
Kaduna Gardens	12	6	6	7	6	1	3	0	3	0
Galma-Shika	10	12	8	8	2	9	4	4	6	3
Total	64	44	50	53	39	33	25	15	26	5

Note: The 102 farmers were each asked to indicate two problems.

Table 2. Crops cultivated by irrigators, 1987-88 season, Nigeria.

Crop	Niger State (n=111)		Kaduna State (n=66)		Total (n=177)	
	No. of irrigators	% of irrigators	No. of irrigators	% of irrigators	No. of irrigators	% of irrigators
Peppers	100	90	45	68	145	82
Leafy vegetables	59	53	32	49	91	51
Tomatoes	16	14	53	80	69	39
Onions	25	23	43	65	68	38
Okra	38	34	30	46	68	38
Sugarcane	48	43	19	29	67	38
Garden eggs	11	10	53	80	64	36
Maize	9	8	48	73	57	32
Carrots	6	5	34	52	40	23
Rice	6	5	11	17	17	10

Table 3. Average farm sizes (ha) in irrigation areas of Nigeria, 1987-88.

Irrigation area	Informal irrigation		Formal irrigation	
	Average	(Std. dev.)	Average	(Std. dev.)
Agaie	0.91	(0.38)	0.44	(0.13)
Bida	0.88	(0.47)	0.52	(0.19)
Chinchanga-Minna	0.47	(0.15)	0.04	(0.02)
Wushishi	1.10	(0.44)	0.40	(0.0)
Bagoma	0.78	(0.34)	0.46	(0.26)
Kaduna Gardens	0.97	(0.35)	0.88	(0.28)
Galma-Shika	0.63	(0.24)	0.48	(0.28)
Total study area	0.82	(0.40)	0.44	(0.28)

Table 4. OLS estimated values of Cobb-Douglas profit functions for data collected from irrigators, Nigeria, 1987-88.

Variable	Designation	Parameter	OLS small and large farms -- informal	OLS small and large farms -- formal	OLS informal and formal	OLS small-scale and medium-scale -- formal
Constant		ln A	6.1777*** (0.7390)	9.2154*** (1.5345)	6.3994*** (0.6219)	12.8188** (2.0072)
Farm size dummy	D_S	a_S	0.0101 (0.0519)	-0.0876 (0.1085)		
Irrigation system dummy	D_I	a_I			0.1801*** (0.0519)	
Irrigation scale dummy	D_N	a_N				see note (c)
Wage rate	ln W	b_1	0.1124 (0.2957)	-1.1666* (0.7113)	-0.3077 (0.2627)	-1.6948*** (0.6812)
Irrigation cost per unit	ln I	b_2	0.2040** (0.0982)	see note (c)	0.0533** (0.0265)	-1.1500*** (0.4391)
Fertilizer price	ln R	b_3	0.1694 (0.2662)	0.1536 (0.1117)	0.4173*** (0.0925)	0.1054 (0.1073)
Hectarage	ln H	a_1	0.4511*** (0.0902)	0.6329*** (0.09421)	0.5706*** (0.0474)	1.7736*** (0.4349)
Family labor	ln FAL	a_2	0.0518 (0.0715)	0.0793 (0.0715)	0.156*** (0.0518)	0.0525 (0.0708)
Fixed assets	ln FIX	a_3	0.1235*** (0.0271)	0.1086 (0.1417)	0.0724*** (0.0135)	0.1723 (0.1099)

[a]Figures in parentheses are standard errors of estimates.
[b]Location dummies are excluded.
[c]Coefficients of variables not estimable due to extreme insignificance.
*$p < 0.1$ **$p < 0.05$ ***$p < 0.01$

Table 5. Factor demand functions for data collected from irrigators, Nigeria, 1987-88.

	Hired labor	Irrigation water	Fertilizer
Farm groups using informal irrigation, distinguished by hectarage			
Small	-0.0472	-0.1176	-0.0148
	(0.0099)	(0.0062)	(0.0008)
Large	-0.1934	-0.1041	-0.0136
	(0.0145)	(0.0091)	(0.0012)
Farm groups using formal irrigation, distinguished by hectarage			
Small	-0.0174	-0.0714	-0.0209
	(0.0058)	(0.0088)	(0.0010)
Large	-0.0840	-0.0631	-0.0156
	(0.0097)	(0.0146)	(0.0016)
All farm groups, distinguished by type of irrigation system			
Informal	-0.0931	-0.1134	-0.0144
	(0.0088)	(0.0059)	(0.0007)
Formal	-0.0284	-0.0720	-0.0207
	(0.0114)	(0.0077)	(0.0009)
Farm groups using formal irrigation, distinguished by scale of irrigation system			
Small scale	-0.0193	-0.0700	-0.0411
	(0.0079)	(0.0185)	(0.0039)
Medium scale	-0.0241	-0.0551	-0.0364
	(0.0088)	(0.0191)	(0.0030)

Notes: Standard errors are in parentheses.
For all regression coefficients, $p < 0.05$; for many, $p < 0.01$.

MULTIOBJECTIVE FARM PLANNING FOR SMALL-SCALE FARMERS IN OGUN STATE, NIGERIA

Bamidele O. Durojaiye

SUMMARY

Small-scale farmers account for most of the food production in Nigeria and other African nations. If agricultural policy is to help them use their resources efficiently, optimum farm plans should be formulated for them by regions or locality. Unfortunately, the few farm-planning models currently available in many of these countries are not useful.

A survey of 51 farm households in Ijebu-North Local Government Area of Ogun State, Nigeria, was conducted in 1988 to obtain the information necessary to formulate a farm plan for the representative farm household in the study area. The average farm household had five family members, and the typical farmer interviewed was male, married, and 48 years old and had a primary-level education. Interplanting cassava/maize/cocoyams, interplanting cassava/maize, and cultivating maize in segregated stands accounted for 74% of total crop-production activities. The average farm size was 2.8 ha; most fields were less than 2 ha. Farm operations relied primarily on household labor and traditional farming practices. Operating capital averaged only ₦ 500, and none of the farmers used borrowed funds.

All of the farmers surveyed had more than one production objective. Using the method of paired comparisons, these objectives were ranked in descending order of importance as follows: maximizing gross margin, satisfying family food requirements, maximizing revenue, and minimizing out-of-pocket expenses. Only the difference in preference between satisfying family food requirements and maximizing gross revenue was statistically significant at the 5% level.

A farm budget was generated to reflect the average land, labor, and capital resources of the farm households surveyed. Yields and prices were also derived from the 1988 survey data. This information was incorporated into standard linear-programming models, which were used to elicit the optimal, feasible values for three of the production objectives, subject to the additional constraint that minimum family food requirements of 2,000 kg of food grain be met. The resulting payoff matrix showed that the maximum gross margin and revenue attainable, ₦ 9,953 and ₦ 10,453, respectively, required the entire ₦ 500 available to the farmer for out-of-pocket

expenses. Conversely, if out-of-pocket expenses were minimized subject to the predetermined constraints, gross margin fell to ₦ 2,394 and revenue dropped to ₦ 2,579.

The trade-off curves between the competing objectives were estimated by first generating the set of nondominated solutions to the farm-planning problem using the noninferior set estimation method. The slopes of the resulting trade-off curves indicated the opportunity costs of furthering one competing objective at the expense of the other. The goal-programming approach was then used to solve the multiobjective farm-planning problem for the optimal, nondominated solution.

Three variants of goal programming have been defined in the literature, differing primarily in their approaches to minimizing the deviation of objectives from their target levels. Due to limited resources for research, only the preemptive-weights version of goal programming was pursued in this study. According to this method, the objectives were iteratively optimized in the order of their predetermined priority. Using this technique, the target level for each objective was met or surpassed, with the exception of the cash-expenditure target. The solution suggested that the typical farmer in the study area should devote 2.47 ha of land to producing cassava/maize/cocoyams invest ₦ 500 in out-of-pocket expenses, and supplement family labor with 30 days of hired labor.

When the possibility of borrowing capital was incorporated into the analysis, the solution values for gross margin and revenue increased by ₦ 1,250 and ₦ 1,408, respectively; the recommended level of hired labor increased; and all of the household's farmland was devoted to producing cassava/maize/cocoyams. At the margin, ₦ 1 in borrowed capital could yield up to ₦ 11 in additional farm income.

Sensitivity analysis revealed that the solutions reached through preemptive-weights goal programming were highly sensitive to the order in which competing objectives were optimized. Therefore, in cases where objectives are competitive and near equal in rank, it may be advantageous to use an alternate method of goal programming that allows for assigning nonpreemptive weights to the production objectives.

The farm-planning solution generated by this study indicated that the income of a representative farmer in the study area could be increased by about 50% under existing management practices without borrowing funds and without jeopardizing family food supplies. The use of as little as ₦ 134 in borrowed funds could raise the typical farmer's income by as much as 70%. These results offer strong evidence of the benefits that farm planning and credit availability could provide in raising the incomes and production of small-scale farmers.

Nigeria and other sub-Saharan African nations face an ever-worsening food crisis as the growth rate of effective demand for food in these countries continues to outpace the growth rate of food production (World Bank, 1986). Analysts have proposed a number of possible reasons for the deepening food shortfall, including a shortage of capital for agricultural investments, the use of inappropriate agricultural technology, the small and fractionated size of farms, lack of political will to effect desirable land-reform programs, technical and allocative inefficiencies in the use of resources, uncoordinated and inconsistent agricultural policies, uncontrolled population growth, and low and unequally distributed national incomes.

This diverse array of explanatory factors indicates that the problem of food shortage in sub-Saharan Africa is multifaceted, and an equally multifaceted approach will be required to resolve it. That approach should include formulating optimal farm plans for small-scale farmers who, together, account for most of sub-Saharan Africa's food production. To date, little attention has been devoted to the role of farm planning in the resolution of the food crisis.

A typical farmer anywhere in the world is faced with a myriad of choices for allocating the farm enterprise's resources between crop and livestock production possibilities to optimize production objectives. Identifying the best farm plan is a difficult task for any farmer, but it is especially difficult for small-scale farmers with little or no formal education. Consequently, farmers in sub-Saharan Africa, over 60% of whom operate on a small scale, have had to rely on tradition, intuition, or introspection to make farm-planning decisions. Yet Nigeria depends upon these small-scale farmers for over 80% of its food production.

If the limited resources available to the many small-scale farmers in Nigeria and other African nations are to be used efficiently, optimum farm plans must be formulated for these farmers by region or locality. These plans also could help policy-makers predict farmers' responses to policy alternatives, thereby sharpening the policy decision-making process. For example, how farm-production decisions would change given an additional hectare of land or the extension of ₦ 2,000 in credit could be predicted from the formulated plans.

Ideally, farm plans are established to meet farm-production objectives given existing resource constraints. Unfortunately, at the policy-making level in Nigeria and many other African nations, farm-planning models are either unavailable or based upon the simplistic assumption of profit-maximization as the single production objective. Farm-survey results such as those obtained by Fitzsimmons and Holmes (1958), Norman (1976), and Smith and Capstick (1976) indicate that maximizing profits is not necessarily the sole, nor even the most important, objective of small-scale farmers. Consequently, more-appropriate

farm planning models and better predictions of farmers' responses to policy changes could be obtained by adopting a multiobjective approach to farm planning.

METHODOLOGY AND PRELIMINARY FINDINGS

Survey information obtained from a sample of farm households in Ijebu-North Local Government Area (LGA) of Ogun State, Nigeria, was used to set up farm budgets reflecting existing production objectives, farm-management practices, and resource constraints. This information was used in a goal-programming model to formulate a farm plan for a representative farm household in the survey area. The resulting farm plan was then subjected to a sensitivity analysis to gauge the sensitivity of the results to changes in the weights and target values assigned to the production objectives.

Data Collection

Eight farming communities -- Origbe-nla, Aldelo, Odosenlu, Mamu, Mene, Egudugbu, Ago-Iwoye suburb, and the Farm Settlement -- were purposively selected for study. Representatives of 51 farm households from these communities were interviewed over a 3-1/2 months during the 1988 cropping season. Information on household characteristics, farm size and management, and farm-gate prices was obtained using structured questionnaires.

Crop yields were estimated by calculating the yields of 10, 10-m x 10-m plots on some of the sampled farms. The average number of stands of each crop in a particular crop mixture was determined, and the crops were later harvested and weighed to determine the per-hectare yield of each crop in the mixture. The computed yield figures were applied to the total hectares of each mixture established by each farmer to obtain production estimates. These production estimates were then valued at the prevailing market prices to estimate potential gross returns.

Information on labor use was collected throughout the survey period, to gauge the labor requirements for various farm tasks and to evaluate the relative contributions of family and hired labor. Family labor was converted to "manday" equivalents, using Norman's (1970) conversion table, where a man aged 15 to 60 is rated as 1.00 adult male equivalent, a woman aged 15 to 60 is rated as 0.75 adult male equivalents, an adult over age 60 or a child between the ages of 8 and 15 is rated as 0.50 adult male equivalents, and the labor contribution of children under age 8 is disregarded.

Estimates of the quantities of seeds and cuttings used by each farm household were based on farmer recall and valued at the prevailing market prices. In addition, each farm household's tools, buildings, and equipment were inventoried.

Study Area

The Ijebu-North LGA is the ninth largest of the 12 LGAs in Ogun State, extending over 96,902 ha and covering more than 200 towns and villages. It is the eighth-most populous LGA in the state, with a population of about 235,850. Agriculture is the predominant source of livelihood; 80% to 90% of the population resides in farm households.

The LGA is served by an inefficient network of urban and rural roads. Most of the roads connecting village to village and village to town are in poor condition and become impassable during the rainy season, posing a major constraint to marketing agricultural produce efficiently and developing the agricultural sector.

The regional climate follows the typical tropical pattern, with the rainy season starting about March and ending about October, followed by the dry season. The area receives about 1,400 mm of rainfall annually and has temperatures of 20°C to 30°C. Rain-forest vegetation predominates, with patches of mangrove forest in some sections.

Local climate and soil conditions are suited to the cultivation of a wide variety of crops. The principal food crops grown include maize, cassava, cocoyams, yams, and bananas. The main cash crops include cocoa, kolanut, and oil palm.

Household- and Farm-management Characteristics

The farm households surveyed had an average of five family members. The typical farmer interviewed was male, married, and 48 years old and had a primary-level education.

Almost all of the surveyed farmers interplanted a variety of food crops. About 74% of the crop-production activities practiced by the farmers consisted of interplanting cassava/maize/cocoyams, interplanting cassava/maize, or cultivating of maize in segregated stands. Cash crops were usually grown in segregated stands; however, in the early stages of growth some were interplanted with shade-providing crops such as cocoa and bananas. Some farmers owned separate fields for food and cash crops, although the fields

sometimes were kilometers apart. Most fields were less than 2 ha; the average total farm size reported by farmers was 2.8 ha.

Farm operations relied primarily on household labor and traditional farming practices. The predominant implements used were hand hoes and cutlasses, which usually lasted for one cropping season. Improved planting materials were not commonly used. On average, operating capital was as low as ₦ 500, and none of the farmers interviewed had borrowed funds.

Most food was grown for household consumption. Any marketable surplus was usually sold to the public or to wholesalers at local rural markets. Wholesalers from urban centers also sometimes bought directly from farms; farmers rarely transported their own produce to urban markets. Previously, cash crops were sold directly to government-licensed buyers at officially determined prices. At the time of the study, cash crops appeared to be marketed freely and competitively.

Farm-production Objectives

Four farm-production objectives were elicited from the farmers during the interviews: maximizing gross margin or profit, maximizing revenue, minimizing out-of-pocket expenses, and satisfying family food requirements. All of the farmers had more than one production objective; 94% had the three objectives other than maximizing revenue; 80% claimed all four objectives.

The farm-production-management objectives were ranked by using the method of paired comparisons (for other examples of the use of this method, see Smith and Capstick, 1976; Harper and Eastman, 1980; and Barnett, Blake, and McCarl, 1982). Each farmer was presented with a list of all possible pairs of elicited production objectives -- six pairs in all -- and asked to select the primary objective in each pair. The relative frequency with which an objective was chosen was used to establish its ordinal rank (see table 1). Using this method, the objectives were ranked in descending order of importance as follows:

- maximizing gross margin
- satisfying family food requirements
- maximizing revenue
- minimizing out-of-pocket expenses

This objective ranking was tested for statistical significance using the method reported by Urquhart and Eastman (1978) and employed by Harper and Eastman (1980). The test statistic for the 5% level of significance is

$$LSD = 1.96\,[B\,(n)(n + 1)/6]^{1/2}$$

where

LSD = the least significant difference between the number of responses
B = the number of farmers surveyed
n = the number of production objectives ranked.

The preference frequency for maximizing gross margin was not statistically different from the preference frequency for satisfying family food requirements; and the preference frequency for maximizing revenue was not statistically different from the preference frequency for minimizing out-of-pocket expenses. However, the ranking of the first two objectives, maximizing gross margin and satisfying family food requirements, over the remaining two objectives was statistically significant.

GENERATION OF OPTIMAL FARM PLANS

A farm budget was drawn up to reflect the average farm size, labor availability, and operating capital of the farm households surveyed. It was assumed that farmers allocated these resources among the three principal food-crop combinations produced: cassava/maize/cocoyams, cassava/maize, and maize. Labor availability and requirements were calculated separately for five consecutive periods during the year, based on average use of family and hired labor for various farm tasks during these periods. Yield estimates and prices of inputs and marketed produce were derived from survey results. The problem, then, was to elicit the set of feasible resource-allocation decisions that would optimize the attainment of farm-production objectives given the predetermined prices, per-hectare yields, labor requirements, and resource constraints. By solving this problem, the optimal farm plan for the typical farmer in the study area could be predicted.

Determining the Set of Nondominated Solutions

When limited resources must be allocated to meet multiple, competing objectives, all objectives cannot be optimized simultaneously. To test the relationships between the production objectives elicited from farmers in this study and to determine the ideal value for each objective, three of the objectives were

individually optimized using traditional linear-programming techniques, subject only to the predetermined resource constraints and the requirement that the fourth objective, satisfying family food requirements, be met. It was determined that a typical farm household in the study area, consisting of five members, would require about 1,360 kg of food grain each year to avoid serious health risks and stunted growth in children, based on standards recommended by the Food and Agriculture Organization of the UN and the World Health Organization. If an allowance of 50% of this estimate were added for extended family members, the typical farm household would need to produce a minimum of 2,000 kg of food grain each year.

The resulting payoff matrix for the four objectives showed that while maximizing gross margins and total revenue were complementary objectives, minimizing out-of-pocket expenses was highly competitive with each of the other objectives (see table 2). The maximum gross margin and revenue attainable (₦ 9,953 and ₦ 10,453, respectively) required out-of-pocket expenses of ₦ 500. In contrast, if out-of-pocket expenses were reduced to the minimum of ₦ 68 necessary to meet family food requirements, gross margin fell to ₦ 2,394 and revenue dropped to ₦ 2,579.

Evaluating methods of calculating trade-off curves. To determine the trade-off curves between the competing objectives, the set of Pareto-optimal (nondominated) solutions to the farm-planning problem must first be estimated; a nondominated solution is one that is generated by an allocation of resources that cannot be amended to further the attainment of one or more objectives without adversely affecting the attainment of another objective.

The four major ways to generate the set of nondominated solutions to a multiobjective problem are as follows:

- **the multiobjective simplex method**, in which all the extreme nondominated solutions are obtained by moving from one extreme nondominated solution to the adjacent extreme nondominated solution (Evans and Steuer, 1973; Zeleny, 1974)

- **the weighting method**, in which the objective function is defined as a weighted sum of the multiple objectives, and the nondominated solutions are obtained by parameterizing the weights (Gass and Saaty, 1955; Marglin, 1967)

- **the constraint method**, in which one of the objectives is optimized while the rest are specified as constraints, the nondominated solutions being obtained by parameterizing the right-hand sides of the objectives placed as constraints (Cohon and Marks, 1973; Haimes, 1973; Miller and Byers, 1973; Cohon, 1978)

- **the noninferior set estimation (NISE) method**, which uses a common linear-programming code iteratively and permits the exact generation of the nondominated solutions when only two objectives are involved (Cohon, Church, and Sheer, 1979)

Cohon (1978) showed that, although the multiobjective simplex method is the most efficient method for generating the nondominated solutions exactly, it is not a good approximating method because of an inherent deficiency in the algorithm.

The NISE method was employed in this study because of its two major advantages over the remaining two methods (Cohon, Church, and Sheer, 1979). First, the NISE method ensures full coverage of nondominated solutions with a minimum number of solutions. In contrast, the other two methods can lead to wasted efforts in the process of generating all the nondominated solutions. The constraint method relies on the analyst's ability to guess both the shape of the nondominated set in objective space and an appropriate increment for constraint values, and the weighting method further depends on the relationship of weights to the nondominated set. The second advantage of the NISE method is that it is the only method that allows the analyst to control the quality of the approximation of the nondominated set.

Some analysts, such as Romero, Amador, and Barco (1987), regard the NISE method as a variant of the weighting method because the NISE algorithm employs a weighted objective function, where the weights are established according to the slopes of the segments connecting the extreme nondominated solutions generated during the iterative process (for more detailed descriptions of these methods, see also Willis and Perlack, 1980).

Applying the NISE method. To generate the trade-off curve between out-of-pocket expenses and gross margin, the values of the objectives at their two extreme points, where expenses were minimized and where gross margin was maximized, were set as the bounds of the trade-off curve between the two objectives. Similarly, the points of minimum out-of-pocket expenses and maximum revenue were set as the bounds of the trade-off curve between those two competing objectives. The sets of nondominated solutions between these bounds, which when connected yield the trade-off curves, were generated via the NISE method (see figures 1 and 2).

The trade-off, or opportunity cost of furthering one objective at the expense of the other, is represented by the slopes of the line segments connecting the extreme, nondominated solutions. For example, the slope of line segment AB in figure 1 shows that in this portion of the trade-off curve, a ₦ 1 increase in out-of-pocket expenses would permit a ₦ 19.49 increase in gross margin. Similarly, the slope of line segment AB in figure 2 shows that the opportunity cost of withholding ₦ 1 of out-of-pocket expenses along this part of the curve is a loss of ₦ 20.15 in potential revenue. The opportunity cost falls to ₦ 10.60 per ₦ 1 of out-of-pocket expenses in segment BC of this curve.

Having generated the set of nondominated solutions, the relevant question becomes, "Which farm plan should the farmer select from the set of nondominated farm plans provided by the trade-off curves?" The answer depends upon the subjective preferences the farmer attaches to the various competing objectives. For example, if the farmer perceives that a reduction of ₦ 345 in out-of-pocket expenses does not compensate for a decrease of ₦ 6,725 in potential gross margin, then the farm plan given by point B in figure 1 will be selected instead of point A. A more formalized approach to solving for the optimal nondominated solution is illustrated below.

Solving for the Optimal Farm Plan

Two major approaches may be used to solve for the optimal, nondominated solution to a problem with multiple objectives: goal programming and compromise programming. These approaches differ largely in the manner in which the preferences of the decision-maker are articulated: The goal-programming approach depends on a priori articulation of preferences. The compromise-programming approach is a method for a posteriori articulation of preferences; that is, the preferences are implicit and are only made explicit after the solution has been arrived at (see Zeleny, 1982). The goal-programming approach was adopted for this study.

The goal-programming approach. Developed by Charnes and Cooper in 1961, the goal-programming approach has two distinct advantages over the traditional linear-programming approach. First, it allows for simultaneous solutions to a problem with multiple objectives; and, second, the objective function of a goal-programming model may be composed of nonhomogeneous units of measure, such as naira and kilograms.

Three principal variants of goal programming have been defined in the literature; preemptive goal programming, archimedean or nonpreemptive goal programming, and multigoal programming (Zeleny, 1982). All three variants rely on identical

specification of goals and constraints, differing only in the formulation of the objective function. The common goal-programming specification of linear goals and constraints is

$$\sum_{j=1}^{n} c_{ij} x_j + d_i^- - d_i^+ = b_i, \quad i = 1, 2, \ldots, m$$

where

x_j	=	n decision variables
d_i^-	=	the negative deviations of the ith objective from its target
d_i^+	=	the positive deviations of the ith objective from its target
b_i	=	m objective targets or goals
c_{ij}	=	technological coefficients

In formulating the objective function, either d_i^- or d_i^+ or both, corresponding, respectively, to the "at most", "at least", and "precisely" specification of goals, may appear in the objective function. All x_j, d_i^-, and d_i^+ must be nonnegative, and the goal deviations, d_i *and* d_i, are to be minimized.

The three variants of goal programming are differentiated by the way in which the goal deviations are minimized. The preemptive goal-programming formulation of the objective function is

$$\min \sum_{i=1}^{r} P_i f_i (d_i^-, d_i^+) = P_1 f_1(d_1^- d_1^+) + P_2 f_2(d_2^-, d_2^+) + \ldots + P_r f_r(d_r^-, d_r^+)$$

where P_1 denotes the first priority, which carries an infinitely larger weight than priority P_2, and where P_2 preempts P_3, and so on. The summation of terms in the objective function is, therefore, redundant or meaningless in cases of competing objectives because the objective with the highest priority will be optimized at the expense of the competing objectives. The theory and application of preemptive goal programming are discussed in detail by Lee (1972) and Ignizio (1976).

The objective function for archimedean goal programming is specified as

$$\min \sum_{i=1}^{r} w_i [f_i (d_i^-, d_i^+)]^p$$

$$= w_1 [f_1 (d_1^-, d_1^+)]^p + w_2 [f_2 (d_2^-, d_2^+)]^p + \ldots + w_r [f_r (d_r^-, d_r^+)]^p$$

where f_i are objectives with weights w_i, and their powers, p, are summed up to form a measure of the total distance from objective targets or goals. All objectives are considered simultaneously. Their weights are not preemptive; instead, they reflect the relative contribution of each objective. The power, p, typically takes on the values 1, 2, or infinity.

The objective function for multigoal programming is of the form

$$\min [f_1 (d_1^-, d_1^+), f_2 (d_2^-, d_2^+), \ldots, f_r (d_r^-, d_r^+)]$$

This function is minimized in a vector sense, identifying all nondominated solutions with respect to the objectives. Objective weights, aggregate function, and distance function are not specified and become useful only after the nondominated solutions have been found. Multigoal programming has yet to receive serious attention and widespread application in the goal-programming literature (Zeleny, 1982).

Despite the power and flexibility with which goal programming can handle planning problems involving multiple and conflicting objectives, a number of potential shortcomings are associated with the technique. Zeleny and Cochrane (1973) noted that, because targets are set a priori and possibly at pessimistic levels, a goal-programming solution could turn out to be dominated. Hannan (1978) also observed that goal programming will not identify unbounded solutions due to a priori setting of targets. These shortcomings can be overcome, however, by identifying the set of nondominated solutions before targets are established (Zeleny, 1982, p. 298), by conducting a parametric analysis of the targets to detect whether it is possible to increase the satisfaction of some objective without reducing the level of others (Romero and Rehman, 1984), or by employing the test proposed by Hannan (1980).

Zeleny (1982, pp. 295-296) also argued that a decision reached on the basis of preemptive weighting is incompatible with the traditional utility-function approach to decision-making and, therefore, is unlikely to be acceptable to the decision-maker. Other analysts such as Boland (1974) and Wierzbicki (1980), however, have said that the preemptive ordering of objectives is a better representation of a decision-maker's decision environment than is the utility-maximization approach. Romero and Rehman (1984) considered this debate a theoretical one, concluding that, from a practical viewpoint, the analyst's attitude toward the representation of the decision-maker's decision environment and objectives will influence the analytical approach taken.

Despite these criticisms, goal programming remains a powerful technique in the analytical tool kit of the operations researcher. Recent applications of the

technique to agricultural and farm-planning problems include works by Wheeler and Russell (1977), Field, Dress, and Fortson (1980), Barnett, Blake, and McCarl (1982), and Romero and Rehman (1984).

Applying preemptive goal programming. Because the resources necessary to pursue the archimedean version of goal programming were unavailable, the solution to the farm-planning problem was limited to the results of the preemptive-weights approach. The individually optimized values of the objectives, obtained earlier from the standard linear-programming model, were used as targets. The objective function of the program was then specified as

$$\text{Min } Z = P_1 d_1^- + P_2 d_4^+ + P_3 d_3^- + P_4 d_2^+$$

where

d_1^-	=	the underachievement of the margin target
d_4^+	=	the overachievement of the minimum family food requirement
d_3^-	=	the underachievement of the gross revenue target
d_2^+	=	the underachievement of the out-of-pocket expenses target

P_1, P_2, P_3, and P_4 represent preemptive weights, indicating the hierarchy of the objectives. Although the farmers' pair-wise comparisons of the objectives did not yield a ranking of objectives that was statistically significant at the 5% level, the resulting hierarchy was used to determine the order in which the objectives were iteratively optimized, and the solution stemming from this ordering of objectives was subjected to a sensitivity analysis.

The preemptive-weights goal-programming solution to the farm-planning problem suggested that the typical farmer in the study area should devote 2.47 ha of the available 2.8 ha of land to producing cassava/maize/cocoyams, supplement family labor with approximately 24 mandays of hired labor from January to early March, supplement with 6 mandays of labor from late March through April, and devote the estimated maximum available for out-of-pocket expenses, ₦ 500, to farm operations. This solution allowed gross margin and revenue to reach their predetermined target levels, while minimum household food requirements were exceeded by 305% and the target level for out-of-pocket expenses was underachieved by 637% (see table 3). Although the target level for out-of-pocket expenses was not achieved, this solution satisfied the four farm-management objectives as closely as possible given the stated hierarchical ordering of the objectives and the assumed prices and resource constraints.

As a comparison of tables 2 and 3 suggests, this goal-programming solution is identical to the solution of the linear-programming problem that identified the

target for maximizing gross margins. In this case, the use of preemptive weights in the goal-programming model effectively prevented any objectives that competed with maximizing gross margins from influencing the solution to the multiobjective problem. When preemptive weights were used with conflicting objectives that were aimed at optimum target levels, the multiobjective problem essentially collapsed to a single-objective problem in which only the first objective (and any noncompeting objectives) could be met.

The optimal farm plan with borrowed capital. Although none of the farmers surveyed borrowed funds during the production season, the models were respecified to include borrowing capital to investigate the effects of credit availability on the achievement of production objectives. Available credit was constrained to ₦ 5,000, which was the maximum amount a small-scale farmer could borrow without collateral from a government credit institution. Interest was specified at the annual rate of 18% to correspond with the rate charged by cooperative societies.

When the possibility of borrowing capital was added to the linear-programming models used to elicit the target values for the farm-production objectives, the maximum attainable gross margin and revenue were substantially increased. The target value for gross margin rose by ₦ 1,250, and the target value for revenue increased by ₦ 1,408. The target value for out-of-pocket expenses remained the same because it was determined by the minimum expenditures necessary to meet basic family food requirements. The new gross margin and revenue targets were obtained with the help of ₦ 133.60 in borrowed funds, which added a total of ₦ 158 to cash expenditures when the annual interest was figured in (see table 4).

The solution to the preemptive-weights goal-programming model was similarly revised when capital borrowing was allowed (see table 5). The solution suggested that the entire 2.8 ha should be devoted to producing cassava/maize/cocoyams. Family labor should be supplemented with 28 mandays of hired labor from January to early March and with 14 mandays of hired labor from late March through April, and out-of-pocket expenses should be increased by ₦ 158 to reflect ₦ 133.60 in borrowed funds at an annual interest rate of 18%. This allocation of resources was estimated to yield the revised target levels for gross margin and revenue, while the target level for meeting family food requirements was exceeded by 359% and the target level for minimizing cash expenditures was underachieved by 869%.

Performing a Sensitivity Analysis

The sensitivity of the optimal farm-planning solution to changes in the rank of farm-production objectives was explored using the same preemptive-weights goal-

programming techniques with each of the possible rankings of the objectives. Not surprisingly, the solutions were highly sensitive to whether the gross margin objective or the out-of-pocket expenses objective was accorded the highest priority. When out-of-pocket expenses were set at the target level of ₦ 68, gross margin and revenue dropped to about 25% of their respective target levels, and only 22% of the household's 2.8 ha of farmland was allocated for cultivation. Solutions obtained using the preemptive-weights version of the goal-programming model are clearly sensitive to the preemptive order of conflicting objectives.

The target levels of the objectives were also varied to determine the sensitivity of the farm-planning solution to changes in target-level specifications. Modest increases in the target levels had no effect on the farm-planning solution. For example, raising the target level for gross margin from ₦ 9,953 to ₦ 10,000 simply resulted in underachieving the new target by ₦ 47. Similarly, raising the target level for out-of-pocket expenses from ₦ 68 to ₦ 100 lowered the underachievement of the objective from ₦ 432 to ₦ 400.

Reductions in the target levels for gross margin and revenue, however, did affect the solution obtained. For example, if the target level for gross margin was reduced to ₦ 7,000, the estimated average income of the farmers surveyed, the optimum solution with and without borrowing capital required only 1.72 ha of land and fewer mandays of hired labor. The revenue target was underachieved by more than ₦ 3,000, the family food-grain supply was overachieved by only 3,663 kg, and the out-of-pocket expenses target was underachieved by only ₦ 234. Similar types of reductions occurred when the target level for gross revenue was reduced.

FARM PLANNING AND POLICY IMPLICATIONS

The results of the research conducted in Ijebu-North LGA of Ogun State indicate that assisting small-scale farmers with farm planning can be one effective means of improving the efficiency of agricultural production in Nigeria and other African nations and, thus, alleviate food shortages.

Through farm planning, the income of a representative farmer in the study area could be raised by about 50% under existing management practices, without borrowing funds and without jeopardizing family food supplies. The use of borrowed capital in the farm plan, in this case as little as ₦ 134, could increase the representative farmer's income by as much as 70%. Marginal analysis showed that a ₦ 1 increase in borrowed capital was capable of improving farm income by about ₦ 11. These results provide strong evidence of the salutary roles that farm planning and credit availability can play in raising the incomes and production of

small-scale farmers in the study area and, by extension, in Nigeria and other African nations.

The survey results confirmed the findings of other researchers that the farm-management decisions of small-scale farmers are based on multiple production objectives, most importantly maximizing gross margin, satisfying basic family food requirements, and minimizing cash expenditures. It is important, therefore, that farm-planning models accurately reflect the appropriate multiple objectives and their relative weights or priorities in the decision-making process.

Where production objectives conflict, farm-planning formulations can indicate the opportunity costs of optimizing one objective at the expense of the other and thereby can provide valuable insights to the farmer and policy-maker. For example, the opportunity costs of reducing cash expenditures by ₦ 1 entailed as much as a ₦ 19.50 drop in the maximum gross margin obtainable for the representative farmer in the study, a result that might cause a farmer to reevaluate the relative weights accorded to farm-production objectives.

Several techniques have been developed to incorporate multiple objectives in formulating optimal farm plans. The use of preemptive-weights goal-programming techniques can result in formulations that are highly sensitive to the ordering of objectives. Indeed, when objectives conflict, the higher-ranked objective can completely preempt the role of succeeding objectives in determining the optimal allocation of resources. In such cases, it may be advantageous to use archimedean goal-programming techniques, which allow for assigning nonpreemptive weights to the production objectives.

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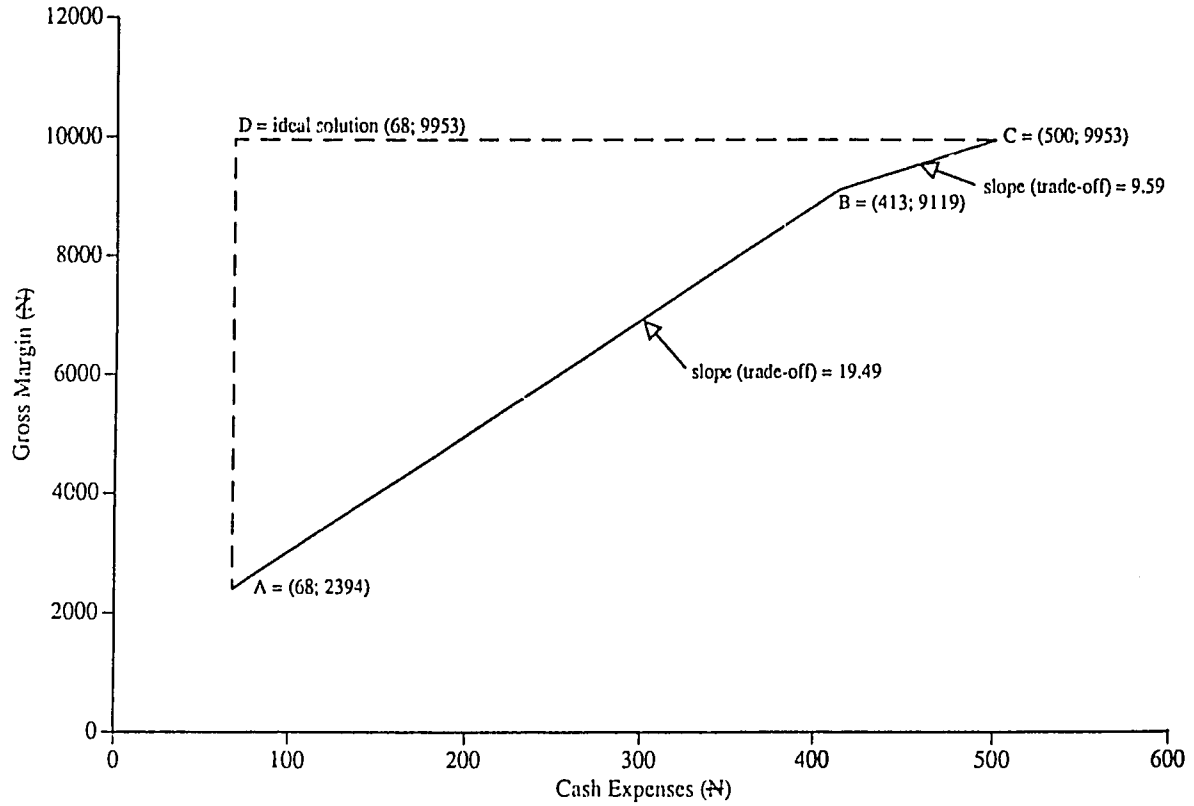

Figure 1: Trade-off curve between gross margin and cash expenses in the multiobjective programming model.

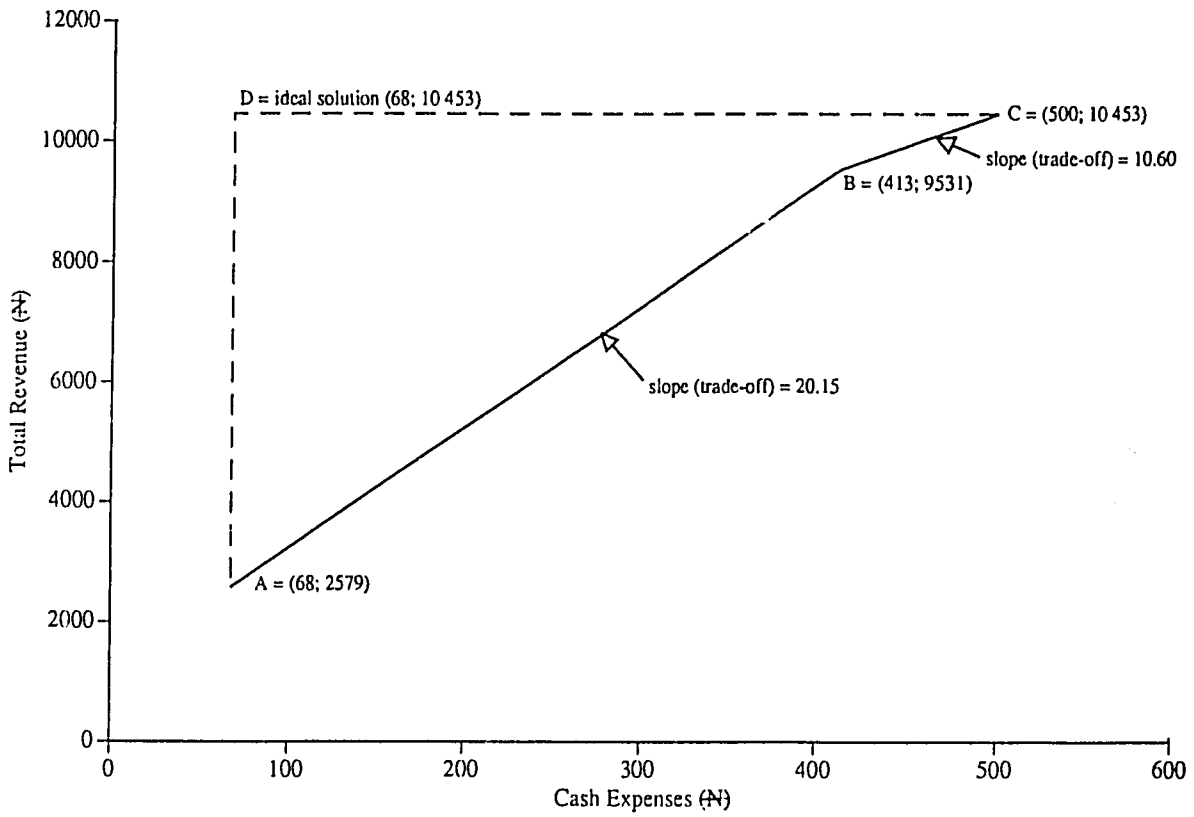

Figure 2: Trade-off curve between total revenue and cash expenses in the multiobjective programming model.

Table 1. Frequency matrix and rank, farmers' production objectives, Ogun State, Nigeria, 1988.

	Food requirements	Gross margin	Out-of-pocket expenses	Revenue	Total
Food requirements		20 (39.22)	19 (37.25)	24 (47.06)	63
Gross margin	31 (60.78)		9 (17.65)	13 (25.49)	53
Out-of-pocket expenses	32 (62.74)	42 (82.35)		25 (49.02)	99
Revenue	27 (52.94)	38 (74.51)	26 (50.98)		91
Total	90	100	54	62	306
Rank	2	1	4	3	

Notes: Numbers in parentheses indicate the percentage of the total sample represented by the frequency. The numbers in the first four rows are the frequencies with which a given column objective was selected over a given row objective.

Table 2. Payoff matrix, farmers' production objectives, without borrowed capital, Ogun State, Nigeria, 1988.

	Gross margin (₦)	Revenue (₦)	Out-of-pocket expenses (₦)	Food grain (kg)
Gross margin	9,953	10,453	500	8,016
Revenue	9,953	10,453	500	8,016
Out-of-pocket expenses	2,394	2,579	68	2,000

Table 3. Solution to the preemptive goal-programming problem, without borrowed capital, Ogun State, Nigeria, 1988.

Activities		
Cassava + maize + cocoyams	2.47	ha
Labor hiring activity from January to mid-March	23.61	mandays
Labor hiring activity from mid-March through April	5.22	mandays

Production objective	**Target**	**Solution Value**
Gross margin	₦ 9,953.01	₦ 9,953.01
Family food requirements	2,000 kg	8,106.26 kg (+305.3%)
Revenue	₦ 10,453.01	₦ 10,543.01
Out-of-pocket expenses	₦ 67.85	₦ 500 (-636.9%)

Table 4. Payoff matrix, farmers' production objectives, with borrowed capital, Ogun State, Nigeria, 1988.

	Gross margin (₦)	Revenue (₦)	Out-of-pocket expenses (₦)	Food grain (kg)
Gross margin	11,203	11,861	658	9,198
Revenue	11,203	11,861	658	9,198
Out-of-pocket expenses	2,394	2,579	68	2,000

Table 5. Solution to the preemptive goal-programming problem, with borrowed capital, Ogun State, Nigeria, 1988.

Activities		
Cassava + maize + cocoyams	2.8	ha
Labor hiring activity from January to mid-March	27.6	mandays
Labor hiring activity from mid-March through April	13.2	mandays
Borrowed capital	₦ 133.6	

Production objective	**Target**	**Solution Value**
Gross margin	₦ 11,203.15	₦ 11,203.15
Family food requirements	2,000 kg	9,198 kg (+359.9%)
Revenue	₦ 11,860.00	₦ 11,860.00
Out-of-pocket expenses	₦ 67.85	₦ 657.65 (-869.3%)

THE IMPACT OF THE LARGE-SCALE ACQUISITION OF LAND ON SMALLHOLDER FARMERS IN NIGERIA

A. C. Nwosu

SUMMARY

Restricted access to land can be a major constraint to accelerated agricultural development. In recent years, restricted access has emerged as a key problem in the southern part of Nigeria. Customary land-tenure systems are breaking down under the impact of cash cropping, population pressure, and the land-consolidation policies of the government. Individuals, corporations, and the government have been acquiring large tracts of rural lands for agricultural and nonagricultural purposes.

Three of Nigeria's communities in which the government has acquired large tracts of land were examined to determine the impact these acquisitions have had on smallholder farms. The government acquired the tracts for an airport, an army barracks, and a university.

Traditionally, farmers have had access to both personal and communal lands. They usually obtained their first plots of land through inheritance. If they needed more land, they could acquire it by receiving it as a pledge, by borrowing it, or by renting it. The government's land acquisitions have interfered with this system.

The results of this study indicated that the large-scale acquisition of land has resulted in an 11% reduction of the aggregate landholdings of the sampled households in the three communities. Additionally, dependence on personal and rented land is increasing and dependence on communal and borrowed land is decreasing.

Despite the apparent shortage of land, however, when the effect of inflation was considered, the large-scale acquisition of land had not resulted in significant increases in the sale or rental prices of land.

While farm size has been significantly reduced following the large-scale acquisition of land in the university project area, similar reductions have not been observed in relation to the army barracks project or the airport project. However, the effect in the airport project area may not

become evident until the government effectively occupies the land and the farmers' access to the land is curtailed. At the time of the survey, the farmers continued to plant crops in spite of government prohibitions.

The expropriation of large tracts of land appears to have intensified the use of land and increased the use of improved inputs. The fallow period appears to have been reduced, and more farmers had begun to apply fertilizers. Despite the intensification, the small farms -- which will become smaller as the population grows -- cannot meet the food and fiber needs of Nigeria in the next decade. Farm size must be expanded. Moreover, because tropical soil breaks down after about 5 years of continuous cultivation and productivity then falls, farming systems affected by land-acquisition projects may not be viable in the long term.

Landlessness has not emerged in the study area. Where farmers have lost all of their land to a government project, they have been able to rent farmland. However, landlessness probably will emerge when the land in the airport project area is occupied. The relocated households have had difficulty renting land from neighbors to supplement what is left of their own farmland. The situation is bound to become worse when the affected communities completely lose access to the acquired lands.

The increasing dependence on rented land and the escalating nominal rental fees in the affected communities will raise the cost of production and constrain farm size. Farmers decide how many plots to rent according partly to the rental fees and the cash available at the beginning of the cropping season. For smallholders whose cash incomes are low, high rental fees could mean renting less land. The cumulative result could be an enormous loss in production since most households rent supplementary farmland each year.

The increasing dependence on rented land may also interfere with agricultural development. Rented lands are not available for the long term investment and development of farm structures required for agricultural growth. Thus, even though renting facilitates access to land, it cannot form the basis for developing commercial agriculture.

Therefore, the government must be cautious and selective in acquiring rural lands. The cost to the rural people who own the land should be carefully considered. It is not enough to make cash payments to compensate for the loss of houses and tree crops; the government should provide alternative lands and build houses for those affected. At present, unaffected communities do not want to alienate their lands permanently and so do not make them available for the displaced communities to settle. Every large-scale land-redistribution program should enable those who lose land to a project to gain land from their neighbors -- placing a small burden on every member of the community rather than a large burden on a few individuals.

Limited access to land can be a major constraint to accelerated agricultural development. In recent years, this problem has emerged as a key constraint in southern Nigeria. Customary land-tenure systems are breaking down under the impact of cash cropping, population pressure, and the land-consolidation policies of the government. Individuals, corporations, and the government have been acquiring large tracts of rural land for agricultural and nonagricultural purposes.

The boldest attempt by the government to foster private ownership and to liberalize access to land was the Land Use Act of 1978. The act initially allowed an individual to acquire the right of occupancy to as much as 500 ha of land for agricultural purposes or 5,000 ha for grazing purposes (Nwoko, 1978). Subsequent changes in policy have reduced the maximum amount of land an individual can acquire under the act to 2,000 ha.

While the Land Use Act has enabled the government, corporations, and influential individuals to acquire large areas of land, it has not facilitated the access of smallholder farmers to land. If the large-scale acquisition of rural lands continues, a large pool of landless farmers could be created.

The problem posed to smallholders by the large-scale acquisition of rural land is especially rife in Imo State, which has 6% of Nigeria's population but only 1.3% of its land area. In 1981, the population density was 451.43 people per sq km (Government of Imo State, 1983). Taking this into consideration along with the fact that over 50% of the people are farmers, it becomes apparent that the expropriation of large tracts of rural lands could hinder smallholders' access to land.

LAND-TENURE SYSTEMS IN NIGERIA

Goody and Buckley (1973) described the customary land-tenure system in Africa as a "communal tenure system of public ownership and private use rights of land." They said that even though communities have control over land, individuals "appropriate use rights of land and the products." Individuals also exercise inheritance rights.

The views expressed by Goody and Buckley are supported in the findings of other researchers in Nigeria. Famoriyo (1981) noted that under the traditional tenure system "no land exists without an owner," in reference to the communal

ownership of land. Individuals are entitled to portions of the communal land as members of the family or clan. However, an individual may not alienate the land permanently without the consent of other members of the family or clan.

According to Adegboye (1977), the combination of communal control over the access to land and private use rights allows families to have continuous use of the same land over time. It also allows families the right to buy and sell land, including the rights to tree crops, through a system of pledging. The traditional tenure system has prevented the emergence of absentee landlords and a landless peasantry. It has hindered land speculation and facilitated social control over private land use (Eicher and Baker, 1982).

Yet the customary-tenure system has its drawbacks: In particular, it breeds uncertainty and insecurity of tenure. It provides no incentive for individuals to make long-term investments on the land or undertake land improvement. Thus, it inhibits agricultural development. In contrast, individualized tenure facilitates the establishment of commercial agriculture (Richards, Sturrock, and Fortt, 1973). This argument lends support to an earlier finding of Van Hekken and Van Velzen (1972), that individual tenure contributed to increased farm size. Individual land-holding also has drawbacks: It fosters inequality and the emergence of a landless class.

In Nigeria, circumstances appear to have forced the increased individualization of land tenure. According to Famoriyo (1981), "growing population density, increasing urbanization and/or rapid transactions in landed property" have forced the establishment of permanent land rights in many parts of Nigeria, especially in the southern region.

The apparent absence of landlord and landless classes in many parts of Nigeria may be attributed to the policies of the colonial government, which prevented foreigners from holding titles to land. Thus, Nigeria has been spared the problems faced by countries like Zimbabwe and Zambia. As reported by Eicher and Baker (1982), an estimated 6,500 commercial farmers control one-half of the land and produce about 94% of the marketable surplus in Zimbabwe. In Zambia, some 300 commercial farmers produced about 40% of the marketable surplus of maize in 1980. Under these circumstances, agrarian reform involves a trade-off between economic rationality and political convenience -- transferring land from commercially oriented farmers to smallholders would probably result in a loss in marketable surplus.

In Nigeria, the government's land acquisition and various land-consolidation programs have weakened the customary tenure system and encouraged individual land ownership. Little land was required for public purposes under

the customary tenure system. Individuals were compensated with alternative land when their land was appropriated. Land acquired for public purposes under customary tenure was used as sites for common grazing, defense, marketing, shrines, and worship.

An era of unprecedented land expropriation by the federal and state governments began in the 1900s, in response to rapid social and economic change. The colonial government used force or payments to acquire land for public purposes. Legislation was introduced to facilitate such acquisitions. With rapid population growth and urbanization, the large-scale acquisition of land has become rampant. Land is now expropriated to build schools, hospitals, universities, airports, recreation parks, and game reserves. The public acquisition of land has meant increasing incursion into agricultural land. Thousands of farmers have become landless and unemployed (Famoriyo, 1981). Thus, large-scale acquisition of rural land evokes questions about the number of people to be affected and the resulting occupational shifts and social disequilibrium.

Since independence, the state has continued to use its power of eminent domain to acquire privately owned land for public purposes. The 1963 constitution stipulates that the government's acquisition of land must be followed by "adequate" or "reasonable" compensation to the previous owners. In the First and Second Development Plans, the government was concerned with regulating the compensation paid for rural land acquired for public projects and with minimizing land speculation, especially in urban areas. The regulation of the compensation for land was aimed at enhancing the government's access to land.

In the Third Development Plan (1975-1980), the government sought to liberalize access to rural lands. The guidelines outlined in the third plan sought to regulate land prices and to remove the constraints on acquiring land for national development. It proposed that the entire country be demarcated into zones and the government prescribe the maximum compensation for each zone.

The 1978 Land Use Act, however, superseded the guidelines in the third plan. The act appears to be a culmination of the efforts made by the government to wrest land-ownership rights from the rural people -- it confers the ownership right of all land on the government. It is supposed to enable the government to allocate land to individuals, institutions, and corporations that require large tracts of land for agriculture.

The impact of large-scale acquisition of rural land on smallholders' access to land and production, especially in areas with high population density, is uncertain. The only empirical work available is a case study by Famoriyo (1981)

that illustrated the principles of compulsory land acquisition under the existing customary tenure system. His results indicated that the Western Region of Nigeria had about 500 cases of compulsory land acquisition between 1952 and 1972. The regional government acquired 51% of this land, the federal government 49%. Building hospitals and developing farm settlements each accounted for 15% of the total number of acquisitions. Other major projects for which land was acquired were agricultural estates (13%), rest houses (13%), educational institutions (11%), and roads (8%). Before the acquisition, 60% of the land was used for farming, 6% for nonfarming purposes, and 34% for undisclosed purposes. By implication, a large proportion of the dispossessed people were farmers. Famoriyo's study did not examine the impact of the government's land acquisition on the dispossessed people's access to land and agricultural production.

Most other reports on the impact of the large-scale acquisition of rural land have been speculative rather than empirical. They are found in the spate of newspaper articles published in the wake of the Land Use Act. Iwunze (1986) was one of the few who looked beyond the interests of the government and the urban elite. He said big business' acquisition of large expanses of arable land is a trend that would culminate in the dispossession of the peasant farmers. The act thus quickens the process of creating a landless peasantry. The groups that had benefited immensely, according to Iwunze, were "millionaire farmers" and big businesses, most of which were multinational corporations.

Nnomeh (1985) shared Iwunze's views, likening the enactment of the Land Use Act to "acting out the biblical proverb" that says, "to those who have, more shall be given, but, as for those who do not have, even the little they have shall be taken away." The land considered undeveloped was often the only property owned by the rural poor; thus, the act confiscates the land of the poor and redistributes it to the wealthy.

Negotiations about the sale and purchase of rural lands have continued in spite of the Land Use Act. Therefore, it is difficult to attribute smallholder's changing access to farmland entirely to the act.

FACTORS THAT AFFECT ACCESS TO LAND IN THE TRADITIONAL TENURE SYSTEM

Three communities were chosen for study in which the government compulsorily acquired large tracts of land. The project areas were selected mainly according to the amount of land acquired and the degree to which the acquired land had been effectively occupied. The Imo Airport project and Imo State University

Project were the largest and the army barracks project was the fifth largest of seven identified projects. The land's occupation, however, was much more complete in the army barracks project than in the two larger projects.

The affected communities in each project area were studied. Fifty heads of households were interviewed in each of the project areas. The respondents were selected through a random-sampling process. The numbers of questionnaires suitable for further analysis were 48 for the airport project, 45 for the university project, and 40 for the army barracks project, totaling 133.

The study sought to determine factors leading to changes in access to land. Such changes can result from traditional land-tenure practices as well as from the large-scale acquisition of land. Inheritance; communal ownership; and purchasing and selling, pledging, renting, and borrowing land all can affect a farmer's access to land.

Inheriting Land

A farmer may gain access to land through inheritance. In Nigeria, when a man dies, his sons usually inherit his land. It is also customary for a man to allocate some of his land to his sons as they come of age to help them establish farms and build houses before they marry. Over 77% of personal land is acquired through inheritance.

Within the last 10 years, 29% of the respondents had allocated land to their sons. Over 78% of the land allocated to sons was derived through the subdivision of land held by the households rather than the purchase of new lands. The average household turned over 0.28 ha annually to its children.

The traditional inheritance process affects farmers' access to land, even though it may not reduce the total landholding in the community. The practice leads to increasing fragmentation of landholdings.

Access to Communal Land

Communal lands belong to a clan or kindred. Even though individuals have use rights, they may not alienate the land permanently without the consent of the other members of the clan or kindred. When a piece of communal land is due for cultivation, as prescribed by the practice of shifting cultivation, each adult male member of the clan or kindred has a portion allocated to him. He may cultivate it or rent it to other farmers for the cropping season. The right he exercises over his portion of communal land usually terminates at the end of the cropping season. The right does not extend to harvesting tree crops, such as oil palm.

Because the use rights are temporary, communal lands are usually not planted with permanent crops and they are not available for long-term development.

It is sometimes suggested that the availability of communal lands is one of the reasons why landlessness has not posed a major problem in Nigeria. The individual who has no personal land usually receives an allocation of communal land. However, in some years, no communal land may be due for cultivation. Given the fallow system, allocations of communal land may be available only once in two or three years.

Selling and Buying Land

In Nigeria, land ownership is shifting from communities to individuals. The governments' large-scale acquisition of land may have accelerated the trend toward individual land ownership in some locations. However, the forces that promote individual ownership operate even in the traditional system and may affect some households' access to land.

The information provided by respondents on the sale of land has limited reliability. Traditional society disapproves of selling land as land is said to belong not only to the present generation but also to generations "yet unborn". So, until recently, land was sold only under dire financial stress. Further, the Land Use Act prohibits selling land. Accordingly, the respondents were reluctant to admit that they had sold land; however, they were willing to talk about land they had purchased. Traditional society attaches no stigma to buying land, and the Land Use Act is understood to forbid land sales, not purchases.

The survey results suggested that the average household purchased 0.09 ha of land a year between 1979 and 1988. The actual figure must be less than 0.09 ha since some of the households must have sold some of their land. Thus, land sales and purchases were minimal in the study area.

The effect of land sales on the agricultural production of a community depends on the use to which the purchased land is put. All of the respondents who had sold land said they sold it to individuals in their communities. Only 61% of the land sold was used for farming; 39% was used for building houses.

Financial needs pressure households to sell land even though doing so is unacceptable in traditional society and illegal under the Land Use Act. Land is often sold to pay for educating children -- especially at the postsecondary level -- building a house, or starting a business. Other sources of major financial stress leading to land sales are major health problems and court cases. Land is the asset commonly sold by poor households when large amounts of cash are needed.

Pledging Land

A farmer also may obtain cash by pledging land. A farmer with financial needs may offer a piece of land as a pledge in return for a cash payment. The person holding the pledge may cultivate the land or rent it to other farmers until the pledger redeems it. Usually, the person holding the pledge has rights over all of the tree crops on the land -- the availability of tree crops raises the value of the land. The proceeds from such crops are regarded as interest payments on the money advanced.

Households pledge land for the same reasons that they sell land, but pledging usually indicates a lesser financial need than selling. As with the sale of land, most respondents indicated that they received land on pledge, but they were reluctant to admit that they had pledged their land.

Thirty-five percent of the respondents said they had received land pledges during the survey year. This indicates that land pledging is a common practice in the study area. The farmer who pledges the land loses access to it, but the recipient of the pledge uses the land only for farming. Thus pledging, unlike selling, usually does not transfer land out of agricultural use.

Renting Land

Farmers can gain access to land by renting it. Rented land is usually planted in arable crops that are harvested in one or two cropping seasons. At the end of the period, rights to the land revert to the owner. The use rights on rented land do not include harvesting existing tree crops.

The respondents indicated that land rental is the most common means of gaining access to farmland. Over 82% of the respondents said they had rented land in the past 10 years. The army barracks project area had the highest incidence of renting because of the presence of the soldiers and their families: They farm intensively and usually rent land from local people to supplement the land allocations they receive from the government. In addition, the army barracks area is easily accessible from Owerri, the state capital; so several urban dwellers rented land for farms in the area.

On the average, households claimed to have rented 2 ha of land a year. Rented land constituted 33% to 47% of cultivated land.

Households generally rent out land they are unwilling or unable to cultivate during the cropping season. Thus, the practice of renting land increases, rather

than constrains, access to land. Alienating land through renting, unlike alienating it through selling or pledging, is commonly accepted in the study area. The practice makes it possible for strangers to have access to farmland and has forestalled the emergence of landlessness, even in the face of rapid population growth.

Borrowing Land

Farmers can gain access to land by borrowing it from a relative or friend without paying a fee. As with rented land, borrowed land is usually not planted with permanent crops. The use rights on borrowed lands do not include the right to harvest tree crops.

Borrowing land is not a common practice. Only about 18% of the respondents had borrowed land for farming in the past 10 years. The university project area was atypical: Close to 38% of the respondents from that area had borrowed land. Borrowing land has declined as the economy has become increasingly monetized.

Effects of the Traditional Tenure System

Land-inheritance and redistribution processes facilitate the access of younger members of the community to farmland. However, when a father redistributes his land to his sons, the father's access to land is constrained. Furthermore, the land is thus redistributed from an experienced farmer to less-experienced but more-energetic farmers. Generally, the land-inheritance and redistribution processes do not take land out of agricultural production, as does building houses.

Thus, factors in traditional land-tenure practices can cause variations in access to land. Nevertheless, except for the few cases in which land is sold to nonlocal people for nonagricultural uses, such factors do not seem seriously to constrain overall agricultural land use.

Landlessness -- having no landholdings but deriving a livelihood by working as farm labor -- is seen as inappropriate in Africa. Traditionally, land is communally owned, and the customary tenure system guarantees each member of the extended family some use rights to the communal land. However, social and economic changes have encouraged the emergence of individual land ownership. Demographic pressures coupled with the large-scale acquisition of rural land could drastically reduce the availability of communal land.

EFFECTS OF THE LARGE-SCALE ACQUISITION OF LAND

The effect of large-scale land acquisitions on smallholders' access to land is difficult to measure directly. This study measured the changes in some indicators of access, including total landholdings of households, average sale and rental prices for land, farm size, the level of use of improved farm inputs, the incidence of landlessness, and the out-migration of rural youths. Changes in the variables since the government's acquisition of land were assumed to result from the expropriation of land.

Effects on Landholdings and Farm Size

Landholdings were reduced by an average of 11% in the affected communities after the large-scale acquisition. Access to rental land increased, while access to communal, pledged, or borrowed land decreased (see tables 1 and 2).

The results of chi-squared analysis did not support the hypothesis that expropriating large tracts of land in the study areas resulted in the reduced farm size. The postacquisition farm size was not significantly different from the preacquisition farm size (see table 3).

The problem with the analysis, here, is that the government's acquisition of land did not coincide with its effective occupation of the land. Long after the government acquired the land in the airport area, a significant proportion of it was still being farmed by the local people. Even as construction commenced on the acquired land, the portions of the land not yet in use were cultivated, though the farmers knew the crops might be destroyed. Much of the land acquired for the army barracks project was farmed by soldiers and their families, who were included in the survey. These circumstances have reduced the impact on farm size of expropriating land.

Farmers generally were not satisfied with the amount of farmland available. Increasing dependence on rented land, rising rental fees, and population pressure are forcing the premature return to fallow lands. According to the farmers, in the past, a piece of land could be left fallow for at least 7 years. More recently, the fallow period has been reduced to 3 or 4 years.

Effects on Sale Prices

Since the supply of land in a community is fixed, expropriating of large tracts of land would be expected to increase land prices. In fact, the nominal price of land almost doubled after the large-scale land acquisitions. However, any conclusion based on nominal prices would be misleading because the period was marked by

high, rising inflation rates. Unofficial estimates indicate that the annual inflation rate has reached four-digit figures since the mid-1980s. To isolate changes in land prices that were due to scarcity, rather than to the general inflationary trend, the nominal land prices were deflated with rural consumer price indexes. The results indicated that, in real terms, the price of land has actually declined over time. Thus, when inflation is accounted for, the study results do not support the hypothesis that large-scale land acquisition has resulted in increased land prices in the study area (see table 4).

Effects on Rental Fees

The average nominal rental fee increased by over 52% after the land acquisitions. In real terms, however, rental fees declined significantly during the period. Again, the results indicated that increases in land-rental fees resulted more from inflation than from any scarcity attributable to land acquisition in the study area (see table 5).

Effects on the Use of Improved Farm Inputs

If the government's acquisition of land were followed by a program to consolidate and reallocate land and distribute improved inputs, it could create larger farms and increase the use of inputs. Even if land were acquired by individuals and organizations to create large farms, the use of improved inputs could be increased in the area: As more and better inputs were used on the new farm, the demonstration effect might lead other farmers to adopt the inputs, too.

This theory could not be tested. More farmers in the study area used fertilizers, agrochemicals, and tractor services after the land acquisitions. (The use of farm credit did not change significantly.) However, the factors that caused the increases were unclear: Around the time of the acquisitions, the government campaigned for farmers to use improved inputs. In addition, the land was not acquired for agricultural purposes, so the demonstration effect was not a factor.

The farmers were asked to comment freely on why they used more or less of the inputs. Over 30% said they increased fertilizer use because of the shortage of land, which has forced them to use each piece of land more intensively. Thus, it appears that expropriating land has led to increased use of fertilizers, not because land has been consolidated into large commercial farms, but because the fallow period has been reduced so fertilizers are needed to maintain the soil's productivity.

Of the farmers who had increased their use of agrochemicals, 1.5% mentioned the need to ensure high yields from their "little" landholdings. About 27% of the

respondents did not use tractors and over 3% did not apply for farm credit because they considered their farms too small. Thus, it appears that the lack of access to land has influenced some farmers' decisions about using improved inputs.

Effects on Landlessness

In the army barracks project area, 60% of the respondents had lost all personal and communal land through expropriation. The farmers retained access to rented land. The losses appeared to be less significant in the airport and university projects' areas.

The difference between the results in the army barracks project area and the other project areas can be explained easily: The physical takeover of land for the army barracks is complete. The acquired land is either occupied by physical structures or is farmed by the soldiers and their families. The original owners of the land have completely lost access to it. However, in the airport project area, the takeover is not complete; farmers are still using some of the acquired land. The university project is in an area of low population density; the takeover has not caused any of the respondents to lose all of their personal or communal land.

The respondents said, at the time of the survey, that the government had warned them that it was illegal to grow crops on the land acquired for the airport project. Because so much land was acquired for the project, landlessness may emerge as the acquired land is occupied by the airport and the law against encroachment is enforced.

Sharecropping is still foreign to the study area. Not a single respondent sharecropped. The local language appears to have no word for sharecropping; and, when the practice was explained, the respondents said they considered it unacceptable.

Effects on Migration

The migration of youths to urban areas has been attributed partly to the difficulty of earning adequate income from practicing traditional agriculture on small, fragmented, uneconomical farm holdings. On average, one able-bodied youth has migrated from each household in the communities studied.

The relationship between rate of migration and government land acquisition was not investigated rigorously. The respondents were asked simply to give the reasons their sons left the villages. It was expected that, if a worsening land situation was a contributory factor, the respondents would mention it.

When the number of respondents mentioning each reason was used as a weighting factor to rank the reasons, the shortage of land for farming ranked least important. It was not even mentioned in the university project area. In the army barracks project area, however, it was the third-most important factor. Again, the difference in results between the army barracks project area and the other project areas indicates that the full effect of land acquisition is not felt until the land is occupied.

Effects on Family and Community Well-Being

The hardship that large-scale government acquisition of land imposes on some individuals in the affected areas can not be quantified. For example, in the airport project area, some of the displaced persons were compensated for their houses in cash but were not allocated land on which to build new houses. Some shared accommodations with relatives. Others became tenants in their own villages -- a situation that they find painful. Some received cash and land in compensation, but they did not receive enough cash to enable them to build new homes -- the compensation (according to those affected) did not take inflation into account. As some of the respondents explained, given the escalating prices of building materials, the compensation could hardly build a decent mud house with a thatched roof.

Land was allocated to some of the displaced families at the rate of one plot per household, regardless of the number of persons in the household. This compounds the problem of finding land for young people as they come of age. Many fear that the communities will disintegrate as the young people set up their homes elsewhere. Respondents also said that the project has claimed some of the most fertile lands.

For the relocated communities, land is ceasing to play a unifying role. It is traditional for the men of the village to meet regularly to discuss issues of common interest. The relocation of households has made such meetings difficult to convene. According to the respondents, the disintegration of communities is further manifested in the increasing number of land disputes and social vices, such as theft and armed robbery.

The women in the displaced and relocated households now have greater difficulty providing for their families. Traditionally, each woman cultivates a back yard garden of vegetables and minor crops for subsistence. The women have no regular income. Yet, the need for a back yard garden was not considered when small plots of land were allocated to households. So the women

must buy vegetables and other minor crops regularly from the market. This situation, they said, is unacceptable as they have no regular income.

More factors are associated with the large-scale acquisition of rural lands than were quantified in this study. Such factors are not taken into consideration when decisions are made to expropriate large tracts of land. A detailed study of these nonquantifiable factors is needed to determine ways to ameliorate the hardship that the government's acquisition of land imposes on rural communities.

POLICY IMPLICATIONS AND CONCLUSIONS

The large-scale acquisition of land has resulted in reduced aggregate landholdings of the sample households averaging 11%. Additionally, dependence on personal and rented land is increasing and dependence on communal and borrowed land is decreasing.

When the effect of inflation is considered, the findings do not support the hypothesis that the large-scale acquisition of land has resulted in a significant increase in the sale or rental prices of land.

Farm size was reduced significantly following the large-scale acquisition of land in the university project area. In the army barracks and airport project areas, however, there has been no significant reduction in farm size. The effect on farm size in the airport project area may not become evident until the access of the farmers to the acquired land is effectively curtailed.

The results also indicate that more farmers used fertilizers, agrochemicals, and tractor services after the large-scale acquisition of land. About 30% of the respondents associated the increased use of fertilizers with the shortage of land which is forcing farmers to reduce the fallow period from about 7 years to 3 or 4 years. The use of farm credit has not changed. The increased use of fertilizers and agrochemicals cannot be attributed entirely to the government acquisition of land, given the vigorous campaign mounted to encourage smallholders to adopt improved farm inputs and practices.

Despite the intensification of input use, it has become apparent that the small farms, which will become smaller as the population grows, cannot meet the food and fiber needs of Nigeria in the next decade. Farm size must be expanded. Moreover, as the tropical soil breaks down after about 5 years of continuous cultivation, productivity falls (Hartmans, 1984). Thus, there is a limit to the intensive use of land. These two problems necessitate greater landholdings per

household than the acquisition of large tracts of land for government projects would allow.

Landlessness has not emerged in the study area. Where farmers have lost all of their land to the government projects, they have been able to rent farmland. Renting land is a common practice. It has prevented the emergence of landlessness, especially in the army barracks project area, where about 60% of the respondents lost all of the personal and communal lands available to them. As the physical takeover of the land progresses in the airport and university project areas, the situation is expected to become worse, and more farmers are expected to depend on renting land. The chances are high that landlessness will emerge when the physical takeover of land in the airport project is complete. The relocated households have difficulty renting lands from neighbors to supplement what is left of their own farmland. The situation is bound to become worse when the affected communities completely lose access to the acquired lands. In these circumstances, the practice of sharecropping and tenancy, which the farmers now find unacceptable, may become appealing.

On the average, 10% of the respondents associated the out-migration of youths with lack of access to land. In the army barracks area, where the physical takeover of land has been completed, the lack of farmland is the third-most important reason that respondents gave for the out-migration. It appears that, as the physical takeover of land progresses, the inadequate supply of farmland will force more youths to migrate from the communities.

The association of the out-migration of youths with the inadequate supply of farmland has implications for the back-to-the-land call by the government. The youths from the army barracks and airport project areas cannot return to the land unless there is a program to make land available to them. The Land Use Act is of little or no assistance in this matter. The youths and those individuals and families who have lost large portions of their farmland cannot acquire more land unless they are able to pay the prevailing rental fee or purchase price.

The farmers in the study area consider the Land Use Act irrelevant for enhancing their access to land in their communities. According to the respondents, it would not be practicable for anyone to occupy his neighbor's land under the pretext that the land has been ceded by the government. The two parties must reach an amicable agreement; otherwise, a family feud would ensue. Even though the farmers were generally aware of the act, not one of them had tried to gain access to land by invoking it.

What the Land Use Act appears to have accomplished in the study area is the dispossession of the rural people of their lands by the government and institutions. It has not facilitated the access of smallholders to land.

The increasing dependence on rented land and the escalating nominal rental fee in the communities have implications for the cost of agricultural production. In addition to raising the cost of production, rising rental fees will constrain farm size. The decision on the number of plots to rent depends partly on the rental fee and the cash available to the farmer at the beginning of the cropping season. For smallholders whose cash incomes are low, high rental fees could mean renting less land. The loss in production that would result from this kind of decision could be enormous in view of the fact that most households rent lands to augment their requirements for farmland.

The increasing dependence on rented land does not augur well for agricultural development: Rented lands are available only temporarily. These lands are not available for long-term investment and the development of the farm structures required for agricultural growth. Thus, even though renting land facilitates access to land, it cannot form the basis for developing commercial agriculture.

The effect of the expropriation of over 6 sq km of land in the airport project area will remain uncertain until the access of the former owners to the land is curtailed. Thereafter, one would also expect a reduction in farm size, considering the high population density of the affected communities.

In conclusion, the government needs to be more cautious and selective in acquiring rural lands. The cost to the rural people who own the land should be carefully considered. It is not enough to make cash payments to compensate for the loss of houses and tree crops; the government should provide alternative lands and build houses for those affected. At present, unaffected communities do not want to alienate their lands permanently and so do not make them available for the displaced communities to settle. Every large-scale land-redistribution program should enable those who lose land to a project to gain land from their neighbors -- placing a small burden on every member of the community rather than a large burden on a few individuals.

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Table 1. Access to Landholdings, before and after government acquisition, Imo State, Nigeria.

	Landholding (ha)			
	Total		Per Household	
Project area	Before	After	Before	After
Imo airport	371	297	3	6
Army barracks	298	301	7	8
Imo State University	923	835	21	19
Total	1,592	1,433	12	11

Table 2. Sources of access to land before and after government acquisition, Imo State, Nigeria.

Project area	Sources									
	Personal Land		Communal Land		Land Received on Pledge		Rented Land		Borrowed Land	
	Before	After	Before	After	Before	After	Before	After	Before	After
Percentage										
Imo Airport	56	64	5	3	8	3	27	29	4	1
Army barracks	12	13	19	17	11	7	50	58	9	5
Imo State University	20	40	56	15	11	12	7	31	6	2
Total	29	39	57	11	10	7	28	40	6	3
Mean hectarage of agricultural land	462 (536.81)	559 (483.19)	430 (309.45)	158 (278.55)	159 (136.31)	100 (122.69)	446 (536.28)	573 (482.72)	96 (73.15)	43 (65.85)

Note: The figures in parenthesis are the expected values.

Table 3. Average farm size before and after government acquisition, Imo State, Nigeria.

Project area	Average farm size (ha)		
	Before	After	t-value
Imo Airport	2	1.6	1.09
	(0.73)	(0.03)	
Army barracks	2.3	2.2	0.51
	(0.16)	(0.36)	
Imo State University	3	1.8	6.38*
	(0.33)	(0.18)	
All areas	2.4	1.8	1.39
	(0.63)	(0.35)	

* $p < 0.01$

Table 4. Average price of land before and after government acquisition, Imo State, Nigeria.

Project area	Nominal price			Real price		
	Before (₦/ha)	After (₦/ha)	t-value	Before (₦/ha)	After (₦/ha)	t-value
Imo Airport	1275	2131		495	390	
	(581.6)	(239.7)	-2.72**	(169.1)	(43.0)	1.23
Army barracks	2349	3807		978.4	692	
	(309)	(617.2)	-4.23*	(129.1)	(69.0)	3.9*
Imo State University	496	1586		189.4	279	
	(300.1)	(557.9)	-3.44*	(74.9)	(62.1)	-1.85
All areas	1374	2508		568	454	
	(867.3)	(1069)	-3.08**	(356)	(184)	1.11

* $p < 0.01$ ** $p < 0.05$

Table 5. Average rental fee for land before and after government acquisition, Imo State, Nigeria.

Project area	Nominal fee			Real fee		
	Before (₦/ha)	After (₦/ha)	t-value	Before (₦/ha)	After (₦/ha)	t-value
Imo Airport	187 (38.7)	240 (7.0)	-2.7**	76.4 (9.7)	45 (7.8)	5.0*
Army barracks	98.4 (17.8)	151 (13.2)	-5.8*	35.8 (2.6)	27.8 (2.9)	4.1*
Imo State University	53.8 (17.2)	108 (13.2)	-5.0*	21.6	20 (4.5)	0.6
All areas	109.3 (62.6)	166.4 (56.1)	-2.54**	44.6 (24.1)	30.9 (11.6)	1.9

* $p < 0.01$ ** $p < 0.05$

DETERMINANTS OF ADOPTION OF IMPROVED OIL-PALM PRODUCTION TECHNOLOGIES IN IMO STATE, NIGERIA

Jude E. Njoku

SUMMARY

Oil palm is one of Nigeria's most important food and cash crops. Most of Nigeria's palm oil is produced by smallholders who own small, wild groves. The trees receive no maintenance and their yields are low. To reverse the decline in oil-palm production, the Nigerian government instituted the Oil Palm Rehabilitation Project to enable smallholders to replant old groves with high-yielding, disease-resistant varieties of oil palm and to use improved inputs and production technologies.

Six improved technologies are recommended by the Nigerian Institute for Oil Palm Research: improved seed varieties, fertilizers, insecticides, herbicides, triangular spacing, and pruning.

Smallholders in six villages were questioned about their use of the improved technologies. Their levels and rates of technology adoption were low. All of the farmers had adopted at least one of the improved technologies, with the average being 2.9 technologies per farmer. A farmer was regarded as having adopted a technology if it was used on the farm to any extent.

The adoption rate was defined as the number of farmers using the technology as a percentage of the total number of survey farmers. Pruning had the highest adoption rate. The use of triangular spacing and improved seed varieties also had high adoption rates. Slightly over half of the farmers used fertilizer. Many farmers did not believe that fertilizer use was necessary after the trees were two to three years old. In addition, fertilizer application is labor intensive, thus its use was constrained by the acute labor shortage in the area. Few farmers adopted the use of insecticides and herbicides. These technologies were expensive because, unlike improved seed varieties and fertilizers, their prices were not subsidized by the government.

A regression was run to determine which factors influenced technology adoption. Tenurial status, cooperative membership, the amount of loan received, and the intensity of extension

service were all found to be significant determinants of the level of adoption of improved technologies for oil-palm production. Farm size, age, formal education, and household size were not significant.

The results of the study showed that the greatest constraint to the adoption of improved technologies was the farmers' perception that their use was complex; for instance, smallholders did not know what types of insecticides and herbicides to use, how much to use, or how to apply them.

Another set of constraints was the high cost of labor, insecticides, and herbicides. Many of the new technologies require intensive labor use, which contrasts greatly with the limited amount of labor expended in the traditional, wild oil-palm groves. Smallholders must hire expensive labor to implement the improved technologies.

For improved technologies to be adopted and properly used, the farmers must be supported by extension services. Currently, Nigeria has no extension workers who specialize in oil palm production. The farmers also must be able to afford the technologies, and the inputs must be available at the time of year that they are needed.

Since institutional factors, such as tenurial status, cooperative membership, loan amount, and extension service intensity, are the major determinants of improved technology adoption, policies that influence the institutional environment may have more impact than those that influence the technical environment. Policies should encourage ownership of land and membership in cooperative societies. Credit programs that reach rural smallholder farmers must be implemented and extension services must be expanded and improved.

Within the last two decades, Nigerian agriculture has been characterized by a low output of its major food and cash crops. As a consequence, the demand for food has consistently exceeded the supply, resulting in widespread hunger, malnutrition, and disease. Foreign exchange earnings from traditional agricultural export commodities have also declined considerably. In some cases, exports of major cash crops have ceased, and Nigeria has moved from the position of major exporter to that of net importer. Even with the current structural adjustment program, agricultural exports have not risen to their pre-1970 levels. Petroleum export earnings have been unstable due to world market fluctuations in crude-oil prices. To counteract these developments, successive Nigerian governments have adopted agricultural policies and programs aimed at increasing food and export crop production through increased support to smallholders, who account for over 90% of domestic agricultural production

(FSM, 1980; FMNP, 1981). Many of these programs have been aimed at encouraging smallholders to adopt improved technologies to increase crop yields.

Oil palm is one of Nigeria's most important food and cash crops. Its major product, palm oil -- the oily red liquid extracted from the pericarp of the palm fruit -- is used for food and is used in the manufacturing of soap and other detergents. Palm kernel, which is a nut extracted during processing by breaking the pericarp, is used in manufacturing margarine and oil-based confectioneries. Palm oil and palm kernel are important items of both domestic and international trade. Nigeria's exports of palm oil and palm kernel constituted 21% and 50% respectively of total world exports of these commodities between 1963 and 1965 (FAO, 1966). Palm-oil exports ceased in 1979 (CBN, 1980) and palm-kernel exports declined from 92.2 tons in 1981 (CBN, 1981) to 59.6 tons in 1983 (CBN, 1983), due to the combined effects of an increase in domestic consumption and a decline in production.

Most of Nigeria's oil palm is produced by smallholders who own wild groves of less than 2 ha. These trees are of an unimproved variety that has low yields and limited resistance to disease and that takes eight to ten years to mature. The mature trees may grow over 30 feet high, which makes them difficult to harvest since climbing becomes almost impossible during the rainy season. Under this system, the wild palms do not receive any care. The result is a perpetuation of low yields and output.

To reverse the decline in oil-palm production, the Nigerian government instituted the Oil Palm Rehabilitation Program, which was designed to enable smallholders to replant their old groves with high-yielding, disease-resistant varieties of oil palm and to use improved inputs and production technologies.

Farmers generally are more willing to adopt new technologies for producing cash crops, such as oil palm, than for producing crops that provide family food security (Nweke, 1988). However, the level of technology adoption by Nigerian farmers is generally low (Abalu and Yoyock, 1980). A number of explanations have been offered for why farmers are reluctant to adopt new technologies. Abalu (1981) attributes the reluctance to innate psychological characteristics of smallholders; inappropriateness of recommended practices; and limited access of smallholders to credit, technical knowledge, and the material means of production. Several studies attribute low adoption rates to illiteracy and inadequate agricultural extension services (Okigbo, 1981; Egharevba, 1983; FMAWRRD, 1987). Others suggest that the relevance, appropriateness, compatibility, and profitability of a technology influence whether it is adopted (Mijindadi, 1978; Adams, 1982; Njoku and Mijindadi, 1985). The results of studies by Akorhe (1981) and Nweke (1981) indicated that the level of

technology adoption on smallholder farms is influenced by the farmers age, literacy rate, access to material inputs of a technology, and food security needs. In addition, institutional factors related to tenurial status, cooperative membership, access to credit, and intensity of extension services significantly influence adoption (Herath, 1983; Mahmud and Muqtada, 1983).

Studies of technological adoption in Nigeria (Basu, 1969; Alao, 1971; Voh, 1979; Mijindadi and Njoku, 1985) have tended to emphasize the relationship between farmers' demographic characteristics and adoption while neglecting other socioeconomic and institutional factors. Moreover, these studies have concentrated on food crops. Technology adoption in oil-palm production has not been studied in southeastern Nigeria, despite the importance of the crop.

SURVEY METHODOLOGY

A survey was conducted in Imo State, Nigeria to determine the levels and rates of adoption of improved oil-palm production technologies, identify influential factors, isolate major constraints, and recommend policies to increase adoption.

Three oil-palm production zones were chosen for study based on the recommendations of the Smallholder Oil Palm Management Unit (SMU), which is responsible for implementing the Oil Palm Rehabilitation Program (OPRP). These areas have the highest concentration of smallholder oil-palm producers in Imo State. From each zone, one Local Government Area was purposively selected based on the intensity of oil-palm production activities. From each Local Government Area, two villages were randomly selected for study, giving a total of six study villages.

From records maintained by the zonal officers of the SMU, a list was compiled of registered oil-palm producers who participated in the OPRP in the selected study villages. A random sample of 30 smallholder oil-palm producers was selected from each of the six study villages giving a total of 180 producers. Although the desired sample size was 120, data collection started with 180 allow for responses that would not qualify for analysis. Only 103 questionnaires qualified, because 77 of the farmers either declined to be interviewed or responded incompletely or unclearly.

At the time of data collection, the SMU had just initiated a program to recover loans from participants in OPRP, and legal action was being taken against defaulters. Therefore, enumerators of this study were assumed to be agents of the government and received minimal cooperation, despite repeated explanations of the purpose of the study.

Single-visit interviews were conducted, during which respondents recalled information about their oil-palm production activities. Questionnaire interviews were supplemented with field visits and farm observations.

All of the farmers surveyed were men, and only two of them were single. Traditionally, raising oil palm has been considered a man's task. Women are only involved in the processing of oil palm. The farmers' average age was 58 years; most were over the age of 60, which was representative of farmers in the area. Most of the oil-palm producers were retired civil servants and teachers. The average farmer had 17 members in his household: a wife, 9 children, and 6 dependents, such as parents, brothers, sisters, and cousins. Most of the households had over 10 members, and 15% had 23 members. The farmers had an average of five years of formal education, although 40% had less than two years of schooling. The average farm size was 2.4 ha: most farms had less than 2 ha. The average amount received as loan was ₦ 532, although 49% of the farmers who received a loan received less than ₦ 100. Only three farmers received loans of over ₦ 1,700. Thus, farmers surveyed tended to be older married men with large households who had low literacy levels, small farms, and limited access to credit. (see table 1)

OIL-PALM PRODUCTION TECHNOLOGIES

The OPRP was designed to encourage farmers to move away from traditional oil-palm production technologies toward improved technologies which increase the yield.

Traditional Technologies

Under the traditional production system, oil palm is grown wild. Existing plants are of an unimproved variety, and no conscious effort is made to plant and maintain them. Spacing is irregular; the distance between palm trees may be one meter or fifty meters. In some areas, palm trees are highly concentrated; in others, they are widely dispersed. Farmers usually do not weed oil-palm groves or apply fertilizer, insecticides, or herbicides. The trees are pruned merely as an aid to harvesting. Wild oil palms usually are intercropped with food crops such as yams, cassava, and maize. Where oil palm groves are dense, the soil becomes impoverished and the trees shade the earth; thus, food crops grown in the groves may be stunted.

The survey found that oil palms are often intercropped in newly established smallholder farms, usually with cassava, which is a staple food in the area.

Because the trees are widely spaced on new farms, this practice is successful. A few kola-nut trees are interplanted with oil palm. Most smallholders also keep some goats, sheep, and poultry around their homesteads, but they do not integrate livestock and oil-palm production.

Improved Technologies

Research at the Nigerian Institute for Oil Palm Research (NIFOR) has led to the development of a number of improved technologies for oil-palm production. These include the use of improved varieties, fertilizers, insecticides, and herbicides as well as optimum spacing and pruning practices. Efforts have been made to disseminate these technologies to farmers (NIFOR, 1981). Chisel-harvesting technology is available at the research station, but farmers have not been informed of it.

The improved, recommended variety of oil palm is Tenera, a cross between thick-shelled Dura and shell-less Pisifera. NIFOR makes Tenera seeds, usually referred to as "extension work seeds," available in sprouted form to state ministries of agriculture, which raise them into seedlings for distribution to farmers (NIFOR, 1981). NIFOR recommends that planting begin at the onset of the rains in late March and be completed by the end of May. For optimum yield, it recommends planting at 9 m triangular (about 29 feet apart) which gives the recommended plant population of 150 palm trees per hectare.

Oil palm responds well to fertilizer. NIFOR recommends that fertilizer be applied during planting at the rate of 78 kg/ha for the physical development of the plant. Fertilizer application should be increased during the second and third years, and then be continued at a rate of 330 kg/ha at least once a year. For higher yields, fertilizer should be applied twice a year.

Fungus diseases are a major problem of both seedling and mature palms in Nigeria. Spraying chemicals on the leaves prevents the spread of these diseases. High-volume spraying of herbicides for weed control is also recommended. In addition, adult palms should be pruned at least once a year, preferably during the dry season.

LEVELS AND RATES OF TECHNOLOGY ADOPTION

A farmer is considered to have adopted a technology if he uses it to any extent on his farm (Ahmed, 1981; Feder, Just, and Zilberman, 1985). In this study, the adoption level, defined as the number of technologies used, (Akorhe, 1981; Nweke and Akorhe, 1983) varied among farmers. Of the six improved oil-palm

production technologies available to smallholders in the area, the highest adoption level among the survey farmers was 4 and the lowest was 1; the mean was 2.9. Four technologies were adopted by 36% of the farmers, three technologies by 39%, two technologies by 11%, and one technology by 14%.

The adoption rate of a technology is defined as the number of farmers using a given technology as a percentage of the total number of survey farmers (Nweke and Akorhe, 1983). (see table 2) Pruning, with an adoption rate of 89%, was the most widely adopted of all the improved technologies. The primary reasons for this were

- Pruning was consistent and compatible with traditional oil-palm production practices. Farmers have always pruned the wild varieties.

- Most of the survey farmers (78%) were convinced that pruning increased fruit yields.

- Some of the survey farmers (16%) believed pruning made harvesting easier.

The adoption rate for triangular spacing was 80%. Not only did the farmers adopt this technology, but they were so concerned about measuring correctly that they often hired extension workers to measure for them.

Improved seed varieties also had a high adoption rate -- 78%. During the initial stages of OPRP, improved oil-palm seedlings were supplied free to farmers as an incentive for them to adopt the improved seeds; seedling prices have continued to be subsidized and the improved variety produces more oil than the traditional varieties.

The adoption rate of 52% for fertilizers was not as high as expected because

- Farmers believed that applying fertilizer was not necessary for high yields after oil palms were in the field for two to three years.

- The special fertilizer needed for oil palm was not always available at the right time.

- Applying fertilizer to oil palms is labor intensive, and the area has an acute labor shortage.

The adoption rates for insecticides and herbicides were low: only one farmer used insecticides and only two used herbicides. Half of the farmers said they did not

use insecticides because incidence of disease was low, 38% because they did not know insecticides existed, and 12% because insecticides were not available. Although most farmers attributed the low insecticide adoption rate to low disease incidence, they often were unable to identify diseased plants in the field. Field observations showed that they did not recognize symptoms of leaf spot and Anthracnose disease attacks. The farmers were able to recognize vascular wilt disease because it led to complete wilting and death of plants; however, they were unable to follow the recommended treatment because they did not have the necessary chemicals or did not know how to apply them.

The adoption rate for herbicides and insecticides was low because of the following factors:

- Farmers did not know which insecticides to use, how much to apply, or how to apply them.
- Many of the herbicides were not available when needed and when they were available, their cost was high.
- Unlike improved seeds and fertilizers which were supplied to farmers at government subsidized prices, herbicides and insecticides were supplied by private chemical companies at market prices.
- Extension agents did not appear to be knowledgeable about the use of either herbicides or insecticides.

Improving the performance of oil palms depends on the farmers' using the improved inputs and practices according to the recommendations. Thus the actual rates and methods of use of improved technologies were compared with the recommendations. The study found that farmers planted fewer oil palms per hectare than was recommended. This means that the recommended spacing of 9 m triangular between plants was not properly adopted. The quantity of fertilizer used far exceeded what was recommended, probably because of farmers' lack of knowledge of the right quantity to use. It may also be due to farmers' inability to translate scientific recommendations into local units of measurement.

DETERMINANTS OF TECHNOLOGY ADOPTION

In analyzing the determinants of adoption of improved oil-palm production technologies, the ordinary least squares regression model was used. This model is specified as follows:

$$TECH = A + A_1AGE_1 + A_2HHS_2 + A_3EDUC_3 + A_4FS_4 + A_5TS_5 + A_6COOP_6 + A_7LAMT_7 + A_8EXT_8 + U$$

where:

TECH	=	Number of technologies adopted by respondent
AGE	=	Age of the respondent (years)
HHS	=	Household size (number)
EDUC	=	Level of formal education (years) of respondent
FS	=	Farm size (ha)
TS	=	Tenurial status (dummy 1 for landowner, 0 otherwise)
COOP	=	Membership of cooperative organization (dummy 1 for member, 0 otherwise)
LAMT	=	Amount of loan received in the survey year by respondent
EXT	=	Number of contacts with extension agents
U	=	Error term

To determine factors which influence technology adoption, the adoption level was regressed on age, household size, education, farm size, tenurial status, cooperative membership, loan size, and intensity of extension services.

The linear, semi-log, double-log, and exponential forms were tried. Based on the values of the coefficient of multiple determination, the number of significant variables, and the conformity of the signs of the coefficients of the independent variables with a priori expectations, the results of the exponential function were chosen and used for further analysis.

Tenurial status, cooperative membership, amount of loan received, and intensity of extension services all were found to be significant determinants of the level of adoption of improved technologies for oil-palm production.

The results indicate a positive relationship between land ownership and adoption level: farmers who owned the land on which they cultivated oil palm adopted more technologies than those who were tenants on the land. This relationship was expected because the insecure tenure of tenants frequently prevents permanent investment on land (Famoriyo, 1978). This is particularly relevant to perennial tree crops like oil palm. Those who own the land are, therefore, more likely to invest labor and capital in their oil-palm trees than those who do not own the land they cultivate. (see table 3)

Membership in a cooperative organization also had a positive coefficient, implying that farmers who were members of a cooperative organization adopted more technologies than those who were nonmembers. Membership in a cooperative improves the access of farmers to information on new technologies, material inputs such as fertilizers and chemicals, and credit for the purchase of inputs and

payment of hired labor. About 64% of the farmers surveyed were members of cooperative organizations.

The relationship between the amount of loan received and the adoption level was positive. Farmers who received credit adopted more technologies than those who did not. This was as expected because the availability of credit enhances farmers' ability to purchase the inputs required to implement a new technology and to hire the labor needed to use the inputs and improved management practices. To follow the NIFOR recommendations for fertilizer application, a farmer would have to spend about ₦ 350/ha or about ₦ 840 for the average plot of 2.4 ha. Labor costs, which usually are higher than costs for other inputs, raise the cost of production significantly. Credit was one of the incentives offered to participants in the OPRP at its inception; however, the average loan amount of ₦ 532 per farmer was low and the credit component of the program was discontinued because of administrative problems. Only 51% of the survey farmers received such loans. However, a few relatively wealthy and influential farmers obtained loans of about ₦ 5,000 from the Nigerian Agricultural and Cooperative Bank for maintenance of their farms during the survey year.

The number of times that an extension worker contacted a farmer, a proxy for the intensity of extension services, had a positive coefficient, indicating that adoption level increases with an increase in the intensity of extension services. In Nigeria, extension agents are the main source of information about most improved agricultural technologies. Adoption rates should, therefore, be higher as the intensity of extension services offered to farmers increased.

Farm size was expected to relate positively to the level of technology adoption, because the owner of a large farm usually has a higher capital base and, thus, can pay for the improved inputs required by a new technology. However, farm size was not a significant variable.

Age was expected to vary inversely with adoption level because age is thought to determine the ability of a farmer to evaluate risks and because old people tend to be more risk averse than young people. However, the coefficient for age was not significant. Years of formal education was not a significant variable either, although it was expected that the years of formal education would influence the ability to assess the risk involved in adopting a new technology.

CONSTRAINTS TO TECHNOLOGY ADOPTION

The greatest constraint to technology adoption is smallholders' perception that the new technologies are complex. Adams (1982) defines an innovation as complex if it

is difficult for farmers to understand and use. This definition seems to apply to several of the improved technologies recommended to smallholder oil-palm producers. For instance, the adoption rates for insecticides and herbicides were low mainly because farmers did not know what kinds to use, how much to use, or how to apply them.

The high costs of labor, insecticides, and herbicides also constrain technology adoption, especially for farmers who have a low capital base and limited access to publicly supported credit. Following NIFOR's recommendations is tedious, time-consuming, and costly. Managing the improved oil-palm varieties involves regularly removing the underbrush, weeding, applying fertilizer and insecticides, pruning, and harvesting. The traditional practice is to provide no management for the wild oil-palm groves. Thus, the adoption of improved oil-palm production technologies is not only complex and expensive but also incompatible with existing practice. These factors have contributed to low level of adoption of improved technologies.

Furthermore, the wild varieties of oil palm have higher yields of palm kernel than the improved varieties. For this reason, the wild groves may not be completely abandoned by smallholders.

POLICY IMPLICATIONS AND RECOMMENDATIONS

The findings of this study have a number of policy implications for programs designed to increase farm output by encouraging smallholders to adopt improved technologies.

First, most smallholders used improved inputs and management practices at levels that deviated considerably from what was recommended. For instance, too few oil-palm trees were planted per hectare, while fertilizer use far exceeded recommended levels. This was in spite of the fact that the fertilizer adoption rate was low. These results suggest that farmers had limited access to the material inputs of the technologies, lacked adequate knowledge about the use of the technologies, or both. Farmers may have interpreted the recommendations incorrectly because they were not presented in local units of measure. They may have used insecticides and herbicides improperly because they did not know which types to buy or because the recommended types were not available or too costly.

In Nigeria, the extension agents are responsible for providing accurate information to farmers on available technologies. Unfortunately, the country's extension system is weak. In the case of oil palm, special extension workers were trained for OPRP at its inception, but the number of these workers was small. After the

World Bank withdrew its managerial and financial support, these extension workers could not be sustained and supervision of smallholder oil-palm producers has been left to the general-purpose extension agents. The World Bank has recently increased its emphasis on extension for major food crops, but it is unlikely that smallholder oil-palm producers will receive any benefit. A policy is needed that will strengthen the extension component of OPRP if improved technologies are to be adopted widely and farm output and productivity are to be increased.

Adoption rates for insecticides and herbicides are low, in part, because the inputs are expensive and not readily available. Unlike improved seeds and fertilizers, these products are not distributed publicly at subsidized prices. It appears, therefore, that to encourage wider adoption of these technologies, some level of subsidy to smallholders is still necessary. In addition, a system of distribution that improves availability of inputs is needed.

If improved technologies are to be adopted widely, they must be simple, relevant, and compatible with farmers' existing practices. The use of improved varieties and pruning techniques have been widely adopted because they fit these criteria. The adoption of such inputs as fertilizers, insecticides, and herbicides, on the other hand, fell below expectations because they appeared complex and irrelevant to increasing production.

The results of this study suggest that institutional factors influence adoption much more than technical or biological factors. Facilitating land ownership, encouraging membership in cooperative organizations, increasing extension supervision, and improving access to credit will enhance technology adoption much more than merely developing technologies and making them available. Therefore, policies are needed that address these institutional factors.

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Table 1. Socioeconomic characteristics of palm-oil producers.

Range	% of Producers
Age (years)	
61+	33
51-60	37
41-50	21
31-40	3
21-30	5
20	1
Household sixe (no.)	
23	15
19-22	10
15-18	14
11-14	27
7-10	32
3-6	2
Formal education (years)	
15+	2
12-14	6
9-11	8
6-8	27
3-5	17
0-2	40
Farm size (ha)	
11+	1
9-10	2
7-8	1
5-6	6
3-4	20
1-2	70
Loan amount received (₦)	
1701+	3
1301-1700	0
901-1300	1
501-900	20
101-500	27
100	49

Table 2. Rates of adcption of improved oil-palm production technologies.

Improved Number of Technologies	% of Survey Adopters	Farmers
Improved seed variety	80	78
Fertilizers	54	52
Insecticides	1	1
Herbicides	2	2
Triangular spacing	82	80
Pruning	89	86

Table 3. Exponential regression results. Determinants of adoption of improved oil-palm production technologies.

Variable	Coefficient	T-Value	Standard Error
Age of farmer	-0.001	-0.743	0.0014
Household size of farmer	-0.0081	-2.213	0.0037
Education	0.0021	0.687	0.0031
Farm size	-0.0037	-0.415	0.0089
Tenurial status	0.2069*	6.362	0.0325
Cooperative membership	0.1011*	2.769	0.0365
Amount of loan received	0.0002*	3.18	0.0001
Extension contact	0.0245*	2.569	0.0095
Constant	0.1238		
$R^2$0.5421			
R^{-2}	0.5032		

*Coefficient significant at the 1% level

THE ROLE OF WOMEN'S TRADITIONAL SAVINGS AND CREDIT COOPERATIVES IN SMALL-FARM DEVELOPMENT

Noble J. Nweze

SUMMARY

The official cooperative movement in Nigeria has had limited success. Although it was introduced over 50 years ago, it has proven unsuccessful at incorporating the majority of rural Nigerians, especially rural women. Yet unofficial indigenous cooperatives continue to thrive.

This study examines women's savings and credit cooperatives in two Nigerian states, Anambra and Benue. Interviews conducted with 150 women members revealed that these cooperatives could help to improve smallholder farming.

The cooperatives' main economic activity was mobilizing members' savings. The average amount saved per cooperative in 1987 was ₦ 6,833 in Anambra and ₦ 4,838 in Benue. Most members spent their savings to meet farm expenses, some to meet nonfarm expenses (such as school fees), and only a few to acquire consumer or durable goods. Although farming was an important economic activity in the areas surveyed, about 65% of the respondents combined farming activities with other occupations.

The members said their accumulated savings were moderately sufficient to meet their needs. Most of the women were satisfied with their access to their savings, especially since it is usually available during the peak labor period when it was needed. A high proportion believed the cooperative was managing their savings well.

Of the 150 members surveyed, 35 borrowed money from their cooperative in 1987, which indicates that extending credit to members was an important secondary economic function for the cooperatives. The loans were used primarily for investments both on and off the farm -- farm investments accounted for 61%. The major problem reported by borrowers was that loan amounts were inadequate.

In 1987, 570 loans were disbursed by 28 of the 30 cooperatives. Interest rates charged ranged from 10% to 50% for members and from 50% and 100% for nonmembers. Members did not consider the cost of borrowing a problem. Most loans were disbursed at the beginning of the cropping season, and most were repaid during the harvest period.

In 17 of the 30 cooperatives, work groups were organized to provide farm labor to members, in rotation, during peak periods of labor demand. The members said the availability of cheap, efficient labor through the work groups allowed them to utilize increased farm land.

Participants had high opinions of their group-based savings and credit cooperatives. They said the cooperatives are particularly effective in making loans available, allowing a long time for repayment, offering moderate interest rates, and keeping the loan-transaction process simple.

It was clear that despite some problems, members plan to continue patronizing their cooperatives even if banks are established in their areas.

The modern cooperative movement in Nigeria has had limited success, probably because the European models that have been followed do not reflect the needs and social structures of Nigerian society. The European types of cooperatives grew from a wide variety of self-help organizations in the 18th and 19th centuries, and each variant reflected the prevailing socioeconomic situation. They were successful in Europe because they were organized to solve specific problems.

While the European-type cooperatives were being introduced into Nigeria, the indigenous cooperatives were ignored because they were regarded as unsatisfactory and irreformable (Strickland, 1934). Yet as the transplanted cooperatives have faltered, the indigenous groups have continued to thrive, attracting immense patronage. So awareness is growing of the need to explore their suitability and potential for fostering socioeconomic development in rural areas.

One form of indigenous cooperative is the group savings and credit association. These associations have been described in ethnological literature but rarely have been systematically studied (Seibel and Damachi, 1982). Indigenous group-based savings and credit activities unite local people, especially women, to identify their needs and mobilize their own resources. By so doing, they provide for themselves what the government and other agencies cannot (Ijere, 1988b).

The resilience and widespread popularity of these cooperatives, despite the impact of colonialism, point to the possibility that they contain important elements that are conducive to local resource accumulation. These elements seem to be lacking in modern cooperatives. The indigenous cooperatives deserve extensive and systematic research to identify their strengths and weaknesses so development policies can take advantage of their contributions, rather than duplicate or undermine them.

HISTORY OF COOPERATIVES IN NIGERIA

Recent estimates of the membership of official cooperatives in Nigeria suggest that, after 50 years, they have reached only three million people (Arua, 1986) -- less than 5% of Nigeria's population -- whereas the third and fourth national development plans envisaged that 25% of the population would become members. Women, in particular, have not been incorporated into the cooperative movement; they account for only 10% of the membership. This rate is low in a country where women constitute at least half of the rural population and work long hard hours as farmers. One reason that is often given for their lack of participation is that the cooperatives were introduced from above, not from below, and therefore lacked the roots required for a mass following (Ijere, 1988a).

Proponents of orthodox cooperatives expected that participation would enhance farmers' access to production credit. However, the evidence shows that loans made through such cooperatives seldom reach rural women.

Other efforts have been made to mobilize rural savings in Nigeria, including the establishment of the Federal Savings Bank (formerly the post office savings bank), development savings certificates, stamp savings cards, and cooperative thrift and credit certificates. As Okorie and Miller (1976) observed, these efforts met with little success because they were inaccessible to most rural farmers and because their formal system of operation tended to preclude patronage by the rural people.

More recently, in 1977, the federal government instituted a rural banking scheme to solve the problem of rural underdevelopment by mobilizing and allocating of funds in a continuous way, while ensuring that such funds were employed productively (Agu, 1986). The scheme was expected to enhance contact between the formal financial sector and rural people and ensure that funds were available to the agricultural sector.

The initiative called for existing commercial banks to open branches in rural areas. Although the number of bank branches has increased since the inception of the scheme, it is not clear that they have addressed the needs of rural people. The rural banks operate similarly to their parent banks in major cities and appear not to meet the savings and credit needs of the rural people.

Other programs were created to support rural credit needs. The Agricultural Credit Guarantee Scheme Fund was developed by the federal government in 1977 as an incentive to banks to finance agriculture. The Nigerian Agricultural and Cooperative Bank grants direct loans to farmers, cooperative societies, and other organizations.

Despite the changes brought about by the establishment of the Rural Banking Scheme, the Agricultural Credit Guarantee Scheme, and the Agricultural and Cooperative Bank, rural women have been largely excluded from institutional sources of agricultural credit. Since women account for at least 50% of the agricultural labor force and dominate some areas of traditional production, processing, storage, and marketing, Nigeria's agricultural productivity and output are inhibited by women's exclusion. However, women's limited access to institutionalized credit sources and the current economic hardships they face may be increasing their participation in savings and credit systems that rely on traditional patterns of social relations and control (Ardener, 1953; Illy, 1973; Okorie and Miller, 1976).

One of the important characteristics of traditional forms of cooperation is that they are widespread. The director general of the International Labor Organization commented (ILO, 1977), "The trend towards more informal associations may become more widespread as such groupings meet the needs of poorer people whose capacity for managing formal associations is still inadequate."

In the same vein, Verhagen (1980) wrote,

> Institutions based on traditional, indigenous forms of collective organization are sometimes advocated as the most appropriate ones for involving the entire population in a balanced process of social and economic development...Village organizations well-rooted in tradition have proven effective in mobilizing participation for development purposes...

The major reason for the proliferation of indigenous and informal groups appears to be that the essential elements of cooperatives are part of the cultures in which these groups are found. In Nigeria, for instance, the life patterns of

people are cooperative. People voluntarily combine efforts to hunt, clear land, build houses, and engage in other economic activities. When the state or government falls short of their expectations, rural people search for local organizations that will enable them meet their needs.

Kurtz (1973) described the forming of such coalitions as an adaptation to poverty or relative deprivation. Informal rural cooperatives are set up to find solutions to basic problems that affect the core participants. They respond flexibly to changes in the socioeconomic environment.

Traditional savings and credit groups constitute one of the most widespread types of self-help organizations in the third world. They assist members in small-scale capital formation or, as Ardener (1964) argues, they create savings. All such associations have the creation of savings as an important feature.

A major attraction of the indigenous groups is the security they provide for the funds. Depositing savings with a cooperative may be the safest way to keep them. As formal savings institutions are virtually absent in most rural areas, the informal cooperatives are performing useful functions by mobilizing savings.

Indigenous cooperatives provide credit on a smaller scale than banks normally are willing to consider. Amogu (1956) showed that, even when banks are interested in lending small amounts, they must be cautious because they cannot always easily assess the reliability of those seeking loans. In contrast, the organizers of indigenous credit associations usually are able to do so.

For this wide variety of reasons, rural women participate in alternative, indigenous group-based savings and credit systems instead of the official cooperative movement.

PROFILE OF MEMBERS OF SAVINGS AND CREDIT COOPERATIVES

This study sought to evaluate the role of women's indigenous group-based savings and credit activities in small farm development -- thus going beyond most ethnological and anthropological studies.

Five indigenous savings and credit cooperatives were selected for study in each of six communities in Anambra and Benue states of Nigeria. Then, five members of each group were selected randomly for questioning, giving a total of 150 participants.

Anambra is one of the eastern states of Nigeria. Its area is about 19,231 sq km, which makes it the third-smallest state in the federation. On the other hand, it ranked sixth in population with 3,596,631 people (1963 census). Its population density -- about 187 persons per square kilometer -- is one of the highest in the country.

Benue's land area of 69,740 sq km makes it Nigeria's seventh-largest state. With 3,041,194 people at the last census, its population density is about 50 persons per square kilometer.

Anambra and Benue are food-producing areas; about 80% of the population is engaged in the agricultural sector, which is characterized by smallholdings. Women produce food crops such as cassava, cocoyams, vegetables, soybeans, benniseed, maize, melons, rice, cowpeas, and groundnuts.

Most of the women surveyed (72%), were between the ages of 30 and 50. The average age was 44 years; only 16% were less than 30 years old. The subjects were grouped according to their status in farming. Those who earned most of their 1987 income from farm work were classified as full-time farmers; those who earned most of their income from nonfarm occupations were classified as part-time farmers (Uwakah, Nweze, and Nwosu, 1980). Less than half of the respondents (35%) were full-time farmers. Most of these tended to be older women whose incomes were supplemented with occasional cash gifts from children and other relatives. The 65% of the women who were part-time farmers were relatively younger and combined farming with other occupations such as petty-trading or teaching.

Less than half of the women (43%) had completed primary school. The women with more formal education tended to farm part time because they also had nonfarm employment or other sources of income.

All but 20 of the women were married. The average number of children per surveyed woman was 5.3 in Anambra and 4.2 in Benue. In addition to children, 60% of those surveyed in Anambra and 42% in Benue had other relatives living with them such as mothers, fathers, brothers, sisters, and cousins.

The subjects' perceptions of their access to production factors and markets did not differ significantly between the two states. Farm tools found in a typical surveyed household included four hoes, two cutlasses, and three sickles, valued at a total of about ₦ 90 (₦ 7 = US$ 1).

Most women farmers interviewed said they relied more heavily on hired labor than on family labor since their children were normally in school during the

farming season. Farmers hire labor for activities such as clearing, tilling, weeding, and sometimes harvesting. Further investigations revealed that some farmers used work groups to supplement hired labor.

Reports of land-acquisition problems were rare. Nearly 90% of the women said they could readily acquire additional farm plots if needed.

Most of the women were keen to adopt new farm technologies introduced by extension agents. They were particularly interested in receiving improved maize seeds, cassava cuttings, vegetable seeds, and chicks. Less than half of the women surveyed used fertilizer in 1987, confirming earlier findings that rural farmers still had mixed feelings about using fertilizers in root-crop production (Eze, 1976).

The subjects welcomed information and services that might improve their economic returns. The combined activities of the ministries of agriculture, agricultural development projects of each state, river basin development authorities, and the Directorate for Food, Roads and Rural Infrastructures provide this information through extension services. Mechanized farming was gradually gaining a foothold in the study areas. Some farmers who could afford it hired tractors to plow the fields.

Each community had at least one market, but the farmers still had problems in selling produce. Due to the lack of storage facilities and the critical need for cash, 86% of the farmers sold their produce at harvest time or shortly thereafter. Thus, they received low prices.

Only 0.7% of the subjects in Anambra and 4.7% in Benue borrowed money from commercial banks in 1987, mainly to meet production expenses. The average loan received from commercial banks was about ₦ 2,065 in Anambra and ₦ 3,692 in Benue.

The respondents had a number of reasons for not obtaining commercial bank loans (see table 1). Inability to meet the loan conditions for institutional credit was the reason given most often. About 27% of the respondents in Anambra said they did not need commercial bank loans. Over 26% of the respondents in Benue said they did not have bank accounts.

ORGANIZATIONAL STRUCTURE

The organizational structure of each indigenous cooperative depended on the socioeconomic functions of the group. Structures did not vary significantly

between the two states. Traditional group-based savings and credit activities were performed within an informal organizational framework; most of the groups had no formal legal basis. They may have a positive functional significance for their participants.

The cooperatives structure was strongly affected by the group's size. The smaller the group, the less elaborate or formalized was the organizational structure. Most large groups, especially those exceeding 80 members, were divided into two to three subgroups, each having separate subcommittees. This arrangement made the large groups easier to administer because it reduced communication problems. Although 65% of the women surveyed claimed that they belonged to two or more cooperatives, no formal relationship existed between any two groups. None of the groups surveyed had branches.

Each cooperative had a committee of officers, including a chair or president, a secretary, and a treasurer, financial secretary, or both. The average number of officers was 3.9 per cooperative in Anambra and 4.1 in Benue. The officers usually were elected and were not paid or rewarded in kind. This finding was similar to that reported by Okorie and Miller (1976).

About 72% of the officers surveyed in Anambra and 60% in Benue had some formal education. They had an average of 7.8 years of schooling in Anambra and 6.3 years in Benue. These averages imply that the minimum qualification for being an officer was a primary school certificate.

Some of the indigenous cooperatives were open to anyone who wanted to participate. Others restricted their membership to the women of one extended family or compound. In fact, in 65% of the cooperatives, only the women of a certain clan or village were allowed to participate; and usually as soon as a woman married into a family, she enlisted in its cooperative. The open groups were larger, averaging 60 members; restricted groups had an average of 27 members. The cooperatives ranged in size from 20 members to 123 members.

Of the 30 cooperatives surveyed, 28 kept records of accounts, attendance, loans, and minutes. In 37%, written by-laws established penalties for being late to meetings, stealing, fighting, defaulting in payment, gossiping, and committing adultery. Fines for these offenses ranged from ₦ 1.00 to ₦ 10.20. Defaulting in payment had the highest average fine of ₦ 10.20 in Anambra and ₦ 7.55 in Benue since regular contributions are the foundation of all indigenous savings and credit associations. Ardener (1964) said fulfilling this financial commitment is a solemn duty that must be performed, even at the expense of other obligations. To minimize the default rate, the leaders of these cooperatives engaged in a wide variety of practices not specified in their written laws, such as

ostracizing the defaulter, presenting her before an oracle, or subjecting her to other traditional sanctions. Such practices are necessary because defaults could not only cause the cooperative to collapse but also destroy the reputation and viability of the ancient institution (Cope and Kurtz, 1980).

All of the cooperatives held regular meetings. At every meeting, each member was expected to deposit a predetermined amount of money. The most common meeting places were the president's residence and members' homes. The women had to travel an average of 1.7 km to meet at the president's house, whereas they would have had to travel an average of 12.3 km to reach a bank. However, contrary to expectations, the nearness of the cooperatives was not an important factor in the women's choice to patronize them rather than banks. Even in the parts of Anambra that had rural banks, it appears that members still preferred to save in their cooperatives.

The two major types of cooperatives with savings and credit functions were the rotating savings and credit cooperatives and the fixed-fund or non-rotating cooperatives. Rotating savings and credit cooperatives are those in which each member contributes to a common fund. The fund is then handed over to a different member at each meeting. In nearly two-thirds of the cases studied, the contributions rotated at each meeting, meaning that returns for a particular day are handed out to a member whose turn it is to collect. The cycle ends when every member has taken a turn. These are the most popular forms of savings associations.

Nearly one-third of the cooperatives studied used fixed funds. Each member contributed a specified amount on a regular basis, and the entire sum was kept safe by a treasurer. At the end of the cycle, all or part of the fund was shared by the members.

In one variant of fixed-fund cooperatives studied in Anambra State, members paid varying subscription rates conforming to what Soen and De Comarmond (1972) described as an allowance for adjustment to the structure of rural society. Thus, women contributed according to their means, and the sum was divided at the end of the cycle in proportion to their contributions. In some associations, part of the fixed fund was set aside to build up a loan fund.

SAVINGS MOBILIZATION

Mobilizing savings and extending credit were the core activities of all the cooperatives studied. The magnitude of these activities depended on the prevailing economic and social environment.

Regular contributions were required of all members. The contributions -- which had to be in cash, not in kind -- varied from ₦ 0.50 to ₦ 10.00 but were usually ₦ 0.50, ₦ 1.00, or ₦ 2.00. The mean contribution was ₦ 1.68 in Anambra and ₦ 1.32 in Benue. The amount each member contributed was stable throughout a cycle.

In 13% of the cooperatives in Anambra, contributions were paid weekly; the rest were paid monthly. In Benue, 27% were paid weekly, 26% were paid monthly, and the rest were paid twice a month, usually on Sundays or market days. In 30% of the cooperatives in Anambra and 86% of those in Benue, members could make multiple contributions and therefore receive the fund multiple times in a cycle.

Most of the members surveyed said that, because they had to contribute to the cooperative regularly, they saved more than they would have saved individually. In 1987, the average cooperative member saved ₦ 167 in Anambra and ₦ 132 in Benue. The average cooperative saved a total of about ₦ 6,833 in Anambra and ₦ 4,838 in Benue. This exceeds the amount contributed in official cooperative societies or development projects in some parts of Benue (Seibel and Marx, 1985).

In the last 5 years, the amount of savings accumulated by the 30 cooperatives studied has steadily increased. The apparent reasons for this trend were increases in membership size and amounts of contributions.

In all of the cooperatives studied in Anambra, and 44% of those studied in Benue, the order of rotation was determined by the leader. In the others, the order was set by general agreement or determined by individual needs. A few disputes arose over the order of rotation. To obviate this problem, the order of rotation was reversed after each cycle in most of the cooperatives.

A large proportion of the savings (81.4%) was spent on productive activities in 1987 (see table 2): 55.5% on farm related expenses and 25.9% on nonfarm expenses. Consumption and durable goods accounted for only 18.6% of savings expenditures.

The investment in agriculture was much greater than the 21% observed by Okorie and Miller in 1976, perhaps because the government recently implemented a rural development campaign that extolled the virtues of agriculture in a depressed economy. In addition, the current structural adjustment program has compelled many people to take up farming.

To evaluate members' perceptions of their cooperatives' savings activities, their opinions were gathered about the sufficiency, accessibility, and security of their funds. The vast majority of women -- 93% -- responded that the amount of their savings was sufficient to meet their needs. Most of the respondents (68% in Anambra and 71% in Benue) were confident that they could use their savings in times of financial difficulty, particularly during the peak period of labor demand. For those who participated in rotating funds, this meant they could receive funds out of turn when necessary. Almost 75% of the respondents considered their funds to be efficiently managed. They were satisfied with the cooperative's accuracy in keeping records and performing calculations, the money's safety, and the officers' honesty.

CREDIT EXTENSION

A lack of funds, high labor costs, and a lack of improved technology were the most important constraints to agricultural production indicated by the women surveyed. Of these, the lack of funds was the most crucial since it constrained the procurement of labor and other agricultural inputs.

Providing credit was a significant function of the cooperatives since members' savings usually were neither hoarded nor lodged in the bank, but instead were lent to members. In 90% of the cooperatives, members could obtain loans; in a few cooperatives, nonmembers also could obtain loans but at higher interest rates than members. This finding conflicts with Okorie and Miller's (1976) report that cooperatives with rotating funds never offered loans since the funds were handed out to members in turn. In fact, many cooperatives had sources of income other than the rotating fund, including fines, earnings of work groups, interest on loans, and small fees.

In 1987, the surveyed cooperatives made 570 loans totaling about ₦ 7,365 in Anambra (an average of ₦ 21 per loan) and ₦ 6,591 in Benue (an average of ₦ 31 per loan). These estimates are comparable with the findings of a study by the Agricultural Project Monitoring and Evaluation Unit from 1976 to 1978, which showed that the credit needs of a smallholder range between ₦ 35 to ₦ 110 per year in Nigeria (Ihimodu, 1986).

Interest on loans ranged from 10% to 50% for members and 50% to 100% for nonmembers. Contrary to the finding of Ijere (1981), interest charges were not discriminatory among members. Interest-free loans were not available from any of the surveyed cooperatives. The calculation of interest was simple and was not stated in percentages.

To get information on the actual interest paid, questions were framed about the amount of money the borrower obtained, the length of time she used it, and the amount she repaid. From this information, the rate paid for the use of one naira for a year was calculated (Miller, 1975).

About 83% of the women indicated that the interest rates charged by their cooperatives were either good or moderate; the remainder were dissatisfied with the interest rates. Charges of 10% to 50% for members are not unreasonable, considering that rural farmers borrow from village money lenders at rates of 100% and more. It follows, therefore, that smallholders would borrow enthusiastically from institutional sources at the current deregulated rate of 15% to 20% if those sources were more accessible to them.

Limits were placed on the duration of loans in 50% of the cooperatives. In 20%, loans could be paid any time before the end of a contribution cycle. Five cooperatives had loan committees comprising a chair, treasurer, and financial secretary that made decisions about loans. In a few other cooperatives, the power to approve a loan was vested in the entire membership.

Members occasionally defaulted on loans in only 13% of the cooperatives. Half of the defaults were related to sickness and mental problems; the rest were made by women who migrated to undisclosed destinations.

Of the surveyed women, 23% borrowed money in 1987. A high proportion of the funds (78.3%) was used to finance farm and nonfarm investments (see table 3); farm investments alone accounted for 61.5%, with 17.4% being spent on hired labor. Trade and school fees accounted for over three-quarters of nonfarm expenditures. Only 18.4% was spent on durable goods, ceremonies, and clothes.

If members' expenditure of their 1987 credit can be taken as typical, then over three-quarters of the loan amounts from indigenous sources are used for agricultural purposes. This finding contradicts the conventional wisdom that rural farmers spend their cash on ceremonies and immediate consumption. Rather, it upholds the view that, if rural savings are properly harnessed, they may complement the formal financial markets in channeling funds to the agricultural sector.

The size and terms of credit are relevant in judging the potential of a credit system to meet the needs of beneficiaries. In this study, about 60% of the respondents thought the average loan size was inadequate. Therefore, although these groups are valuable sources of credit, the sums they yield are small and, thus, the loans they offer often can only meet farmers' urgent financial needs. If

members had access to additional funds, they could expand farm hectarage, employ additional labor, or purchase costly inputs such as fertilizer.

The size of the fund, the amounts of contributions, the size of membership, and the length of the contribution cycle are interdependent in a typical savings and credit cooperative. Thus, the amount of loanable funds available from a cooperative should be commensurate with its membership size. This relationship held true for most of the cooperatives.

If credit is to benefit farmers, it must be available at the time of year the farmer needs it to pay for agricultural inputs (Miller, 1975). Thirty-six loan beneficiaries were interviewed to determine in what months they received their loans and to establish the relationship, if any, between the peak demand for loans and the beginning of the cropping season.

Most loans were disbursed during January, February, March, and April -- the beginning of the cropping season in most parts of the study area. As expected, the due dates for 56% of the loans came during the peak harvest months of November and December, when cash is available from the sale of produce. These loans made early in the year and repaid later in the year are partly responsible for the inadequacy of loanable funds in indigenous cooperatives. Cooperatives often do not have funds available during the cropping season.

Seasonality also affected the cooperatives' savings functions. When funds are rotated, some members get their turns in the off season. The cooperatives surveyed had a system whereby participants who needed the fund before their turn could pay a specific amount for the privilege of using the fund when needed. In some cooperatives, the order in which participants got the collective deposit was reversed each cycle, so some members could look forward to a better position in the next cycle. This finding is similar to that of Miracle, Miracle, and Cohen (1980).

GROUP-BASED FARM LABOR

To obviate the high cost of labor, some members in 17 of the 30 cooperatives banded into work groups that moved from one farm to another until all members' farms were visited. The work groups provided labor to members for farm operations that ranged from clearing, preparing soil, planting, and weeding to harvesting and processing. The average work group had six members in Anambra and nine members in Benue. The member whose farm was visited entertained the group with kola, food, and drinks. The work groups received cash payments only when they worked on a nonmember's farm. In 56% of the

work groups, unwritten rules governed group functions, entertainment, discipline, and duration of existence. Since the groups had no officers or formal leaders, the chair of each parent association usually was responsible for the arbitration of disputes. The period of peak demand for labor coincided with the months the work groups were most active on members' farms.

The lack of labor constrains the extent of work done in smallholder agriculture. About 72% of work-group participants in the sample said their groups enabled them to do more work on their farms than they could have done otherwise, and 20% said the amount of additional labor was satisfactory. For these participants, the assistance of work-groups made possible greater planting precision, better weed control, better harvesting, and less wasteful processing and storage.

Labor use is correlated with total output. According to Olayide and Atobatele (1980), the labor available for cultivation and weeding limits the amount of land a farmer can manage, and the labor available for harvesting the crops limits the final output. For a significant proportion of the respondents, work groups were dependable sources of farm labor that enabled members to cultivate additional land.

About 93% of the respondents indicated that, by working together, they accomplished more at a lower cost, implying increased productivity. Labor costs constitute over 60% of the total cash cost of production due to recent wage increases and a decreasing number of farm hands (Falusi and Olayide, 1980). Members rated the labor-management potential of their work groups highly.

THE FUTURE OF SAVINGS AND CREDIT COOPERATIVES

The surveyed women generally intended to continue patronizing their cooperatives. This is hardly surprising in the light of the enthusiasm with which members contributed regularly and the satisfaction they expressed with their cooperatives' forms of mutual assistance.

About 90% of the respondents indicated that proximity of source was not the major reason they continued to patronize their cooperatives. Although farmers resorted to indigenous cooperatives, in part, because dependable alternatives were lacking, most respondents said they would continue their memberships even if formal financial systems were introduced in the rural areas. Other reasons given for continued membership were ready availability of loans, moderate interest rates compared to those of the village money lenders, and simplicity of loan transactions.

Some respondents said their cooperatives had no problems. Of the problems that others reported, inadequacy of loan amount was mentioned most frequently (59 responses). Most of the cooperatives could not issue new loans until earlier ones were repaid. Thus, delays often resulted. In addition, because the loans from the cooperatives were too small to meet the farmers' needs, members sometimes were compelled to borrow from other sources, such as money lenders, friends and relatives, and occasionally banks. Other problems mentioned by the members were short intervals for loan repayment, poor record keeping, and confusion in determining the order of rotation. Lack of leadership was frequently mentioned as a problem in Benue, but not in Anambra.

Despite the problems they expressed, it was clear that members of indigenous cooperatives had no acceptable alternatives for savings and credit services. Most of the respondents emphasized the value of members' help during illness, funerals, and other ceremonies, which implies that the cooperatives perform insurance functions not provided by formal institutions.

POLICY IMPLICATIONS AND RECOMMENDATIONS

The results of this study have implications for banking and rural development policy. The members of indigenous cooperatives have demonstrated ingenuity and flexibility in organizing savings and credit activities that serve a variety of purposes. They could apply those qualities to supporting the government's rural development policies, if they were given greater attention and consideration in the planning process.

Indigenous savings and credit cooperatives also offer a potential launch pad for modern cooperatives. The success of such reformed cooperatives would depend largely on the extent to which they retained the culture-appropriate attributes of the present indigenous cooperatives. If they were perceived as growing from traditional values, rather than as being imposed from outside, they could form the basis of development.

The problem of inadequate funds mentioned by most of the women surveyed suggests that indigenous savings and credit cooperatives need to be assimilated by the formal financial sector, which includes commercial banks and other lending agents. Establishing a link between formal financial markets and farmer organizations will further mobilize rural savings and ensure the adequacy of loanable funds in rural savings and credit cooperatives. Such a link should be integral to Nigeria's rural banking policy.

Collective investment opportunities should be introduced to make savings more attractive in rural areas. Cooperative training centers should be established to offer short-term courses on viable small-scale ventures and cooperative management for rural women.

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Table 1. Reasons for not obtaining commercial bank loans given by members of indigenous savings and credit cooperatives in two states of Nigeria, 1987.

Reason	Farmers giving this reason					
	Anambra		Benue		Anambra + Benue	
	Number	%	Number	%	Number	%
Could not meet loan conditions	19	25.68	28	52.83	47	37.01
Did not need loan	20	27.03	3	5.66	23	18.11
Had no bank account	1	1.35	14	26.41	15	11.81
Was unable to repay loan	15	20.27	0	0	15	11.81
Found commercial interest rates too high	13	17.56	1	1.89	14	11.02
Found bank transactions too complex	4	5.41	4	7.55	8	6.3
Had no knowledge of bank transactions	2	2.7	3	5.66	5	3.94
Total	74	100.0	53	100.0	127	100.0

Table 2. Uses for shares of rotating fund by members of indigenous savings and credit cooperatives in two states of Nigeria, 1987.

Use	Anambra		Benue		Total	
	Freq. of mention	Total expend. (₦)	No. of	Total expend. (₦)	Expend. (₦)	% of grand total
Farm expenditures						
Hired labor	70	982	31	761	1,743	16.5
Fertilizer	71	631	53	533	1,164	11.0
Seeds	60	316	14	516	832	7.8
Processing	7	220	5	320	540	5.1
Implements	23	96	5	407	503	4.7
Transportation	11	163	44	260	423	4.0
Hired tractor	0	0	2	350	350	3.3
Storage	5	82	5	110	192	1.8
Livestock	3	48	3	30	78	0.7
Livestock feed	0	0	2	68	68	0.6
	250	2,538	164	3,355	5,893	55.5
Nonfarm expenditures						
School fees	46	609	45	795	1,404	13.2
Hospital fees	7	180	46	516	696	6.6
Trade	4	430	0	0	430	4.1
Savings	0	0	2	208	208	2.0
	57	1,219	93	1,519	2,738	25.9
Consumption and durable goods						
Clothes	37	463	54	364	827	7.8
Festivals and ceremonies	51	221	30	416	637	6.0
Pocket money	42	336	0	0	336	3.2
Durable goods	3	170	0	0	170	1.6
	133	1,190	84	780	1,970	18.6
Grand total	440	4,947	341	5,654	10,601	100.0

Table 3. Uses for credit from indigenous savings and credit cooperatives in two states of Nigeria, 1987.

Use	Anambra		Benue		Total	
	Freq. of mention	Total loans (₦)	Freq. of mention	Total loans (₦)	Loans (₦)	% of grand total
Farm expenditures						
Hired labor	13	1,734	8	1,280	3,014	17.4
Seeds	18	2,952	0	0	2,952	17.0
Seedlings	12	1,804	3	360	2,164	12.5
Fertilizer	15	1,184	9	625	1,809	10.4
Transportation	3	229	1	100	329	1.9
Cassava cuttings	3	146	0	0	146	0.8
Rice nursery	1	85	0	0	85	0.5
	65	8,134	21	2,365	10,499	60.5
Nonfarm expenditures						
Trade	10	739	7	521	1,260	7.3
School fees	16	785	8	438	1,223	7.1
Savings	5	301	2	85	386	2.2
Hospital fees	8	200	0	0	200	1.2
	39	2,025	17	1,044	3,069	17.8
Consumption and durable goods						
Durable goods	12	770	33	587	1,357	7.8
Ceremonies	14	538	7	402	940	5.4
Clothes	18	558	13	339	897	5.2
Pocket money	10	580	0	0	580	3.3
	54	2,446	53	1,328	3,774	21.7
Grand total	158	12,605	91	4,737	17,342	100.0

NUTRITIONAL CONCERNS IN AGRICULTURAL RESEARCH IN NIGERIA

Lily A. Ohiorhenuan

SUMMARY

The failure of traditional agricultural research to produce tangible improvements in human health and nutrition in most developing countries has resulted in a call for research institutions to reevaluate their research methods and priorities and to incorporate nutritional goals into their research more explicitly. The need for establishing more effective approaches to solving hunger and nutrition problems is particularly obvious in Nigeria, where malnutrition remains widespread despite the efforts of research institutes to develop improved food production technologies.

A review of the literature on nutrition in agricultural research provides insights into why traditional agricultural research has had little success in alleviating malnutrition in developing countries such as Nigeria, and offers proposals for ways in which nutritional concerns can be more effectively incorporated into agricultural research efforts.

It was found that both structural limitations and conceptual deficiencies have reduced the effectiveness of agricultural research in developing countries. The most significant structural limitations are researchers' limited control over project funding and over the application of their research results. Research priorities and objectives are often determined by outside funding sources, which in the case of many developing countries has led to a research emphasis on export crops and other programs and objectives that have little direct bearing on nutrition. Researchers typically have had even less control over whether and how their research results are implemented. For example, wide-spread farmer adoption of new agricultural technologies has sometimes been hampered by inadequate credit, input subsidy, or price support provisions, or by inadequate market infrastructure.

The principal conceptual deficiency in past agricultural research has been its failure to recognize and address the root causes of malnutrition. Malnutrition has been conceived of as being essentially a problem of insufficient supply, when it is actually the result of poverty, and therefore primarily a problem of ineffective demand. New yield-enhancing technologies are

irrelevant to subsistence farmers who have limited access to land, credit, production inputs, and market opportunities, and who cannot afford to purchase additional food, should it become locally available. Yet these are the farmers who produce the bulk of Nigeria's food and whose families are most at risk of suffering from malnutrition. This failure to consider the needs and resource constraints of small-scale farmers has led to misplaced research priorities and the development of inappropriate technologies, and has been singled out as a major reason for the failure of agricultural programs to increase food production and reduce the incidence of malnutrition in developing countries.

Agricultural research also suffers from a lack of reliable comprehensive data on the specific nutritional needs of Nigeria's population subgroups. Most nutritional studies rely on food balance sheets which compare estimated aggregate food supplies with estimated aggregate food demand, both on a per-capita daily basis. But food balance sheet estimates differ substantially according to the assumptions used in their derivation, and also cannot provide information on how the food supply is distributed geographically, seasonally, within localities, or among adults, infants, and children.

The issue of more effectively addressing nutritional concerns in agricultural research surfaced during a series of meetings held in Nigeria and around the globe in the late 1970s and the 1980s. The general consensus of these meetings was that agricultural researchers and program analysts needed to place greater emphasis on the explicit, *ex ante* consideration of nutritional objectives in their programs. The need for agricultural research institutes to cooperate with nutritionists and others in the collection of necessary nutritional data and in the development of appropriate analytical methodologies was recognized. Specific recommendations made at the meetings pertained to the need for agricultural research institutes to develop technologies which are appropriate to the needs and environments of those who are nutritionally at risk. In particular, the need was identified for improving food storage capabilities and emphasizing farming systems which protect soil resources and provide food throughout the year. Other studies pointed to the importance of lowering the cost of crop production to low-income farmers, and of considering local consumer tastes and preferences in the development of new food crop varieties and crop technologies.

To determine the extent to which nutritional concerns are being incorporated into agricultural research in Nigeria, this study examined the programs conducted by three agricultural research institutes between 1981 and 1985. One national institute, the International Institute for Tropical Agriculture in Ibadan, and two national institutes, the Agricultural Research and Training Institute in Ibadan and the National Root Crops Research Institute in Umudike, were included in the study.

It was found that all three institutes have made progress in addressing nutritional concerns in the design and execution of their projects. There has been increased emphasis on farming systems programs, and projects aimed at improving the nutritional and storage qualities of seed and crops. Intercropping techniques which make optimal use of soil nutrients and provide food

throughout the year are being investigated, particularly at the National Root Crops Research Institute. All three institutes have been involved in the Nigerian government's various efforts to increase food production, including efforts to boost the production on small-scale farms.

Despite these encouraging signs, very few of the research projects conducted by these institutes were directly related to nutrition. Increasing food-crop yields remained the primary objective. Nutritional benefits were expected to accrue indirectly and automatically in the form of increased food availability.

It is argued that more explicit consideration of nutritional objectives in the institutes' research has been limited by

- the short lapse of time the institutes have had since the issue surfaced to restructure research programs and develop appropriate data bases and methodologies
- the difficulty of implementing the general recommendations which have been made for incorporating nutritional concerns in agricultural research
- the institutes' dependency on outside funding which limits their role in the determination of research priorities and objectives
- the institutes' dependency on outside sources such as the government to cooperate in the promotion and dissemination of new agricultural technologies aimed at low-income farmers
- the lack of direct communication and working relationships between agricultural researchers and nutritionists

What is required is a team approach. In particular, it is recommended that agricultural scientists and nutritionists collaborate within a nutrition planning framework. Using linear programming techniques, the required amounts of calories, proteins, and micronutrients to satisfy local diets can be translated into specific food production targets geared to meet the needs and preferences of local populations. Using this approach, food crops that are the most generous and economical suppliers of certain limiting nutrients in regional diets can be determined and promoted. The approach helps to evaluate the nutritional goals of current agricultural research and to identify those areas where research priorities need to be reordered.

National and international agencies have reformulated their responses to the problems of hunger and malnutrition in developing countries as they have been forced to acknowledge the magnitude and intractable nature of these crises. Initial efforts of international aid agencies to combat hunger problems (primarily through direct donations of food and production inputs) have been

recognized as being costly, aid dependent, and short term (Berg, 1981). Similarly, national efforts to address hunger and nutrition problems by boosting economic growth and development have met with mixed success, and have failed to benefit those most in need (Forrest, 1981; Sen, 1981).

More recent efforts have focused on bringing developing countries closer to self-sufficiency in food production. Substantial agricultural research has been devoted to the development of improved technologies and methods for increasing food crop yields in food-deficit countries. Yet, for various reasons, food shortages and malnutrition continue to plague many developing countries, particularly in sub-Saharan Africa. The failure of traditional agricultural research to produce tangible improvements in human health and nutrition outside of a few countries has resulted in a call for research institutions to reevaluate their research methods and priorities and to incorporate nutritional goals into their research more explicitly.

This paper reviews the literature on nutrition in agricultural research and examines the research programs of three agricultural research institutes in Nigeria to

- determine why traditional agricultural research has had such little success in alleviating malnutrition in developing countries such as Nigeria

- evaluate the progress of the Nigerian-based research institutes in adapting their research programs to include explicit consideration of nutritional concerns and objectives

The agricultural research institutes examined include the International Institute for Tropical Agriculture (IITA) in Ibadan, the Institute for Agricultural Research and Training (IAR&T) in Ibadan, and the National Root Crops Research Institute (NRCRI) in Umudike. IAR&T is part of the Nigerian university system. Together with NRCRI and several other national food-crop research institutes, it is funded through the Federal Ministry of Science and Technology. Each of these national institutes specializes in particular Nigerian commodities. IITA is examined for comparison purposes and because it belongs to an international system of agricultural research institutes within which the notion of emphasizing nutrition in agricultural research was developed.

LIMITATIONS OF PAST AGRICULTURAL RESEARCH

A review of the literature on nutrition and agricultural research in developing countries indicates that both structural limitations and conceptual deficiencies

have been responsible for the failure of agricultural research institutions to effectively address the nutritional concerns of developing countries.

Structural Limitations

The most significant structural limitations involve project funding and application of research results.

Project funding. Individual researchers and research institutions are typically dependent on outside sources for much of their funding. These funding sources, whether governmental or private, play a key role in determining research goals and objectives. If nutritional concerns are not emphasized in the research requests made by funding sources or in the project proposals they agree to fund, it may not be possible for researchers to include these concerns. For example, government and industry concern with export production has resulted in heavy expenditures on research to improve the yields and quality of export crops such as cocoa and tobacco. While such research is important, it has little to do with alleviating malnutrition and draws researchers and resources away from other potential projects which might bear more directly on the subject.

Application of research results. Researchers have even less control over whether and how their research results are implemented than they do over what research projects are funded. A research project's contribution to a target population's nutritional welfare depends primarily on public awareness and support, and only secondarily on the nature and quality of the research done. It is policy makers and practitioners who determine whether a new agricultural technology will be used and to whom it will be made available. The point has been made, therefore, that although applied agricultural research is an important element in the struggle to achieve national food security and eliminate malnutrition, its role can be overemphasized (Noonan, 1983); and some place the responsibility for the failure of the agricultural sector to provide sufficient food for the population directly on state policies (Olayide, 1980; Idachaba, 1980).

Conceptual Deficiencies

Several conceptual deficiencies have contributed to the failure of institutions to address nutritional concerns in their research. Most research has been directed toward increasing the aggregate food supply or has been biased toward export crops or crops consumed by the affluent. In addition, the needs of subsistence farmers have not been considered in the development of new technologies. Agricultural research has also suffered from the lack of reliable comprehensive data on the specific nutritional needs of Nigeria's population subgroups.

Focus on food supply. The traditional response of agricultural researchers and policy makers to the nutrition problem has been to seek ways to increase food production. The problem has been conceived of as being largely one of inadequate supply. Therefore, the agricultural solution has been to improve yields through the development of more effective fertilizers and pesticides and hardier, higher-yielding hybrids.

This emphasis on yield-improving technologies, however, is an overly simplistic approach to the malnutrition problem. It is now generally recognized that malnutrition is the result of poverty, and therefore is primarily a problem of ineffective demand rather than insufficient supply (Sen, 1981; Pacey and Payne, 1985). At the heart of the nutrition problem is an income distribution problem. New agricultural technologies, for cash crops as well as food crops, can only improve yields and profits for those farmers who can afford them. They are irrelevant to subsistence farmers who have limited access to land, credit, production inputs, and marketing opportunities. These farmers tend not to adopt any new technology unless it is readily available to them and substantially reduces per-unit costs of production.

Similarly, increases in aggregate national food production can only benefit those who can afford to consume the food produced. To benefit those most in need, increased food supplies must be locally available and accompanied by food cost reductions or higher real incomes, or both (Mellor, 1978). This may require government intervention as well as sensitivity on the part of agricultural researchers to the cost and applicability of new technologies researched. In the absence of such sensitivity or intervention, production and consumption benefits of new agricultural technology will primarily accrue to those whose subsistence is already secure, and the gap between rich and poor will widen.

Emphasis on increases in aggregate national food production can also be inappropriate if researchers and policy analysts fail to recognize the seasonal dimensions of the malnutrition problem. Food supplies are at their lowest during the off-season and especially just prior to harvest. Some farmers actually harvest sufficient food to sustain their families throughout the year, but are unable to maintain an adequate diet during the off-season due to food spoilage and losses to pests. To address this problem, researchers and analysts must look for ways to increase not only total food supplies, but supplies throughout the year. Emphasis needs to be placed on the storage qualities of food crops and on farming systems which provide farmers with multiple harvests, in addition to high crop yields.

Increasing total food supplies also may not be the most efficient solution to malnutrition caused largely by diarrheal infections and diseases, which are

especially common among children in Nigeria. While increased consumption is required by those who suffer from severe diarrhea, the long-term solution has more to do with improved water supplies and health and sanitation facilities in poverty-striken areas.

Crop emphasis. Another reason given for the poor performance of agricultural research in many developing countries, and in Nigeria in particular, is that research expenditures have not been allocated in the most equitable and efficient manner. According to the congruence principle, the ratio of the research expenditure for a commodity to its economic value should be equal for all commodities. However, there has been a bias in national agricultural research towards export crops and crops consumed primarily by the affluent. Crops such as cassava, sweet potatoes, and maize, which are staple crops eaten mainly by their own producers, have had "sub-congruence" ratios in sub-Saharan Africa, while animal products and export crops such as soybeans have had much higher ratios. For example, in 1976 Nigeria spent $3.75 million of its national research budget on soybean research and $2.69 million on cassava research. Yet soybeans covered only 0.17 million hectares in 1975 and 0.19 million hectares in 1982, while cassava covered 1.0 million hectares and 1.2 million hectares in those same years. A study which developed a measure of overall commodity congruence between research outlay and product output ranked Nigeria 23 out of the 26 developing countries included in the study.

When agricultural research has concentrated on the nutrition problem more explicitly, it has tended to focus on protein-rich foods or on increasing the protein content of traditional food staples. This is because the nutrition problem is often seen as being primarily a problem of protein deficiency. Various studies of food consumption and nutrition in Nigeria have indicated that total calorie intake may be close to sufficiency levels in some parts of the country, but that there is a protein deficiency problem throughout Nigeria (National Nutrition Survey, 1965; Olayide, 1972; Idachaba, 1980; Omololu, 1983; FAO, 1987). Furthermore, in all areas of Nigeria except the coast, where fish are available, cereals are the primary source of protein in the diet. The average share of animal protein in crude protein intake has remained about 13%, which is lower than the share of 20% recommended by the Food and Agriculture Organization.

In recent years, however, nutritionists and policy analysts have come to realize that some of those suffering from protein deficiency are actually eating enough protein to satisfy their protein requirements. The problem is that their total caloric intake is low, and so the protein they consume is utilized as calories to supply their energy needs rather than as protein for growth and maintenance of body tissues (Pacey and Payne, 1985). Therefore, programs which advocate supplementing diets with expensive, protein-rich foods to reduce protein

deficiency may in some cases be misallocating resources that would better be spent on ensuring adequate caloric intake.

Appropriate technology. No new technology, no matter how well intended, can improve the nutrition situation in a country unless it is designed to accommodate local needs, tastes, and conditions. One of the most basic reasons given for the limited success of agricultural research in the region has been its failure to adequately consider the needs and resource constraints of small-scale farmers. Most of Nigeria's population is engaged in subsistence farming and the incidence of malnutrition is suspected to be highest in rural areas (ILO, 1981; Omololu, 1983). It follows that new agricultural technologies should be targeted for this population. Technologies which are practical or affordable only for the large-scale farmer may increase aggregate production but actually worsen the situation of the small-scale farmer who then faces heavier competition at local markets for the sale of his produce. Similarly, labor-saving technologies which can be effectively applied only on large-scale farms displace farm laborers and add to the malnutrition problem.

In an assessment of the various programs of the federal government to expand production on small-scale farms in Nigeria, it is noted that the national crop research centers were heavily involved in the mass adoption of the technology package that was recommended by IITA (Okigbo, 1982). The government commissioned that institute to develop an "appropriate" package. The much-praised, high-yielding varieties of cassava which resulted were reported to result in a three-fold yield increase. However, despite the good intentions of the government and research institutes, there has been no improvement in food supplies, no reduction in prices, and no increase in cash crops. Critics have blamed labor shortages, other resource shortages, and logistical problems for the failure of these programs. The appropriateness of the recommended technology has seldom been questioned. Yet the programs typically required heavy subsidization of inputs to resource-poor farmers who could not sustain production when subsidies were not forthcoming: the proposed technology did not accommodate the resource profiles of the average small-scale farmer.

Similarly, intercropping is practiced on more than 90% of the cropped area in most of sub-Saharan Africa, but serious research on intercropping was only undertaken in the 1970s. Today, less than 20% of all agronomic research in the region deals with intercropping systems.

In addition to expense and local needs, new technologies must consider local tastes. The yellow maize story in Nigeria is well known. The yellow variety of a maize species grown in the United States was adapted by IITA to local conditions in parts of southern Nigeria. The protein content of the introduced

maize seed was much higher than that of the locally prevalent white variety. But farmers rejected the new maize on the grounds of taste. The yellow variety was more chaffy, and consumers preferred the blander white variety.

Target population data. Even if agricultural researchers were amply funded and specifically directed to research appropriate technologies for reducing the incidence of malnutrition in Nigeria, they would be hampered by the lack of reliable, comprehensive data on the incidence and specific local causes of malnutrition. A large-scale nutritional survey, with its own data requirements, has never been done for the whole country. The only national nutrition survey for Nigeria was done in 1965 by the University of Ibadan. Although it was an important and informative survey, it covered only three geographical zones; the savannah north, the rural coastal belt, and an urban location (Omololu, 1983). A series of micro-level nutritional studies have also been done on specific communities, primarily in northern Nigeria (Ransome-Kuti, 1972; Simmons, 1976; Udo, 1982; Smith and Hossein, 1973; Hill, 1968; Norman, 1974).

Most nutritional studies, however, have relied principally upon national food balance sheets which compare estimated aggregate food supply with estimated population consumption requirements. Aggregate food supply is estimated by adjusting estimated crop and livestock production figures for storage losses, intermediate demand needs, and net trade. The protein and calorie contents of the food supply are estimated and these aggregate figures are then divided by the population estimate and the days of the year to determine the nation's average daily calorie and protein supply on a per capita basis. The average daily per-capita demand for food is estimated by taking into account population demographics and the protein and energy requirements of the various population subgroups (such as infants and pregnant women). Because data is often inconsistent and patchy, only rough estimates of food supply and demand are possible, and these estimates can vary widely according to the data sources used and assumptions made.

Food balance sheets can be helpful in gauging a country's general nutritional status over time and vis-a-vis other countries, but are of limited use in determining nutrient-deficient population subgroups. The food balance sheet method of assessing nutritional status cannot provide information on how the food supply is distributed geographically, seasonally, within localities, or among adults, infants, and children.

The agricultural researcher or policy analyst intent upon improving the nutrition situation must therefore either sift through and rely upon those studies that have been done or conduct new studies to determine what most needs to be accomplished for whom, and how it would most appropriately be done.

PROPOSALS FOR INCORPORATING NUTRITIONAL CONSIDERATIONS

The nutritional effects of agricultural research have seldom been the main focus of agricultural research institutes. At best, it has been expected that nutritional benefits would be diffused through the income and employment effects of increased output. The contribution of research has been assumed to be the residual after all other factors that contributed to increased production are accounted for. However, even using this limited measure of the value of agricultural research which considers only increases in aggregate production, sub-Saharan agricultural research performance has had a dismal record (Chambers and Ghildyal, 1985; Chambers and Jiggens, 1986; Lipton, 1985; Maxwell, 1984; Spencer, 1986). Slight annual increases in total food production have been attributable almost exclusively to increases in area under cultivation; suggesting that technological change has had little effect on Africa's food production. In the meantime, analyses of the current food situation in Nigeria show ever-widening gaps between supplies and demand as the population continues to increase (Ekpo, 1984; FAO, 1987; Folayan, 1984; Idachaba, 1986; Olayemi, 1988).

Studies concerning the nutrition/agriculture interface in Nigeria were scattered prior to the 1980s (Idusogie, 1969; Okigbo, 1974), but the idea that nutritionists and agricultural planners should harmonize their approaches to food and nutrition stimulated a series of conferences and studies on food production and nutrition in the late 1970s and 1980s. A national conference on food and nutrition policy in Nigeria was held in 1979, which placed much of the blame for the agricultural sector's poor record of achievement on governmental policies which systematically ignored the agricultural sector after 1970, when oil became the leading national income producer (Atinmo, 1983). When the balance of payments could no longer sustain a large food import bill, national attention switched to increasing public awareness of the worsening food situation.

In 1984, a workshop on incorporating nutritional goals into international agricultural research was held in Addis Ababa under the direction of the United Nations Administrative Committee on Coordination's Subcommittee on Nutrition, the International Agricultural Research Centers (IARCs), and the International Food Policy Research Institute (Pinstrup-Andersen, 1984). The workshop focused on current and potential methods for strengthening the *ex ante* consideration of nutritional concerns in agricultural research, as opposed to *ex post* assessments of its effects.

One of the main findings of the workshop was that none of the agricultural research centers was able to provide data on the nutritional effects of their

research except by inference from aggregate production and demand statistics. Diet surveys were not part of the research programs. It was recommended that the IARCs make it explicit in the interpretation of their mandates that due consideration be given to nutritional issues in center activities. It was suggested that there are four areas of decision-making in which nutritional concerns can be accommodated (Pinstrup-Andersen, 1984):

- Establishment of commodity priorities. Emphasis should be on commodities that
  a. occupy a large portion of the budget of households with malnourished members
  b. use a large share of land and labor resources
  c. generate employment and income for households with malnourished members

- Examination of commodity characteristics. In addition to yield, consideration should be given to
  a. nutrient composition
  b. consumer preferences
  c. processing methods
  d. storage qualities and methods

- Choice of technology characteristics. Technology should be developed which is
  a. suited to local environments
  b. expected to have acceptable employment effects
  c. a net benefit to targeted farmers
  d. labor saving for small-scale farmers

- Focus of research on production systems. Focus should be on the appropriate mix of cash and subsistence crops to meet nutritional needs, whether from own production or through purchase.

It was specifically recommended at this workshop that IARCs

- begin research on human nutrition globally or for selected countries,commodities, and research programs; with emphasis placed first on the development and testing of appropriate analytical methodology

- undertake or promote collection and analysis of data to provide an estimate of the relative importance of each major food commodity in the diet, food expenditure, and income of the rural and urban poor and malnourished, and of how the poor and malnourished adjust food consumption in response to changes in incomes and food prices

- consider the incorporation of issues related to the interaction between human nutrition and agriculture into their training programs on production, farming systems, and research management

- explore the feasibility and potential utility of establishing or strengthening links with nutrition institutions and related agencies that can provide nutrition support services

These workshop recommendations were endorsed at the June 1985 Technical Advisory Committee (TAC) meeting of the Consultative Group on International Agricultural Research (CGIAR) in Los Banos, Philippines. At this meeting, TAC recommended that policy research be conducted to determine methods of more effectively addressing the problem of malnourishment and to ensure that the benefits of the CGIAR system's production research reach low-income people. It was recommended that this focus on effective methodologies receive high priority in the short term.

TAC also determined that increased research efforts should be directed toward selective problems of storage and processing of food and feed at the village and farm level. Roots and tubers were singled out as meriting particular attention in research efforts to improve postharvest technologies.

The Los Banos meeting was followed by a "nutrition and agricultural research roundtable" at IITA in April 1986. It was the institute's first attempt to familiarize scientists with the nutritional implications of its research activities. The primary objective of the roundtable was to discuss the Addis Ababa and Los Banos recommendations and to recommend guidelines with specific reference to IITA. Special attention was given to the following:

- a review of possible methodological approaches for determining the nutritional effects of IITA's technologies

- an assessment of the status of home economics and nutrition education and extension within educational facilities and the ministries of Agriculture and Health

- a discussion of postharvest technologies of selected IITA commodities and their suitability to be targeted for improvement

In the discussion of how nutritional goals could be incorporated into international agricultural research, some general guidelines were identified (IITA, 1986).

- Commodities with characteristics of both yield and quantity must be fairly well-balanced in the system.

- Priority must be given to cropping patterns which ensure food availability throughout the year.

- Agricultural technologies need to be appropriate for physical and biological as well as socioeconomic and political environments.

- Technologies should be targeted to those nutritionally at risk.

It was expected that nutritional considerations could be integrated within a farming systems methodology which aims to

- assess the nutritional needs of farm households

- evaluate the impact of new technologies on food consumption and nutrition of the farm household

- determine the most appropriate farming system which would ensure a greater availability of food throughout the year

- determine the most appropriate cropping systems that would sustain or improve soil fertility

The roundtable conclusions reflect the institutional advocacy of the explicit role of IARCs, and especially farming system research, in nutrition (Pinstrup-Andersen, 1984; Frankenberger, 1984; Maxwell, 1986). It was expected that the IITA would collaborate with national institutions in on-farm research. The IITA would be responsible for devising suitable on-farm research methodologies for which the national agricultural institutes would lend logistic support. This type of arrangement has been found to be mutually beneficial (Ruttan, 1986; Tripp, 1984).

RESEARCH PRIORITIES AT AGRICULTURAL RESEARCH INSTITUTES

To determine the extent to which nutritional concerns are being incorporated into agricultural research in Nigeria, the programs conducted by three agricultural research institutes were examined.

International Institute of Tropical Agriculture

IITA functions within a worldwide network of research and training centers. Principal financing for IITA is arranged by the Consultative Group on International Agricultural Research. The institute's research priorities are determined by the Technical Advisory Committee which also serves thirteen other international agricultural research institutes.

IITA's research efforts are concentrated on crops of the humid and subhumid zones, which include Nigeria. Specifically, research is devoted to cowpeas and soybeans in the grain legume improvement program; maize and rice in the maize and rice improvement programs; and yams, cassava, sweet potatoes, and cocoyams in the roots and tubers program, which collaborates with NRCRI. The institute also has a farming systems program which was formerly the Agricultural Economics Unit.

In 1984, IITA had a total research staff of 151 people, of whom about two-thirds were core researchers. The farming systems program had a staff of 54, the grain legume and maize programs each had staffs of 24, and the rice, and roots and tubers programs had staffs of 17 and 32, respectively. Both staff size and funding for the farming systems program have been reduced since then.

While IITA serves some of Nigeria's agricultural needs, its research retains an international perspective. IITA collaborates with several regional and extra-regional research institutions, especially in its rice and maize programs and for some particular commodities such as soybeans. It serves the international community in the exchange of germplasm and technical information. Research projects on high-yielding crop varieties, and crop diseases and pests that are relevant to several countries are given priority at IITA. Only those research projects targeted to Nigerian ecosystems are classified in this study, and external collaborative programs were omitted. In Nigeria, the target users of IITA's technology are small-scale, progressive farmers. Most semisubsistence farmers do not have the resources to adapt IITA's technology.

A more detailed breakdown of IITA's research activities over the period 1981 to 1985 reveals their nature, content, and priorities. As shown in table 1, 83.1% of IITA's research projects, outside of its farming systems program, were devoted to improving yields directly or through improved disease and pest resistance. Projects devoted primarily to crop management and crop quality (nutritional and consumer preference) improvements accounted for 11.9% and 3.3%, respectively, of the crop research projects conducted over this period.

The main tasks of the farming systems program are to develop improved management technologies for crops and soil. Food crop production technologies

have received the most research attention; on-farm research and on-farm adaptive trials are being integrated into the program. From 1981 to 1985, 40.8% of the program's research projects were focused on soil and land management, 35.6% were focused on cropping systems, and 23.5% were devoted to postharvest technologies (see table 2).

Besides commanding the largest staff, the farming systems program recorded more projects and produced more publications than the other programs over this period (see table 3). While these are indications of the strength of the farming systems program, projects are not of uniform cost or duration, and therefore should not be strictly compared. The total number of research projects increased by more than 41% between 1981 and 1985. This was largely due to the institute's involvement in the Nigerian government's national accelerated food production program.

The nature of a research institute's publications are another indication of its research priorities. Of the 439 publications produced over the 5-year period, 24.6% pertained to disease and pest resistance, 19.8% pertained to soil conservation, 12% pertained to breeding experiments, and 22.3% pertained to crop management, including weed control (see table 4). The remaining 21.2% was divided among miscellaneous farming systems research and other publications.

In general, the records show a close correspondence between size of staff, number of projects, and number of publications for each program. Based on 1984 staff sizes and research records for the period 1981 to 1985, farming systems studies accounted for 33% of the research, 51% of the publications, and about 36% of the research staff. The cereals programs accounted for 27% of the projects, 12% of the publications, and 27% of the staff. Grain legume studies comprised 22% of the research, 19% of the publications, and 16% of the research staff. The roots and tubers program accounted for 18% of the research, 18% of the publications, and 21% of the research staff.

Institute For Agricultural Research And Training

IAR&T has a staff of about 50 researchers in its research division. This staff serves three programs at the institute: the farming systems program, the food legume improvement and production program, and the industrial crops improvement program. Only the former programs are considered here, as the latter program has had little to do with nutritional concerns.

Farming systems research. Early farming systems research concentrated on identifying pests that attack crops like cassava, maize, and sorghum, and

evaluating the extent of their damage. Both on-station experiments and field research were conducted, and the effectiveness of various chemical control methods was established.

Later, research switched to cropping systems surveys on rice, tomato, maize, okra, and cassava. Specific studies on intercropping patterns were undertaken. The aim of this research was to determine the economic, technical, and sociocultural constraints associated with selected farming practices. On-farm research on maize, cowpeas, cassava, and vegetables was also conducted, to determine their economic feasibility in southwestern Nigeria.

The change of government in 1979, from 13 years of military rule to civilian rule, represented a major structural break in the organization of the research institutes. The nature and emphasis of research programs were changed. Formerly, individual researchers had been relatively free to conduct basic research according to their individual interests and disciplines. Under the new arrangement, political appointees are nominated to the national institutes' governing board that approves institute programs and projects. Research programs are expected to be geared toward the country's national priorities. In 1980, therefore, the institutes were expected to participate in the achievement of the goals of the fourth National Development Plan (1981 - 1985). The government's concern over increasing the production of food by small-scale farmers was channeled into the Farming Systems Unit.

In 1981, two other programs were merged with the farming systems program. These were the cereals improvement and production program and the vegetables improvement and production program. These programs had been conducting research on vegetables and cereals which included the screening of breeding lines with subsequent trial evaluations to test the crops' response to pests and diseases, fertilizer treatments, and various cropping practices. After being merged into the farming systems program, the cereals program centered on the screening and selection of suitable parent stock from cultivars obtained from outside sources, such as IITA. The cultivars were selected on the basis of production qualities such as yield, and disease and pest resistance. The vegetable program aimed for developing a package of improved methods for the production of vegetable crops, including improved seeds, and advice on planting and fertilizer application.

Due to these changes in organization and program focus, the farming systems program has developed an interdisciplinary approach to on-farm research. It has also developed closer ties to the farmers it serves, because it is now their particular circumstances and concerns that form the basis of the program's research.

Food legume improvement and production. The institute's food legume improvement and production program has focused on the biological breeding of cowpeas and soybeans. In its early years, the program concentrated on breeding and evaluating varieties of these crops for yield and resistance to pests and diseases. Later, cowpeas were also bred to be more physiologically robust, to reduce storage losses. Chemical studies on insecticide effectiveness have also been conducted by this unit. More recently, the unit's research program has reflected the federal government's goals of increased food production and its charge for the institute to conduct research into the agricultural problems of southwestern Nigeria. Soybean research, which had been the responsibility of IAR&T for over a decade, was recently relocated to a northern research institute.

Classification of research activity. Between 1980 and 1986, IAR&T's Farming Systems Unit was involved in 27 projects. Of these, 37% were disease and pest resistance projects mostly involving maize, 26% were on-farm research projects, 22.2% were soil nutrient management projects, 7.4% were crop management projects, and 7.4% related to the nutritional status of mushrooms (see table 5). The high percentage of disease and pest resistance projects reflects the inclusion of the cereal improvement program, which merged with the farming systems program in 1983.

The institute's food legume, cereal, and vegetable improvement programs accounted for a total of 56 research projects between 1980 and 1986 (see table 6). Of these, 85.7% centered on cowpeas or soybeans. Nearly 70% of the projects involved breeding, mostly for disease and pest resistance and for yield performance. Four projects, 7.1% of the total, pertained to breeding to reduce storage losses. Only two projects were concerned with improving the nutritional quality of a crop, and these involved cowpeas.

National Root Crops Research Institute

Farming systems research. NRCRI's farming systems program was established as a separate unit in 1983. Crop protection studies in this program have included weed control measures in various intercropping systems of yams and cassava, and maize and soybean. Cropping systems research has investigated the nutrient requirements of various root crop seed mixtures, fertilizer application, and cropping practices for efficient soil nutrient utilization and the maintenance of soil fertility.

Research emphasis is on cropping mixes in soil and crop management. Large-scale production of seed yams from minisett in the yam improvement program has been evaluated in pilot farm tests. Large-scale intercropping systems have been compared when staking, planting, and crop mixtures were alternately varied. Also, one or two benchmark socioeconomic surveys have been reported for the southeastern part of Nigeria.

Roots and tuber research. Research in NRCRI's roots and tuber program emphasizes farm and crop management practices for increasing crop yield and product use. Yam and cassava have received the most research attention. Both basic research, such as breeding, and adaptive research has been carried out. An average of about 10 studies per year were conducted for each of these commodities between 1981 and 1985. However, in 1982 yam research activity was strengthened. The new minisett technology for increasing seed yam production was tested, and optimal planting preparation and cultivation practices were identified. Because yam tubers, like other root crops, are prone to more rapid deterioration in storage than other types of crops, yam research has also been devoted to storage loss reduction. Ware-yam farm management practices used in selected areas of southeast Nigeria were assessed to improve cultivation and storage practices. The methods used to reduce storage losses were mainly chemical. A substantial amount of research has also been done on methods, both organizational and chemical, to control field and seed yam diseases. Since 1983, adaptive minisett-technology research has been extended to breeding and multiplication of seed yam.

Cassava research has focused on the control of pests and diseases by chemical and biological methods, and on optimum planting conditions. The majority of studies have been on the organization and management of farming practices. Pest control research has been intensified in recent years; and breeding, chemical, and integrated management methods have been investigated. Cassava is always intercropped with other major food or cash crops. About one-third of cassava research projects at NRCRI have focused on optimum nutrient and soil requirements and intercropping arrangements for cassava-based intercropping mixtures.

Irish potato research has involved screening potato cultivars and selecting seed stock. Most research is experimental, on-station work. The focus of research is on improving the physiological robustness of seed, and on establishing the nutrient requirements. The number of seed-quality improvement studies has exceeded the number of studies conducted on cultivation procedures.

Cocoyam research. Cocoyams are not easily propagated. Therefore, cocoyam research at NRCRI focuses primarily on seed material production and the establishment of the ideal planting and cultivation conditions. Research has also been done on product use. Cocoyam breeding research began in 1982, using minisett technology. Cocoyam cultivars have been screened for qualities which increase their consumer appeal.

Classification of research activity. Although many of NRCRI's projects have mixed objectives, most of the research projects conducted between 1981 to 1985 centered on crop management, seed production, and disease and pest control

objectives (see table 7). Farming systems, cassava, and Irish potato research also devoted 13% or more of their projects to the achievement of soil management objectives. The yam program was the only one to emphasize storage objectives in more than 11% of its projects. Almost all the on-farm research done over this period was conducted by the farming systems program, which focused on on-farm research in 15% of its projects. All of the programs devoted less than 10% of their research projects to postharvest or processing studies, and less than 5% of their research projects to crop nutritional or consumer preference improvements.

RECOMMENDATIONS FOR INCORPORATING NUTRITIONAL CONSIDERATIONS

Examination of agricultural research activity at these three research institutes indicates efforts are being made to consider nutritional aspects in the design and execution of agricultural research projects. This is particularly evident at IITA, where there has been a strong commitment to farming systems research, including cropping systems and postharvest technology research. Recent changes initiated at the two national institutes have also strengthened their farming systems programs. NRCRI's consideration of nutritional objectives can be inferred from its substantial research on intercropping systems, crop storage, and postharvest utilization. Both of the national institutes publish many extension publications, and all three institutes have been involved in the various strategies of the federal government to increase food production, including strategies to increase the food production of small-scale farmers.

Despite these encouraging signs, very few of the research projects conducted at these institutes between 1981 and 1985 were directly concerned with nutritional objectives. Increased food-crop yields remained the overriding concern of research projects conducted over this period. Nutritional benefits were expected to follow indirectly and automatically in the form of increased food availability.

There are several likely reasons why nutritional objectives have not been more explicitly incorporated in the institutes' research programs. First, even under the best of circumstances, it takes time to restructure research programs and to develop appropriate methodologies for undertaking new research concerns such as the elimination of widespread malnutrition. Projects conducted over the period 1981 to 1985 would hardly have had time to benefit from the national and international debate on the subject, which was not well publicized in Nigeria until the mid-1980s. Indeed, IITA's roundtable was not held until 1986.

Second, recommendations such as those that resulted from the Addis Ababa, Los

Banos, and IITA meetings, including the Pinstrup-Andersen recommendations (1984), are difficult to operationalize. For example, "technology that benefits the malnourished" is hard to identify, since a disaggregation into malnourished groups is itself difficult, and especially since the underlying causes of malnutrition are not always food related. Similarly, the suggestion made at the meetings and elsewhere (Idachaba, 1983) that crop research priorities be determined in part by the nutritional significance of the crop, is too broadly applicable to be of much help. Applying this criterion, crop research should concentrate on cereals, seeds and nuts, pulses, and roots and tubers, which are almost all the food crops grown.

Determining food crop research priorities strictly by the relative share of land currently devoted to each crop or by estimated gaps between future supply and demand are not optimal because they are biased in favor of the status quo. Demand for food is partly a function of relative food prices, and consumer taste, information, and income constraints. As these change, so can the demand for particular foods. To prioritize crop research expenditures solely according to existing crop demand is to assume the existing consumption pattern is optimal or fixed.

A third possible reason for the near absence of explicit nutritional objectives in the research programs examined is the institutes' dependency on outside sources for project funding. As mentioned earlier, for better or worse, research priorities are generally influenced, if not determined, by available funding. The IITA's program mandates are harmonized with those of the international research network to which it belongs. The two national centers have responsibilities toward agricultural problems in their specified geo-ecological zones, and research priorities are at least partially determined by political convenience. The national institutes' role in the various federal government strategies to increase food production was essentially limited to the execution and extension processes. Despite staff knowledge of technological possibilities, the institutes were not instrumental in project initiation or in the determination of project objectives until very recently.

Fourth, the adoption of institute-developed, technological improvements by small-scale or subsistence farmers is typically dependent on government cooperation as well as local acceptance. It is of limited use for the institutes to develop more efficient, nutritious, or yield-enhancing technologies for subsistence farmers if there is no outside commitment or ability to subsidize or disseminate the technology as necessary. The cassava example, cited earlier, is a case in point. In other cases, improved market infrastructure, such as farm-to-market roads and access to credit, may be required before new agricultural technologies can be effectively adopted.

Finally, it is difficult to determine and pursue appropriate nutritional objectives in agricultural research when nutritionists and agricultural scientists in Nigeria rarely work together or even talk directly with each other. The agricultural scientist still assumes the nutritionist's place is at the utilization stage, and the nutritionist assumes the scientist belongs at the production stage of the food production cycle.

What is required is a team approach. The aim of the agricultural scientist should be to provide those technologies which would ultimately be accepted by small-scale farmers, who provide the bulk of the food in Nigeria. The aim of the nutritionist should be to match, as closely as possible, nutrient requirements with available supply. The aim of government is, in part, to promote the security and well-being of the people, which in the case of malnutrition, may require efforts to expand services and income-earning opportunities to those who need them most.

In particular, it is proposed that a linear programming approach to nutrient planning in Nigeria would bring the roles of the nutritionist and agricultural scientist together. This approach has been identified elsewhere, but the idea is still in its rudimentary stages for Nigeria (Olayide, 1983). A large-scale study involving roots and tubers, cereals, and grain legumes is envisaged. The nutritionist's role would be to determine optimal diets for the different cultural areas of Nigeria. These would be broken down into food items, and the quantities of each food required would be specified according to the nutrients which that food supplies. Those combinations of foods which supply particular, desirable nutrient profiles would emerge. There would be several combinations that provide varying quantities of the required calories, proteins, and micronutrients. The task of the agricultural scientist would be to determine which techniques of production produce which commodity combination, and at what cost. In compiling a total diet, a linear programming model would determine which technique (a cropping sequence or an intercropping pattern, for example) gives the required nutrients at the lowest cost.

Using this approach, efforts could be made to promote the production of those food crops that are the most generous suppliers of certain limiting nutrients in the regional diets. The approach helps both to evaluate the nutritional goals of current agricultural research and to identify those areas where research priorities need to be reordered.

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Table 1. Distribution of IITA's research projects by objective from 1981 to 1985.

Year	Resistance to yield reducers		Yield increase	Crop management	Crop quality improvement
	Disease	Physiological			
1981	51	4	17	17	3
1982	52	1	32	6	1
1983	71	3	42	24	5
1984	80	1	48	13	9
1985	68	1	40	12	2
Total	322	10	179	72	20
Percentage	55.1		29.7	11.9	3.3

Source: Compiled from IITA's annual reports, various years.
Note: Farming Systems Program excluded.

Table 2. Components of research projects by IITA's Farming Systems Program from 1981 to 1985.

Nature of project	Number	Percentage
Land development and soil management	52	
Soil tillage and seed preparation	29	
Nutrient management	29	
Soil-plant-water relationships	8	
Subtotal (soil, land management)	118	40.8
Plantain	12	
Agronomy, cropping systems	24	
Mulch management	19	
Alley cropping	23	
Weed management	25	
Subtotal (cropping systems)	103	35.6
Evaluation of machines, tools, farm inputs	13	
Farming systems analysis, economic benchmark	40	
On-farm research	14	
Storage	1	
Subtotal (postharvest)	68	23.5
Total	289	100

Source: Compiled from IITA's annual reports, various years.

Table 3. Distribution of IITA's research projects by program from 1981 to 1985.

Year	Farming systems	Grain legume	Cereal	Roots & tubers	Total
1981	40	29	30	33	132
1982	78	37	31	24	170
1983	62	40	63	38	203
1984	59	56	74	31	220
1985	50	48	52	36	186
Total	289	210	250	162	911
Percentage	31.7	23.1	27.4	17.8	100

Source: Compiled from IITA's annual reports, various years.

Table 4. Distribution of IITA's publications by principal objectives from 1981 to 1985.

Year	Disease and pest resistance	Farming systems research/ On-farm research	Breeding	Soil conservation/ protection	Crop management	Weed control	Other	Total
1981	17	5	10	10	10	7	14	66
1982	16	2	11	27	8	11	7	78
1983	29	7	16	19	26	3	22	130
1984	31	13	11	21	19	0	12	110
1985	15	3	5	10	14	0	8	55
Total	108	30	53	87	77	21	63	439
Percentage	24.6	6.8	12	19.8	17.5	4.8	14.4	

Source: Compiled from IITA's annual reports, various years.

Table 5. Distribution of projects by IAR&T's Farming Systems Unit from 1980 to 1986 according to principal objectives.

	Disease and pest resistance	Soil nutrient management	Crop management	Nutritional status	On-farm research
Cassava	1	1	-	-	-
Maize	8	-	1	-	-
Sorghum	1	-	-	-	-
Mushrooms	-	-	1	2	1
Rice					2
Crop systems	-	5	-	-	4
Total	10	6	2	2	7
Percentage	37.0	22.2	7.4	7.4	26.0

Source: IAR&T's unpublished program reports.

Table 6. Distribution of project objectives by crop for IAR&T's food legume, cereal, and vegetable improvement programs from 1980 to 1986.

	Breeding for disease and pest control	Breeding for yield performance (seed multiplication)	Breeding to reduce storage losses (physiological)	Soil and crop management	Evaluation trials	Grain quality	On-farm research
Cowpea	8	11	-	1	4	2	-
Soybean	7	4	4	1	5	-	1
Cereal	1	2	-	1	-	-	-
Vegetables	1	1	-	2	-	-	-
Total	17	18	4	5	9	2	1
Percentage	30.4	32.1	7.1	8.9	16.0	3.6	1.8

Source: IAR&T's unpublished reports and annual reports, various years.

Table 7. Distribution of NRCRI's research projects by objective from 1981 to 1985 (percentage).

	Disease and pest control	Seed prod.	Crop mgt.	Soil mgt.	Crop quality imp.	Storage	On-farm research	Postharvest processing	Other	Total
Farming Systems Program	-	-	45.0[a]	35.0	-	-	15.0	5.0	-	100
Yam	19.2	38.4	16.4	-	-	19.2	-	5.5	1.3	100
Cassava	34.8	4.3	30.4	17.4	2.2	-	4.3	4.5	2.1	100
Cocoyam	4.3	30.4	39.1	4.3	4.3	8.6	-	8.6	0.4	100
Irish potato	18.4	34.2	21.1	13.2	2.6	10.5	-	-	-	100

Source: NRCRI's annual reports and program reports, various years.
[a]All weed control.

INCREASING RICE OUTPUT THROUGH TRACTOR USE IN ANAMBRA STATE, NIGERIA

O. Okereke

SUMMARY

As Nigeria struggles to provide adequate food for its rapidly growing population, increasing the production of rice has become an important goal. One means of increasing rice output is to use tractors on the rice farms. Currently, only a limited number of farmers use tractors.

This study is based on a survey of 60 rice farmers in Anambra State, Nigeria. It estimates and compares the rice output from traditional farms using only manual labor and that from farms using tractors. It also estimates labor input and the costs and returns of production in both systems of farming.

There was no significant difference between the socioeconomic characteristics of farmers who used only manual labor and those who used tractors. The only difference was that 72% of the tractor users had attended an agricultural training program organized by the Ministry of Agriculture and Natural Resources.

Tractors were used only for clearing land, plowing, and harrowing. In fields where tractors were used, these tasks plus transplanting were begun and completed in July. On farms where the work was done manually, these tasks plus transplanting were begun in May but were not completed until August. Thus, farmers who used tractors were able to complete the subsequent operations one month earlier than farmers who did not use tractors.

Farmers tended to be aware of the benefits of using tractors. One of the most important constraints they faced was that tractors were not readily available, in spite of the existence of private and government tractor-hire services. The government tractors were frequently in need of repair.

The value of most of the farm inputs used in rice production did not vary significantly based on whether or not the farmer used a tractor. Tractor users applied more herbicides and insecticides, which they were able to get at a lower price than were the manual farmers because the Ministry of Agriculture and Natural Resources provided these goods at subsidized prices to farmers who adopted modern technologies.

The requirements for and distribution of labor, however, were significantly different for farmers who used tractors. Some of the labor formerly used to prepare land for rice production could be used in other crop enterprises. However, using tractors may increase labor needs on the farm at later stages in the growing season: Weeding and harvesting may demand more labor if using tractors increases production.

To prepare a hectare of land for a rice farm, the survey results indicated that it was less expensive to use a tractor than to use manual labor. A traditional farmer would pay ₦ 345 for clearing land and ₦ 450 for manually tilling a hectare; whereas a tractor user would pay only ₦ 250 a hectare for the tractor and ₦ 60 for the supervisory labor.

Labor costs were the most important production expenses, since they accounted for 82% to 91% of the total costs per hectare. By reducing the amount of labor needed, tractors helped to reduce the total cost of production.

The net return per hectare, defined as the difference between gross return and total cost of production per hectare, was significantly higher for farms that used tractors. For tractor users, the gross return was ₦ 6,231 a hectare, and the total cost was ₦ 3,060 a hectare. Thus, the net return was ₦ 3,171 a hectare. For farms that relied exclusively on manual labor, the gross return was ₦ 4,616 a hectare, and the total cost was ₦ 3,465 a hectare. Thus, if tractors were not used, the net return was ₦ 1,151 a hectare.

A regression analysis was run to determine the effects of four variables on the total output of rice. For farmers using tractors, the tractor-hire charges and capital depreciation and labor input were significant and positive variables; the cost of variable inputs was significant but negative. Farm size was not significant. For farmers not using tractors, labor input was significant and negative and the cost of variable inputs was significant and positive. Neither the tractor-hire charges and capital depreciation nor labor input was significant.

The results of this study indicate that using tractors is profitable under some circumstances and confirm that tractor use ensures timely preparation of land to take advantage of the early rains.

Government policies should ensure that tractors are available to farmers. The government tractor service has been unreliable; farmers rely instead on private tractor services. The institutional framework must be developed to expand the availability of tractors and spare parts. Tractor use will become more profitable if it is expanded to minimize labor bottlenecks during harvesting and threshing.

Nigeria's current agricultural development policies and programs emphasize providing adequate food for the rapidly increasing population and providing raw materials for domestic industries. Rice's significance as a staple food is

increasing in Nigeria. Domestic consumption of rice rose from about 3 kg/yr per person in 1970 to about 11 kg/yr per person in 1980 (Obiechina and Otti, 1985). Although, compared with some other West African countries such as Liberia, Sierra Leone, and Côte d'Ivoire, Nigeria's per capita consumption of rice is low, the increase in rice consumption is striking and indicates the need for increased production. Until rice imports were banned in December 1985, Nigeria was a net importer of rice. During the last civilian administration, from 1979 to 1983, huge sums of money were spent on rice imports to augment local supply. Rice imports in Nigeria rose from 6,700 metric tons in 1975 to 650,000 metric tons in 1980, representing a 960% increase in import demand (Obiechina and Otti, 1985). In 1982, under the aegis of the technical subcommittee of the Green Revolution National Committee, a special program was created to boost rice production. Thus, it has become important to determine how rice production can be increased. Using tractors on rice farms may be one means to achieve increased production.

THEORETICAL FRAMEWORK

Insufficiency of capital resources has been one of the bottlenecks in Nigeria's economic growth and development. Economic theory emphasizes capital formation as the main lever in development. The rural areas of Nigeria still experience the circle of poverty in which the low level of people's incomes leads to a low level of savings, which, in turn, results in a low level of investment. With little investment, capital accumulation is minimal and productivity, output, and incomes are restricted. A state of poverty is perpetuated.

Nurkse (1953) and others believe that the hope of countries caught in this circle of poverty lies in injecting capital into their economies. Capital can be added to an economy in many forms. In an agricultural economy, tractors represent one kind of large capital investment. Researchers have divergent views on the benefits of the mechanization of agriculture based on differing technical, economic, and sociological factors.

The debate on the benefits of tractor power and animal power centers on the substitution and net-contribution viewpoints. The substitution view sees tractors and animals as two different power sources that are technically perfect substitutes; any operation powered by tractors is assumed also to be feasibly powered by a combination of animals and humans (Binswanger, 1978). A switch from animal or human power to tractor power is a function of factor prices or factor scarcities. For example, if the opportunity cost of labor and the cost of maintaining plow animals rise significantly, then farmers will shift to using tractors. On the other hand, if the wage rate and the cost of animal power are low, the need for tractors will not arise. Tractor use is thus considered to be an

important means of growth, provided that the wage rates and animal-power costs are rising.

The net-contribution view of tractors emphasizes the fact that the lack of power is a primary constraint to increased agricultural production in developing countries, regardless of factor prices. The greater power of tractors allows a more thorough and deeper tillage than is possible using animals or human labor. Land reclamation can be achieved more easily with tractors than with animal or human labor. Similarly, tractors achieve a higher level of precision. The superior power and speed of tractors permit more timely operations, thus contributing to higher yields. They also increase the potential for double cropping, especially of cereals such as rice, maize, and wheat. Higher yields and double cropping would, ultimately, lead to higher output levels, which would require more labor use in nonmechanized operations. Consequently, using tractors could contribute to increased agricultural production without necessarily displacing labor. Hence, tractor use would be consistent with employment objectives, even in low-wage economies. Thus, the net-contributor view suggests that tractors would not displace labor (Binswanger, 1978).

However, this optimistic view of tractor use assumes that there is a regular, timely supply of tractor services. The most significant constraint to using tractors in developing countries, such as Nigeria, is their irregular and untimely availability due to the tractors' frequent breakdowns, the lack of spare parts, and bureaucratic bottlenecks (Oramah, 1986). This situation is most common when the government controls the tractor supply. The inevitable consequences are late planting and poor yields.

The work of Farrington and Abeyratne (1984) in Sri Lanka showed that tractors had a clear advantage over animal power in cultivating of large expanses of rainfed land. It also indicated that a large volume of hired labor was required in spite of mechanization, and the net income of tractor owners was 16 times higher than that of nonowners.

Some research findings, such as those of Ekong (1977) and Anazodo (1985), indicate that certain mechanized farm operations use more labor than nonmechanized operations. This suggests that, under appropriate circumstances, mechanization may create a higher demand for labor. For example, using tractors could lead to an increase in the area under cultivation and a subsequent increase in output levels. This might lead to an increased demand for labor in nonmechanized operations such as weeding, harvesting, parboiling rice paddy, drying, and winnowing.

RESEARCH OBJECTIVES AND METHODOLOGY

The main objective of this study was to determine the relationships between tractor use and both rice output and the employment of the rural labor force. Specifically, the study estimated and compared rice output, labor input, and costs and returns from traditional farms using only manual labor and that from farms using tractors; and it evaluated the overall profitability of tractors in rice production.

The study covered sample villages in Uzo Uwani and Abakaliki Local Government Areas of Anambra State, Nigeria. These two local government areas are representative of rice-farming areas in southeastern Nigeria. In Uzo Uwani, a World Bank rice project and an irrigated rice-production scheme of the Anambra Development Authority (ADA) are largely mechanized. In addition, several small-scale farmers are engaged in producing rice in the area. In Abakaliki, rice cultivation is essentially the work of smallholder farmers. The topography of these two areas, consisting of gently rolling plains, makes them amenable to tractor use. In selecting the sample villages, efforts were made to identify and select villages in which tractors were used alongside traditional farming methods.

Data was obtained from a random sample of 30 rice farmers from each of the two local government areas. Thus, 60 farmers were surveyed; 30 of those farmers used tractors. The sample frame consisted of lists of farmers who hired tractors from the Agricultural Development Authority, the Ministry of Agriculture, and the Anambra State Tractor Hiring Unit, and of rice farmers within the area of study who did not use tractors. Additional information was obtained from the World Bank rice project and from ADA rice-production data, technical reports, and feasibility study reports

In spite of the availability of tractor-hiring services in the two study areas, many farmers continued to use a hoe and cutlass to prepare land. Land thus prepared produces low levels of rice. If small farmers, who form the bulk of food producers in the country, continue to practice manual cultivation, it will be difficult to increase production to meet the rapidly growing demand.

Previous studies have tended to recommend agricultural mechanization to farmers without specifying what mechanization would be appropriate to the area and acceptable to the farmers. Rice farmers need mechanization that will help them prepare the land in time for early rice planting. Tractors can help to satisfy this need.

Only a small number of farmers used tractors to prepare land for rice cultivation. This study investigates the economic barriers to farmers' adoption of the new technology. Given the increasing rural-to-urban migration of labor, it is important to demonstrate to small farmers the potential of tractors to increase rice output and profitability.

The Cobb-Douglas model is appropriate for determining the ratios of output to labor and output to capital. The model used was the Cobb-Douglas production function:

$$Y = AX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} U \quad (1)$$

where

Y = rice output (kg/ha)

A = scale factor, which is greater than zero and which is assumed to grow at a steady rate

X_1 = farm size (ha)

X_2 = amount of farm labor (worker days/ha)

X_3 = tractor-hire charge per hectare and capital depreciation of equipment (₦)

X_4 = variable capital costs (₦/ha)

U = stochastic variable of error term which takes account of unexplained factors affecting rice production

The exponents, $b_1 \ldots b_4$, represent the relative proportion of rice output contributed by the various inputs, $X_1 \ldots X_4$, and also indicate the elasticity of output with respect to changes in the X_s.

Equation 1 was converted into the double-log form expressed explicitly as:

$$\log Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + \text{Log } U \quad (2)$$

Although other functional forms like the semilog and linear were tried, the lead equation was the double-log form. The signs and magnitudes of the b coefficients conformed to a priori expectations.

In addition, the costs and returns of production and the profitability of the two systems were determined. The t-test was used to determine if there was a significant difference between the mean output of rice per hectare from traditional farms and from farms using tractors (see table 1). The extent of tractor use was

measured by the number of hours of tractor use for the farming season by the sampled farmers.

SOCIOECONOMIC CHARACTERISTICS OF RESPONDENTS

The respondents ranged in age from 20 years to 60 years, averaging 34 years. The number of years they spent in school ranged from 2 to 15 and averaged 9. The size of the household ranged from 3 members to 16 members; the average household had 7 members: 3 men and 4 women. There were no significant differences between the farms that did not use tractors and those that did on the basis of farmer's age, farmer's formal education, or household size. For 70% of traditional farmers and 80% of tractor users, farming was the primary occupation. The respondents engaged in secondary occupations such as public service, trading, and handicrafts.

Seventy-two percent of the tractor users had agricultural training, which averaged 4 months in duration. The training included instruction on planting and maintaining rice and using agrochemicals. The training programs were organized by the extension service of the Ministry of Agriculture and Natural Resources.

Except for differences in agricultural training, the socioeconomic characteristics considered did not vary between traditional farmers and tractor users. Thus, variations in rice productivity between farms that did not use tractors and those that did cannot be attributed to the effects of these socioeconomic characteristics.

FARMING SYSTEMS

Farming in the study areas centers on arable cropping. The three major crop enterprises are yam-based crop mixtures, cassava-based crop mixtures, and rice. In yam-based mixtures, yams are the main crop, and cassava, maize, groundnuts, legumes, and vegetables also are grown. Cassava-based mixtures consist of the same crops, excluding yams. Rice is an important crop in the study areas and is usually grown alone. Farmers also raise poultry, sheep, and goats.

The significance of the rice crop lies in its high cash value. The net cash return from rice enterprises is often used to offset cash losses incurred in other crop enterprises, especially yam-based crop mixtures (Okorji and Obiechina, 1985). Harnessing the cash-yielding potential of rice will help to ameliorate the financial burdens of rural farming households, thereby enabling them to break the circle of poverty.

Rice is grown primarily in swamplands because of its high water requirements. Elsewhere, rice fields are usually irrigated. On fields where tractors were used, clearing land, plowing, harrowing, and transplanting were begun and completed in July (see figure 1). On fields where tractors were not used, land preparation began in May, but transplanting was not completed until August (see figure 2). The other operations, including weeding, applying fertilizer and other chemicals, and harvesting, were completed at least 1 month earlier on rice fields where tractors were used. Therefore, using tractors to prepare land enabled farmers to be timely in performing farm operations. Okigbo (1971) observed that yields were higher when farm operations were performed on time. In addition, the peak labor demand for yam and cassava production is during May, June, and July. The labor released from rice production could be used for weeding yam and cassava fields and staking the yams.

Because rice has a gestation period of only about 5 months, it is possible to grow two crops of rice in a calendar year. However, due to the absence of irrigation facilities, the surveyed farmers had not adopted this practice.

FARM RESOURCE AVAILABILITY AND UTILIZATION

The average size of farm holdings in the surveyed households was 5.18 ha -- an increase of 63% over the previous season's farm holdings. This remarkable increase in the amount of land cultivated by farmers can be attributed to the ban on importing rice and other food crops. In addition, the structural adjustment program emphasizes the use of local sources for raw materials, thereby increasing local demand for crops and raising their prices. Farmers in the Uzo-Uwani area participate in the farm settlement scheme, which makes large expanses of land available for cultivation. Over 80% of the farmland cultivated by respondents in the Uzo-Uwani area was acquired through lease; in the Abakaliki area, 53% was acquired by inheritance, 39% by lease, and 8% by purchase. While the average size of the farms that did not use tractors was 4.72 ha, the average size of the farms that used tractors was 5.65 ha in the survey year.

Farm Labor

Farm labor was provided by family members and hired workers. Tractor services were used only for preparing land, which includes clearing, plowing, and harrowing. The most important reasons for using tractors, according to the surveyed farmers, were that it saved time (69%) and it made for better soil water retention (23%). Those who did not use tractors on their farms gave their reasons as the scarcity of tractor services and the time wasted in obtaining the services (75%), high cost (36%), and extremely bad roads to the farms (29%). Farmers were

generally aware of the benefits of using tractors, including weed control (33%) and enhancing yield and improving soil fertility (56%). However, about 7% of the tractor users complained that, because of the terrain, some parts of their fields could not be cultivated by tractors.

The most important source of tractor services in the study area was privately owned tractor-hire services, which were used by all the respondents. The tractor-hire service of the Ministry of Agriculture and Natural Resources was used by only 12% of the respondents who used tractors. During the survey period, most of the government-owned tractors had broken down. Seventy-five percent of the respondents felt that owning a tractor would enable them to cultivate more hectares of farmland on a timely basis.

Fixed Capital Assets and Funds

The capital assets owned by a typical rice farmer included a hoe, shovel, cutlass, shelter for implements, spraying machine, trowel, tarpaulin, rake, sickle, and digger. The farmers said they did not own enough of these implements because they did not have enough money to acquire and maintain additional ones. The sources of funds available to the farmers, in order of importance, included personal savings, friends and relations, Isusu clubs (rotating savings-and-credit clubs), and cooperative societies. Only 4% of the respondents obtained loans from commercial banks during the farming season. All of the respondents reported that inadequate financing was a major constraint. Seventy-nine percent of the respondents said that inadequate funds prevented increased production; 21% said effective maintenance of the farm, especially weeding, was difficult due to a lack of funds. On the average, the rice farmers required between ₦ 3,000 and ₦ 5,000 to meet the financial needs of their farms for the season. Farmers said that, if they had more money, they would hire tractors, buy fertilizer, and hire additional labor.

Agrochemicals

Agrochemicals, including fertilizers, herbicides, and insecticides, were widely used on rice fields. Most farmers did not apply chemicals to their yam and cassava fields because they believed that chemicals damage tuber crops. However, the farmers believed that fertilizer increases the yield and enhances the rapid growth of rice, which enables it to subdue weeds; so nearly all of the farmers used fertilizer on their rice fields. However, the scarcity and high price of chemical fertilizers kept 4% of the farmers from using any and caused many farmers to use suboptimal amounts. Only 39% of the farmers used herbicides and insecticides on their farms in the survey year.

RESOURCE ALLOCATION TO RICE ENTERPRISES

The amount of land allocated to rice production during the 1988-89 season increased, on the average, by 20% over the previous year. Farmers who did not use tractors increased their land area by 38.5%, while farmers who used tractors increased theirs by 1.3%.

The proportion of farm area devoted to rice cultivation, however, decreased from 89% of the farmland in surveyed households in the previous year to 66% in the survey year. The demand rose suddenly for other food products, especially cassava for making *gari*, during 1987-88. Farmers altered their pattern of land allocation to take advantage of the price increases for food crops (Okorji and Okereke, 1988). Although this situation was more common among tractor users, the differences in net returns from other crop enterprises relative to that of rice may have been responsible. In addition, factors such as the value of land and the costs of tractor use, which directly affect production costs, may play a role in determining the proportion of land allocated to rice production.

The value of a hectare of swampland favorable for producing rice increased by over 100% in the study areas from 1987 to 1989. The value of land in Uzo-Uwani was significantly lower than in Abakaliki because farmers in Uzo-Uwani worked under the farm settlement scheme, for which a token fee was paid as rent for land.

The value of most farm inputs used in rice fields did not vary significantly between tractor users and nonusers. The difference in the quantity of rice seeds used per hectare was not statistically significant at a 5% level (see table 2). The cost of rice seeds used by respondents ranged from ₦ 1.04 a kilogram to ₦ 1.13 a kilogram. The most important source of rice seeds was the farmers' own stock, which met 60% of the total seed requirement. Seeds purchased from the market accounted for 39% of the seeds used; the remaining 1% was obtained from other sources, including the Ministry of Agriculture and Natural Resources and cooperative societies. The IR8 and IR1416 rice varieties were most popular among the respondents. However, while respondents from the Abakaliki area cultivated mostly IR8, their Uzo-Uwani counterparts cultivated IR1416. The availability of rice seed determined which of the two varieties the farmers chose. The farmers said the most important reasons for preferring these two varieties were their good yields (66%), early germination (10%), and resistance to adverse weather conditions (13%).

The quantity of fertilizer applied per hectare was higher for rice farms that did not use tractors, although the difference was not statistically significant at a 5% level. The disparity in fertilizer application between these two groups of farmers might be attributed to the fact that better tillage by tractors reduced the need for

fertilizer. The main constraints to fertilizer use were its lack of availability and its high price. While the official price was ₦ 10.00 per 50-kg bag, farmers paid as much as ₦ 20.00 per 50-kg bag. Farmers obtained 90% of the fertilizer they used from local traders at prices above the official rates. In the survey year, all of the farms that used tractors and 96% of the traditional farms applied fertilizer to their rice fields.

The quantities of herbicides and insecticides applied to rice fields by tractor users were significantly higher than those applied by traditional farmers in the survey year. While 60% of the tractor users applied herbicides and insecticides, only 18% of the traditional farmers did so. The Ministry of Agriculture and Natural Resources provided agrochemicals at a cheaper rate to rice farmers who had adopted modern innovations, such as tractors. Hence, the average costs to farmers who used tractors were ₦ 25.94 a liter for herbicides and ₦ 17.05 a liter for insecticides, while traditional farmers faced prices of ₦ 29.38 a liter for herbicides and ₦ 23.38 a liter for insecticides.

About 46% of the farmers who did not use herbicides said it was because of the high cost, 10% because the herbicides were scarce, and 43% because they did not know herbicides existed. All of the farmers who used insecticides said they did so because the chemicals helped control pests. The farmers who did not use insecticides gave the following reasons: There was no pest outbreak (31%), they lacked money (50%), or they did not know where to obtain the chemicals (14%).

Labor input, in terms of worker days per hectare, was lower for farms using tractors (see table 3). The only operations for which tractors were used were clearing land, plowing, and harrowing. Tractor rental was charged on a per-hectare basis. Labor was measured in worker days; the wages for hired laborers were paid on a daily basis. Labor requirements were significantly different, depending on whether or not tractors were used. The labor input for weeding, scaring birds, and harvesting and threshing was higher for farms using tractors. When tractors were used, weeding was the most labor-intensive operation, followed by harvesting and threshing. When tractors were not used, weeding had the highest labor requirement, but was followed by preparing land. The use of a tractor on the farm reduced the labor input for seedbed preparation and influenced labor demand for other operations. For instance, the respondents stated that plowed fields, especially swampland fields, needed more weeding because plowing made the soil softer and stimulated the growth of weeds. However, plowing the fields made planting and transplanting rice easier.

With an average rice farm size of 2.87 ha and an average time of 5.50 hours of tractor service per hectare, the total amount of tractor service for the 30 sampled farmers who used tractors during the season was estimated at 473.6 hours.

It is less expensive to use a tractor to prepare a hectare of land than to use manual labor. At an average wage of ₦ 15 a day (see table 4), a traditional farmer would use 23 worker days at a cost of ₦ 345 to clear the land and 30 worker days at a cost of ₦ 450 to till a hectare of farmland. Thus, the total cost would be ₦ 795. A tractor user would pay ₦ 250 per hectare for the tractor to clear, plow, and harrow a similar field and ₦ 60 for 4 worker days of supervisory labor, for a total of ₦ 310. Using a tractor to prepare land saved an average of 50 days of labor per hectare. This labor could be used to improve the timeliness and effective performance of other farm operations. Not only does the use of a tractor require less labor, but also it results in better prepared fields.

The total value of farm implements after depreciation was much higher for tractor users than for traditional farmers. None of the farmers interviewed owned tractors. Most of the tractor users owned expensive spraying equipment; only two of the nonusers owned spraying equipment.

The value of farm inputs used per hectare was higher on farms where tractors were not used, although the difference was not statistically significant at the 5% level. Labor cost was the most important item affecting production cost since it accounted for 82% to 91% of total costs per hectare. Thus, the most effective way to lower rice-production costs would be to reduce the labor requirements. This suggests that mechanization should be used not only for preparing land, but also for other labor-intensive operations such as harvesting and threshing rice.

Farmers preferred to obtain tractor services from the private sector. They encountered problems obtaining tractor services from government agencies. They said that only a limited number of tractors were available and they wasted time filling out forms. These problems were largely responsible for many farmers' not adopting tractor technology.

OUTPUT AND RETURNS FROM RICE ENTERPRISES

Both output and revenue realized per hectare were higher for farms using tractors. The quantities of rice seeds, fertilizers, herbicides, and insecticides used per hectare did not differ significantly between farmers who did not use tractors and those who did. However, the difference in the yield of rice per hectare was statistically significant at the 5% level. The higher yields could have resulted from the effects of such factors as the proper tillage and cultivation of soil or timely performance of farm operations.

A Comparison of the Productivity of Farm Resources

The net return per hectare, defined as the difference between gross return and total cost of production per hectare, was significantly higher for farms using tractors (see table 5). For tractor users, the gross return was ₦ 6,232 per hectare and the total cost was ₦ 3,060 per hectare. Thus, the net return was ₦ 3,171 per hectare. For farms that relied exclusively on manual labor, the gross return was ₦ 4,616 per hectare and the total cost was ₦ 3,465 per hectare. Thus, when tractors were not used, the net return was only ₦ 1,151 per hectare.

Tractors increased labor productivity so that the value of labor's gross return per day was higher than the average daily wage rate. Labor was more productive on farms using tractors -- each worker day of labor produced an additional ₦ 17.63. On farms without tractors, each worker day produced only an additional ₦ 4.31, given the average wage rate of ₦ 15.00 per worker day.

Similarly, ₦ 1.00 invested in production yielded ₦ 2.04 for farmers using tractors and ₦ 1.33 for traditional farmers. Capital was thus more productive on rice farms using tractors. Both of these values were higher than the prevailing interest rate of 10% on savings deposits, which was the opportunity cost of capital funds invested in rice production in the survey year. Farm resources were used profitably on rice production, but the resources were more productive when tractors were used.

Regression Analysis

The Cobb-Douglas production function was used to measure the effect of farm size (X_1), labor input per hectare (X_2), tractor-hire charge per hectare and depreciation of capital equipment (X_3), and the cost of variable inputs, including seeds and agrochemicals (fertilizer, herbicides, and insecticides), used per hectare (X_4) on rice output. The following results were obtained.

For farms using tractors:

$$\text{Log } Y = 2.60 + \underset{(0.209)}{0.23}\log X_1 + \underset{(0.221)}{0.45}\log X_2 + \underset{(0.078)}{0.43}\log X_3 - \underset{(0.052)}{0.81}\log X_4$$

$R^2 = 0.88$ F = 28.64

For farms that did not use tractors:

$$\text{Log } Y = 7.40 - \underset{(0.279)}{1.21}\log X_1 - \underset{(0.267)}{0.39}\log X_2 + \underset{(0.074)}{0.02}\log X_3 + \underset{(0.125)}{0.35}\log X_4$$

$R^2 = 0.88$ F = 29.16

On farms using tractors, farm size (X_1) was not significantly related to rice output; on traditional farms, it was. The negative relationship between farm size and rice output in traditional rice farms could be attributed to the fact that increased farm size poses greater labor and other management problems that adversely affect rice output.

The relationship between labor input (X_2) and rice output was positive and statistically significant when tractors were used; the impact was negative and nonsignificant when tractors were not used. The impact of tractor rental fees and capital equipment depreciation (X_3) was positive and significant when tractors were used, and positive but nonsignificant when tractors were not used. The impact of the cost of variable inputs (X_4) was significant and negative when tractors were used and significant and positive when tractors were not used.

A similar regression model was used to determine which variables affected rice output per hectare. The variables of labor input (X_1), value of seeds and agrochemicals (X_2), tractor-hire charges and depreciation costs (X_3), and value of labor input (X_4) were regressed onto the rice output per hectare, or yield (Y_1). The following equations were derived.

For farms using tractors:

$$Y_1 = \underset{(0.204)}{0.539X_1} + \underset{(0.187)}{0.498X_2} + \underset{(0.132)}{0.468X_3} + \underset{(0.265)}{0.572X_4}$$

For farms that did not use tractors:

$$Y_1 = \underset{(0.266)}{0.789X_1} + \underset{(0.179)}{0.512X_2} + \underset{(0.311)}{0.741X_3} + \underset{(0.302)}{0.779X_4}$$

It can be deduced from the equation that greater labor is required on traditional farms to achieve a unit change in output per hectare. The value of seeds and agrochemicals (X_2), which is a reflection of the quantities used, has similar impact on output on all farms.

In addition, these variable were regressed onto net return per hectare (Y_2). The following equations were derived.

For farms using tractors:

$$Y_2 = \underset{(0.016)}{-0.022X_1} + \underset{(0.122)}{0.248X_2} + \underset{(0.014)}{0.033X_3} = \underset{(0.022)}{0.058X_4}$$

For farms that did not use tractors:

$$Y_2 = \underset{(0.198)}{0.408X_1} + \underset{(0.103)}{0.231X_2} + \underset{(0.046)}{0.196X_3} + \underset{(0.071)}{0.192X_4}$$

The values of seeds and agrochemicals used per hectare have a comparable relationship with net return from all farms. The relationship between net return and labor input per hectare, value of total labor, and tractor-hire charges and capital equipment is higher for farms that do not use tractors.

SUMMARY AND RECOMMENDATIONS

The results of this study show that using tractors is profitable under some conditions and confirm that it ensures that land is prepared in time to take advantage of the early rains.

Farmers who did and did not use tractors did not differ significantly in their characteristics or in the quantities of inputs they used. But farmers who used tractors had significantly greater yields of rice per hectare because using tractors let them prepare the land in a single process, improved tillage and soil mixture, hastened the completion of subsequent operations, and reduced labor requirements.

The farmers were aware of the benefits of using tractors, but most could not afford to buy tractors and had difficulty hiring tractor services. Because the government tractor-hire services were unreliable, those that used tractors usually hired private services.

The greatest increases in productivity come from using tractors for preparing land, harvesting, and threshing. So, to meet Nigeria's rising demand for rice, steps should be taken to ensure that tractor services are available to farmers when they are needed. The expansion of private tractor-hire services should be encouraged by creating an institutional framework that increases the availability of tractors and spare parts. The present policy of the Nigerian government that lifts the tariff on agricultural machinery and spare parts will help to solve the problem of scarcity.

Farmers who do not use tractors also should be assisted in increasing their farms' productivity. The agroservice centers, which were established during the green revolution, should be reactivated to sell inputs to farmers. The farmers should not be required to adopt tractor technology to obtain the inputs they need.

This study also revealed the need for further research as follows:

- The social and private costs and benefits of tractor use should be compared.
- Tractor use should be included in studies of activities such as processing and marketing to get a more comprehensive picture of the effects of mechanizing rice production.
- The effect of tractor use on soil fertility, particularly over the long run, should be studied.

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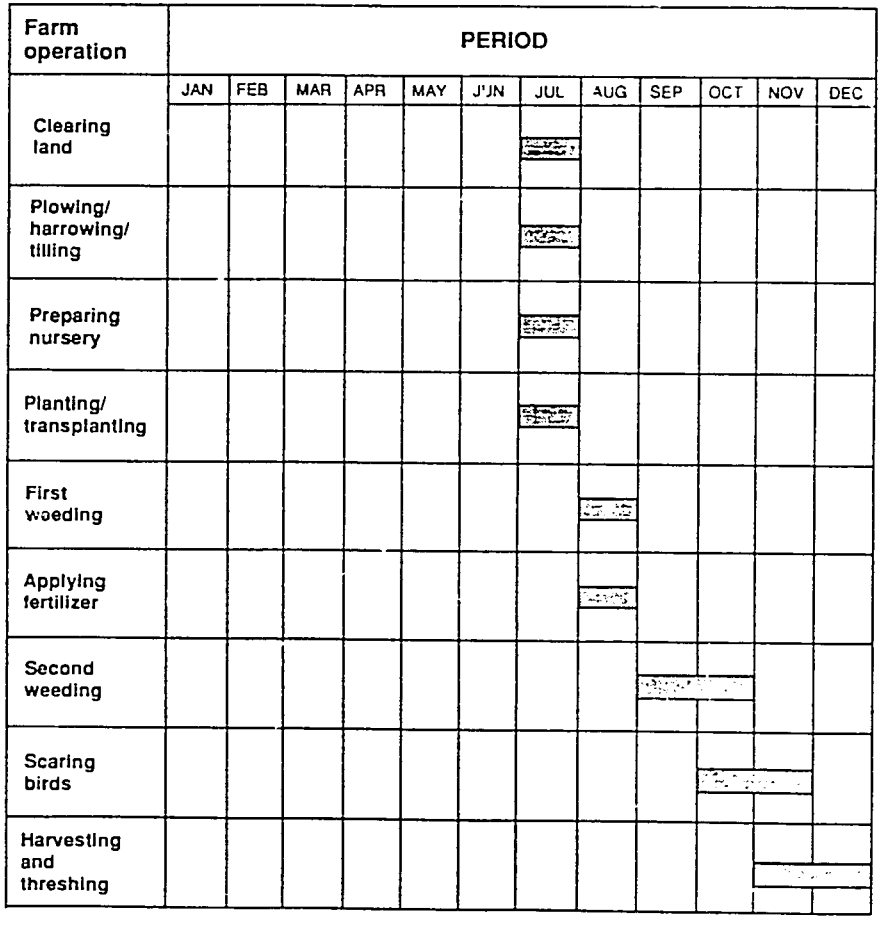

Figure I. Calendar of farm operations when tractors were used, Anambra State, Nigeria, 1988.

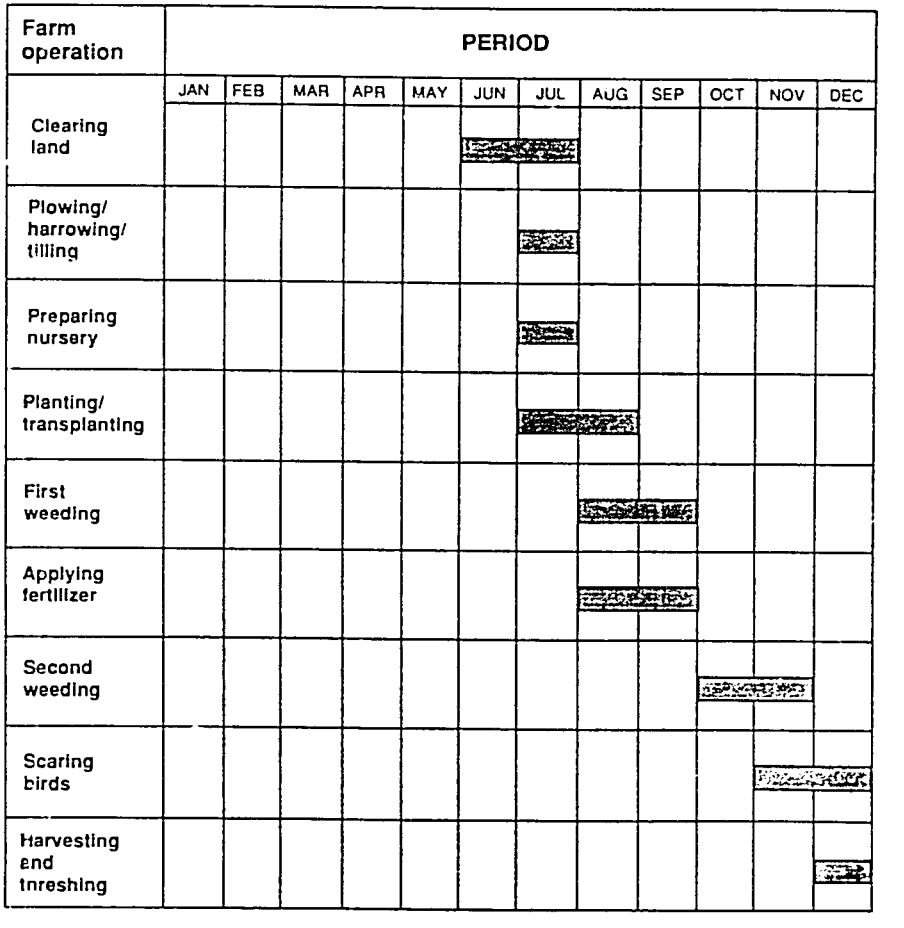

Figure 2. Calendar of farm operations on traditional farms, Anambra State, Nigeria, 1988.

Table 1. Results of t-test performed on data collected from farmers in Anambra State, Nigeria, 1988.

Parameter	Mean values: Farms using tractors	Mean values: Farms not using tractors	T-value	Prob.
Rice output (kg/ha)	3434	2544	1.97	0.050*
Total labor input (worker days/ha)	191	233	2.05	0.046*
Total labor cost (₦/ha)	2501	3136	2.23	0.031**
Total cost of production (₦/ha)	3060	3465	1.26	0.215
Total revenue (₦/ha)	6232	4616	2.96	0.005**
Net revenue (₦)	3171	1151	2.80	0.008**
Farmer's age (yrs)	34.0	37.9	1.16	0.254
Farmer's education (yrs)	7.3	5.6	1.25	0.217
Farmers agricultural training (months)	2.2	0.9	1.09	0.283
People in household	6.3	5.8	0.48	0.633
Rice seeds used (kg/ha)	141	119	1.24	0.220
Fertilizer used (kg/ha)	136	169	1.45	0.154
Herbicide used (liters/ha)	2.6	1.0	1.42	0.162
Insecticide used (liters/ha)	2.2	0.7	1.01	0.318

*$p < 0.05$. **$p < 0.01$.

Table 2. Cost of farm inputs used per hectare of rice produced, Anambra State, Nigeria, 1988.

Input	Farms using tractors: Quantity	Farms using tractors: Cost (₦)	Farms not using tractors: Quantity	Farms not using tractors: Cost (₦)
Rice seeds	141.00 kg	159.37	118.96 kg	124.06
Fertilizer	136.49 kg	57.20	168.50 kg	65.50
Herbicide	2.60 liter	67.45	1.031 liter	30.26
Insecticide	2.19 liter	37.35	0.68 liter	15.90
Labor	191.0 days	2501.43	233.0 days	3436.44
Farm implements		237.65		92.99
Total value		3060.45		3465.15

Table 3. Average labor input (in worker days) per hectare of rice produced, Anambra State, Nigeria, 1988.

Operation	Farms using tractors				Farms not using tractors		
	Family labor	Hired labor	Tractor	Total	Family labor	Hired labor	Total
Clearing land	2			2	6	17	23
Preparing seedbed	2	0	5.5 hrs	12	12	12	24
Preparing nursery	2	2		4	4	2	6
Planting and transplanting	10	10		29	12	24	36
Weeding	27	52		79	26	46	72
Applying fertilizer	2	3		5	6	1	7
Applying other chemicals	2	2		4	4	5	9
Scaring birds	2	11		13	4	6	10
Harvesting and threshing	23	30		53	26	20	46
Total	72	119	5.5 hrs	191	100	133	233

Notes: Tractors cleared the land and prepared the seedbed in a single process. Tractors were not used for other operations.

Table 4. Average rates of pay for farm operations, Anambra State, Nigeria, 1988.

Farm operation	Rate of pay (₦/day)		
	Adult male	Adult female	Children
Clearing land	14	10	5
Preparing seedbed	15		
Preparing nursery	10	10	5
Planting and transplanting	12	12	5
Weeding	10	12	5
Applying fertilizer	8	8	
Applying other chemicals	6	8	
Scaring birds	8	4	2
Harvesting and threshing	10	8	5

Table 5. Summary of cost-return analyses of data collected from farmers in Anambra State, Nigeria, 1988.

Item	Farms using tractors	Farms not using tractors
Gross return (₦/ha)	6231.68	4616.20
Total cost (₦/ha)	3060.45	3465.45
Net return (₦/ha)	3171.23	1151.05
Gross return (₦/day)	32.63	19.81
Gross return/total cost	2.04	1.33
Net return/cash outlay	1.04	0.33

RURAL BANKING IN NIGERIA: DETERMINING APPROPRIATE POLICY VARIABLES

Aja Okorie

SUMMARY

Ten years after the establishment of the Rural Banking Scheme in Nigeria, there are clear indications that the problems and issues that led to the scheme are still prevalent. These include a low level of rural savings mobilization, inadequate use of banking services, and the lack of credit for the rural people. This paper examines the central assumption of the Rural Banking Scheme that increasing the physical proximity of banks to rural people enhances rural savings mobilization and, in turn, increases the flow of funds to the rural sector. A variety of approaches to encourage rural banking have been tried in developing countries. These include quasi-cooperative banks, development banks, independent rural banks, and quasi-commercial banks. The latter are the type established in Nigeria, through legislation requiring commercial banks to open branches in rural areas.

Rural residents and rural bank branches were surveyed to determine which variables played a factor in determining rural bank use. Discriminant analysis determined that four variables were significant in discriminating between rural bank users and nonusers. These variables were household income, years of formal education, gender of respondent, and the awareness of the existence of the rural bank branch. The proximity of the bank to the respondent's residence was not a significant determining variable.

The data collected from the respondents who used rural banks was used in a regression analysis to determine which factors influenced the savings behavior of rural residents. Sixty-seven percent of the amount deposited in rural banks was explained by the variables of annual income, proximity of rural banks to residential homes, level of education, household size, and efficiency of bank workers. However, 80% of this explanation was accounted for by annual income.

A number of variables that were expected to be important were not. These included occupation, leadership position, age, the interest level paid on savings accounts, and membership in other

savings associations including isusu clubs (traditional rotating savings and credit societies), cooperatives, and age-grade societies.

Orthodox urban-based banking is capital intensive and capital biased. The Nigerian rural banking system is merely an extension of the urban banking system. It was not designed to meet the needs of the rural people. In the rural banks, the rich and the poor pay different prices to obtain the same level of service or to transact the same business. Therefore, the rich tend to use the banking services, while the poor and the illiterate prefer to patronize traditional savings and credit systems where they obtain better, faster, and cheaper services.

A continuation of the emphasis on a banking system with a capital and urban bias will certainly benefit the rich, and perhaps the middle class, but not the rural poor. Such policies will continue to deny the majority of Nigerians access to banking services, even when the physical distances between the people and the bank branches are reduced.

Thus, a new strategy must focus not only on the development of the physical banking environment, but also on the institutional infrastructures which will reduce the socioeconomic distance between the rural poor and the banks. The rural people must be a part of the rural bank ownership and management. The bank staff must adopt a more flexible approach in their operations to make their services more competitive and attractive. Finally, policies should be designed to increase and redistribute income to the rural poor.

Ten years after the establishment of the Rural Banking Scheme in Nigeria, there are clear indications that the problems and issues which led to the scheme are still prevalent. These include a low level of rural savings mobilization, inadequate use of banking services and the lack of credit for rural people (Okorie, 1986; Okorie, 1988; Ewulu, 1986). Although many banks were established in rural areas to correct these problems, their failure to do so is indicative of flaws in the choice of policy variables for designing the scheme.

The central assumption of the Rural Banking Scheme was that increasing the physical proximity of banks to the rural people enhances rural savings mobilization and in turn, increases the flow of funds to the rural sector. The frequency of use of the banking services would be expected to increase as well.

This study investigated the factors that affect rural savings mobilization to determine whether the physical proximity of rural bank branches is an important factor in rural people's participation in the banking system.

THE BANKING SYSTEM IN NIGERIA

The banking system in Nigeria dates back to the colonial period. A review of its origins shows that priority was given to urban centers in the establishment of banks. The Bank of British West Africa, established in 1893, opened its first branch in Lagos in 1894. In 1916, a colonial bank (taken over in 1925 by the Barclays Bank and now owned by the Union Bank of Nigeria, Ltd.) started operation in Lagos and concentrated its commercial activities in urban centers. These and other colonial banks were primarily concerned with the financing of import/export trade and other locally based expatriate enterprises.

The first successful indigenous banks were the National Bank of Nigeria, Ltd., which was established in 1933, and the African Continental Bank, Ltd., established in 1948. Unfortunately, these early indigenous banks had a difficult time competing against their foreign counterparts due to a lack of capital. In their struggle to survive, they lost sight of the goal of serving the needs of the rural population, and, like their foreign counterparts, they focused their strategy on the big cities and commercial centers.

The development of the banking system in Nigeria has continued to concentrate in the urban centers, neglecting the rural areas. By April 1977, there were 18 commercial banks in Nigeria, with 470 branches. Less than 20% of these branches were located in rural areas, where more than 80% of the estimated 80 million Nigerians live (Central Bank of Nigeria, 1977). These statistics demonstrate a gross under-banking of the Nigerian economy, especially in the rural sector.

In recognition of the fundamental inadequacy of banking facilities in the rural areas, the Federal Government developed the Rural Banking Scheme. The scheme was based on a financial review committee report, that recommended that the government compel commercial banks to open branches in rural areas (Okigbo, 1976). The objectives of the scheme were to mobilize savings from rural areas for development purposes, provide credit to small-scale industries, and encourage banking habits among the rural population (Central Bank of Nigeria, 1984).

The rationale behind the development of rural banks is that capital is important as an instrument of development and must be mobilized for this purpose. The Nigerian government also assumed that the process of rural capitalization and monetization depends upon the availability of financial institutions and services in the rural areas.

APPROACHES TO RURAL BANKING

Despite the widespread popularity of traditional financial institutions in the rural sectors of Nigeria and other developing countries, it is generally accepted that formal financial institutions are critical in the development of the rural areas. Formal financial institutions monetize transactions and facilitate sociocultural, political, and technological developments. Unfortunately, they do not cover the rural sectors adequately in most developing economies. Thus, many developing countries have felt the need to increase banking facilities in rural areas through special programs.

A variety of strategies for developing rural banking have been tried in developing countries. These include creating quasi-cooperative banks, development banks, independent rural banks, and quasi-commercial banks in the rural areas.

Quasi-cooperative rural banks are those based on regional cooperatives. China and Kenya have tried this approach (von Pischke, 1981). In Pakistan, in 1976, the government established a Federal Bank for Cooperatives (Haroon, 1986), and this brought cooperative finance under direct federal control.

The state cooperative banks in India have played important roles in mobilizing rural savings, extending credit, and bringing about socioeconomic development in rural areas. The State Cooperative Bank in Assam in the northeastern region of India has 43 branches spread through the rural areas and has recorded high levels of savings deposits (Yeshwanth, 1985). A study of the activities of the state cooperative banks in the northeastern region of India indicates that they have two dynamic roles in the socioeconomic development of the rural areas: they provide credit and act as a catalytic agent. However, their ability to perform these roles is predicated on effective coordination between governmental agencies and the banks (Yeshwanth, 1985).

In Tanzania and Zambia, state-run development banks have made a deliberate effort to extend their branches to the rural areas (Due, 1976).

The independent rural model is exemplified by the rural banks in Ghana. The first Ghanaian rural bank was established in the central region in 1976. Ten years later, there were 107 rural banks spread through all but the Northern region. Rural banks in Ghana are unit banks, owned jointly by the Bank of Ghana and the local people. The Bank of Ghana owns the preference shares, while the local people own the ordinary shares. Each rural bank is independent and survives solely by its own viability. The board of directors of each rural

bank is selected from the local shareholders. The Bank of Ghana's Rural Banking Department supervises all of the operations of the rural banks and provides technical support. The staff members of each rural bank are only employees of that particular bank; thus, they can only have their jobs as long as that bank survives. The local directors of the bank recommend suitable citizens of the locality for employment when available. The Ghanaian variant has been described as "showing itself to be the real catalyst in rural development" (Duncan, 1987), even though the loan repayment default was as high as 90%.

In the quasi-commercial bank model, the government compels commercial banks to extend their branches to rural communities as a deliberate policy to promote banking activities in rural areas. Commercial banks usually will not establish these rural branches without coercion due to their high cost (Ewulu, 1986). This is the model that is being used in Nigeria. Banks in Nigeria are not unit or independent banks as in Ghana or the Philippines; rather, they are branches of the commercial banks (Okorie, 1988; Awosika and Nwoko, 1983).

The design of rural banks is critical to their effective functioning. Appropriate policy variables therefore need to be identified initially. When there are indications of flaws in the design process, it is important to reevaluate the process and make changes. The failure of the rural people to use the rural bank branches indicates that it is necessary to reevaluate and redesign the Nigerian rural banking system.

VARIABLES AFFECTING RURAL BANKING IN NIGERIA

A survey of rural residents and rural bank branches was conducted. The rural residents were chosen from 30 villages in 10 local government areas in Anambra State. The banks were selected purposively from the 10 areas to ensure that the leading commercial banks that actively participate in the Rural Banking Scheme and those banks with Anambra State as one of the catchment states were included.

The majority of those surveyed were men. Two-thirds of the respondents were between 20 and 40 years old. Only 11% of them were over 50 years old. As is typical in rural areas, 64% had 6 years or less of formal schooling. Only 1% had a university education, although an additional 8% had vocational training beyond secondary education at a college of technology, education, or agriculture. The occupations of the respondents were well distributed: 30% were farmers, 30% were paid workers (including teachers), 22% were artisans, and 14% were traders. Seventy-two percent of the respondents had no banking experience prior to the introduction of the rural bank branches (see table 1).

Discriminant Analysis

Discriminant analysis was performed on the results of a sample of 250 rural residents. Each of the ten area samples included 13 to 14 bank users and 11 to 12 nonusers. The binary grouping variable for the analysis was the use of rural bank facilities. To distinguish between the bank users and bank nonusers, twelve variables were chosen to measure the respondent's socioeconomic and cultural characteristics.

The step-wise procedure was used to select the best discriminating variables. Four variables -- annual income, years of formal education, gender of respondent, and the awareness of the existence of the rural bank branch -- were significant at the 5% level. Four variables -- age, occupation, distance of bank branch from residence, and membership in a cooperative society -- were not eliminated by the step-wise procedure, but they did not contribute significantly as discriminating variables. The final four variables -- leadership position, household size, membership in an isusu society (traditional rotating-credit group) or membership in an age-grade society -- were dropped during the step-wise procedure because their values were too low.

The linear discriminant function was used and can be represented as

$$d = b_1Z_1 + b_2Z_2 + b_3Z_3 + b_4Z_4$$

where

Z_1 = the standardized value of years of formal schooling (*YFS*)
Z_2 = the standardized value of gender (*GED*)
Z_3 = the standardized value of awareness of the existence of the rural bank (*AWB*)
Z_4 = the standardized value of total annual income (*ANI*)

The estimated equation is as follows:

$$d = 0.757\ (YFS) + 0.270\ (GED) + 0.428\ (AWB) + 0.326\ (ANI)$$

The group centroids were -0.606 for nonusers of rural banks and 0.508 for users.

The Wilk's lambda criterion and the standardized canonical discriminant functions both confirmed that the variables identified by the step-wise procedure were significant discriminating variables. In addition, the validity of the discriminant function can be derived from the classification result for the two groups. The classification routine was able to identify 75.4% of the nonusers of rural banks and 69.1% of the users. Thus, on the average 72% of the respondents could be correctly classified using the discriminant function.

Regression Analysis

To determine the factors that influence the saving/banking behavior of the rural people in the studied areas, 131 respondents who saved with the rural banks were identified as a basis for a multiple regression analysis.

Sixty-seven percent of the amount deposited in rural banks was explained by the variables of annual income, proximity of rural banks to residential homes, level of education, household size, and efficiency of bank workers. However, 80% of this explanation was accounted for by annual income (see table 2).

Discussion of Results

The income variable was highly significance in explaining the savings behavior of the rural people. The coefficient of the variable was positive, implying a positive marginal propensity to save with banks. In other words, the higher their annual income, the more rural people are willing to save in the rural banks. This is similar to the behavior of the rural Ghanaian cocoa farmers as reported by Akaah, Dadzie, and Dunson (1987). Income was also one of the significant discriminating variables between rural bank branch users and nonusers, which is indicative of its importance in policy analysis.

The roles of income and education in determining the savings behavior of the rural person are complementary. To a large extent, income determines how much is to be saved; education influences where the money is to be saved. Evidence from this study shows that while a rural illiterate would prefer to save with an isusu club, an educated rural person would prefer to save with a bank.

The regression analysis identified years of formal schooling as an important variable that determined the volume of savings banked with a rural branch. People with higher levels of formal education were more likely to deposit their savings in a bank. Furthermore, the discriminant analysis showed education as the most significant variable separating rural bank users and nonusers. A closely related variable, the awareness of the existence of the rural bank branch, was the second most significant in distinguishing between users and nonusers of rural bank facilities.

In both rural and urban areas of Nigeria, people tend to associate wealth with occupation. Traders are generally expected to be wealthier than farmers and artisans; consequently, they are expected to have more savings and do more banking. Similarly, politicians, civil servants, and village leaders are presumed to have used their positions to obtain wealth. In addition, the senior and intermediate staff of public and private organizations are compelled by their

employers to receive their salaries through banks. Therefore, it was expected that occupation would be an important variable. However, occupation was not significant. Occupation may be less directly related to income than was expected. It does not necessarily follow that traders are wealthier than farmers, since in a rural setting, large farmers may be richer than petty traders.

Leadership position was also expected to be an important variable. Traditional leaders are opinion leaders who are usually consulted in the process of introducing any innovation to their communities. They are therefore expected to be among the early adopters of any innovation. However, the majority of the local leaders fell below the modal values of the sample for the variables of income and education, which were the most crucial factors influencing banking habits.

The prominence of the gender variable in separating users and nonusers of rural bank branches is understandable within the cultural framework of Nigeria. In rural Nigeria, men are regarded as the breadwinners of the household, and they consequently have the prerogative of making most economic decisions, such as whether or not to bank. Even when women participate in such decision-making, the implementation is usually left to men.

Household size was negatively related to the amount saved in the rural bank branch, which is consistent with expectations. In general, the ability to save depends on disposable income and on expenditure; which in turn, is influenced by several factors, including the number of dependents per income earner (Abbot, 1985). With a large number of dependents, the chances of saving become limited as more mouths have to be fed. However, the marginal nature of the contribution of the household size variable in the savings behavior model and its non-appearance among the major discriminating variables was contrary to expectations. These show that household size may not be as critical in rural banking policy considerations within the sampled area as the other demographic variables.

The proximity of the bank to the residential homes of customers and potential customers was negatively related to amount saved, which is consistent with general expectations and the rationale for the government's policy. Customers are discouraged from carrying out transactions with a bank if they have to walk long distances. While the physical bank accessibility variable was important in explaining the savings behavior of the rural people, it was not obvious in discriminating between users and nonusers. Thus, the focus on physical distance as an important factor hindering the inculcation of banking habits among rural people needs to be taken with caution.

It was expected that age would be an important discriminating variable since conservatism and risk aversion are both generally associated with old age. It was therefore expected that younger people would have a greater tendency to accept an innovation such as rural banking. Again, the expectations were not verified by the empirical evidence. In part, age may not have appeared as a significant discriminating variable because two-thirds of the respondents were between the ages of 20 and 40.

Rural banks constitute only one of the numerous channels of saving for the rural people. Isusu clubs, age grades, and cooperative societies are other channels through which people save money. Other people simply choose to keep their savings at home (Okorie and Miller, 1976; Okorie and Obeta, 1986). The variables of membership in isusu clubs and age grades were dropped by the step-wise procedure. While membership in cooperative societies was not dropped, further analysis suggested that it was not a significant variable. The greater importance of the positive relationship between cooperative societies and rural banking may be because isusu clubs and age grades meet the banking needs of rural people while cooperatives do not; thus, people who are members of cooperatives are more likely to save at a bank. In addition, cooperatives tend to provide information about banking and encourage their members, who tend to have higher incomes and levels of education, to bank. The nonsignificance of the age grades, isusu clubs and cooperative channels could be because the majority (68%) of those who did not deposit their savings in the rural banks preferred to keep their savings at home. This finding may be distorted because some people who state that they prefer to keep their money at home may save it with isusu clubs and other traditional institutions at a later time.

The level of interest was expected to be an important factor in rural people's decision of where and how much to save. If high interest on savings deposits is offered by rural banks, it is expected that people would opt to save more with the banks. The relationship between interest considerations and the amount saved was positive but not significant. The nonsignificance may have arisen from either of two reasons. First, rural people may have realized the negative nature of the real return on financial savings with banks in Nigeria, due to inflation rates which are estimated at over 50% per year. In this case, higher deposit rates may be needed to raise the level of financial savings. But higher deposit rates will mean higher lending rates. Second, it could be that the dichotomous scale of measurement of the variable (asking participants to respond either yes or no to the question of whether the level of interest was a consideration in their decision of whether to put their savings in the bank) could not capture the interest consideration adequately.

The attitude of the banking staff could inhibit the rural customers from saving with rural banks as well, especially if the potential customers had been discriminated against in the urban branches. But since very few of the respondents had prior banking experience, the effect of this did not appear to be significant.

SOCIAL BIAS NATURE OF THE NIGERIAN BANKING SCHEME

The attitude and behavior of rural people in Anambra State towards the rural banks can be understood in the context of banking as an innovation with social bias. An innovation is said to possess a factor bias if its introduction encourages a greater use of one factor in preference to an other (Yapa and Mayfield, 1978). This occurs when the innovation increases the marginal productivity of one factor more than it does that of another factor. For example, an innovation which raises the marginal productivity of capital relative to that of labor is capital-biased. The factor bias acquires social bias when the access to inputs or factors of production is restricted to a small segment of the society (Griffin, 1974).

In terms of overhead and operating costs, orthodox urban-based banking is capital intensive and capital biased. The rural banking scheme in Nigeria is a mere extension of the branches of the urban-based commercial banks to the rural areas. Thus, the rural branches are capital biased. While the rich businessmen or influential politicians, who can afford to give tips to the bank staff, are attended to promptly, the poor and illiterate peasant may remain unassisted for hours. The underprivileged consequently pay higher service prices. In addition, they are often denied access to bank services, such as credit. Often, the bank staff blame the rural poor for the bias, claiming that the poor are unable to present acceptable collateral and are timid and conservative.

As access to banking services become more or less restricted to a small segment of the society, the capital bias in rural banking acquires social bias. The prices of banking services in Nigeria therefore carry social bias. The structure, operations, and effects of the rural banking scheme in Nigeria can therefore be analyzed within the framework of Griffin's model of biased innovation and social fragmentation of factor markets.

The vertical axis, OP, in figure 1, represents labor and traditional banking attributes. It connotes the attributes of the rural poor. These include a low educational level, traditional values and culture, as well as the operational emphasis of the traditional banking systems, such as familiarity, close contact, honesty, and personal integrity. The traditional banks include isusu clubs, age-grade societies, and family meetings, which render basic savings and credit

services to members in traditional communities. The horizontal axis, Ob, represents capital and modern banking attributes. It connotes all the attributes of the privileged class, such as wealth, a high level of education, access to power, and a sophisticated appearance. These attributes are emphasized by the orthodox urban banking system. Bb and Pp are price lines, while Qq is the service isoquant.

The traditional banking systems, by the nature of their operations, are labor-augmenting, which tends to displace the isoquant Qq, into the region PRB; consequently, the underprivileged rural poor view them with favor. On the other hand, the orthodox banks displace the isoquant to the region of pRb, which is capital-augmenting. The privileged favor them because of their factor and service price advantage. The movement of the isoquant to the region of OBRp means that an innovation is neutral, and can be adopted by both the rich and the poor.

These have implications for rural banking scheme designers and policy-makers. Designers should aim at articulating a program which would result in a neutral innovation capable of moving the isoquant (of its output or services) to the neutral region of the schematic figure.

The overall effect of the structure and operations of the Nigerian rural banks is that the rich and poor pay different prices to obtain the same level of service or to transact the same business from the banks. The rich and the poor choose different channels to obtain banking services in response to the service prices they face. Consequently, the rich and well-educated tend to use the orthodox bank services because of the prompt attention they receive; the poor and illiterate prefer to patronize the traditional banks in the form of age grades, isusu clubs, and family meetings, where they obtain better, faster, and cheaper services.

DIRECTIONS FOR THE FUTURE

The lack of access to the rural banks due to poverty, lack of education and information, or gender-based discrimination raises an important policy issue. How can an effective rural banking system be designed to arrest the marginalization of the rural poor and underprivileged?

Designing effective rural banks hinges on the identification of appropriate policy variables. These are variables that will enhance the creation of a neutral innovation in the banking process, which can be adopted by the educated and illiterate, the politically strong and weak, and the rich and the poor. Rural banks based on such principles will diffuse rapidly, attract local patronage, and become economically viable.

Unfortunately, policies are seldom socially neutral (Yapa and Mayfield, 1978). Thus, the adoption of a particular line of development policy is largely a matter of which groups are favored. A continuation of emphasis on a banking system with capital and urban bias will certainly benefit the rich and perhaps the middle class, but not the rural poor. Such policies will continue to deny the majority of Nigerians access to banking services, even when the physical distances between the people and the bank branches are reduced.

This realization has led to the questioning of the basis of the existing rural banking development strategies in Nigeria. Empirical evidence from this study points to the need for a new direction and strategy of rural bank development -- one that is designed to benefit the rural poor.

Also, these findings agree with those of Miracle, Miracle, and Cohen (1980): for a formal financial institution to succeed in savings mobilization and extension of credit in the rural areas, it should incorporate the features that make informal savings-and-loan associations attractive to the rural dwellers.

Thus, a new strategy must focus not only on the development of the physical banking environment but also on the institutional infrastructures that will reduce the socioeconomic distance between the rural poor and the banks. This will involve special training for rural branch managers and the staff in rural sociology and psychology to enable them to appreciate the rural people and to serve them better. Also, the policy must incorporate a mass education campaign on rural banking services to narrow the information gap.

The other factors which tend to alienate and distance the rural people from the banks will need to be reviewed. The rural people must be a part of the rural bank ownership and management, while the bank staff should become more friendly and honest with its rural customers. The bank staff must adopt a more flexible approach in their operations as a means of making their services more competitive and attractive. General policies specifically designed to increase and redistribute income to the rural poor need to be pursued concomitantly.

By implementing these strategies and pursuing the new directions, Nigerian policy-makers would be joining the worldwide wave of interest in plans and programs that benefit all strata of the economy and not just a privileged minority. This will usher in a rural bank system consistent with the Nigerian government's current emphasis on rural development.

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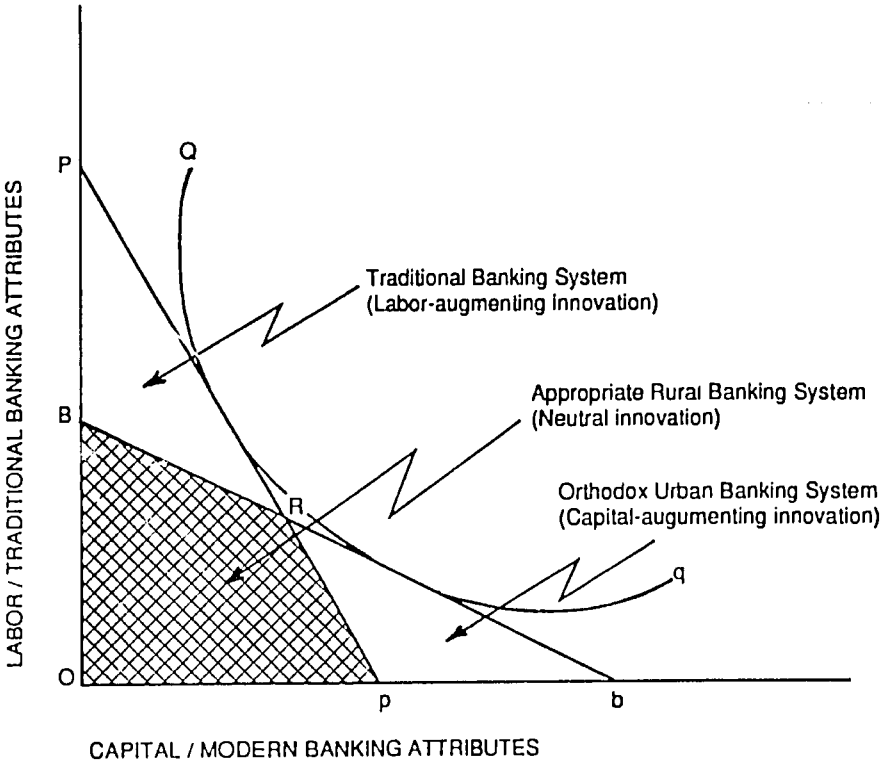

Figure 1. Banking systems in developing economies as biased innovations.

Table 1. Socioeconomic profile of study respondents.

Characteristics and categories	Distribution	
	Users (%)	Nonusers (%)
Gender		
Male	83	75
Female	15	25
Age (years)		
20 - 30	34	35
31 - 40	36	36
41 - 50	22	15
Over 50	7	15
Level of education (years of formal schooling)		
No formal education (0)	12	35
Primary education (1-6)	36	45
Secondary education (7-12)	38	17
College of technology, agriculture, education, or other (13-15)	13	4
University education (greater than 12)	2	0
Occupation		
Farmer	25	34
Teacher/Paid worker	44	15
Artisan	17	27
Trader	14	23
No response	6	2
Number of dependents		
0 - 5	34	39
6 - 10	48	47
11 - 15	13	8
16 - 20	3	3
Greater than 20	2	2
No response	0	2
Previous banking experience[a]		
Banked before	48	9
Had not banked before	52	91

Table 1. Continued

Characteristics and categories	Distribution	
	Users (%)	Nonusers (%)
Personal annual income (₦)[b]		
Less than 1000	2	22
1000 - 3000	35	47
3001 - 5000	23	16
5001 - 7000	13	5
7001 - 9000	10	4
9001 - 11,000	2	3
11,001 - 13,000	2	1
13,001 - 15,000	2	1
Greater than 15,000	9	1
No response	2	1
Awareness of rural bank existence		
Aware	100	97
Not aware	0	3
Has a relative working in the bank		
Yes	32	5
No	68	95

[a]Banking experience before the Rural Banking Scheme was started.
[b]Average exchange rate during period of study was $US 1 = ₦ 7.00.

Table 2. Regression analysis.

Variable	Estimated Coefficient	Standard Error	t value
Intercept	-0.6963	0.0646	14.9799
Annual income	0.9677	0.0821	-1.6687
Efficiency of bank workers	-0.137	0.0858	1.0956
Level of education	0.094	0.0858	1.0956
Proximity of rural banks to residential homes	-0.0518	0.0487	-1.0637
Household size	0.0216	0.0758	0.285
R-Square for equation	0.6842	0.6077	
F-Value for equation	54.15		

EFFICIENCY OF RESOURCE USE IN RICE PRODUCTION SYSTEMS IN ANAMBRA STATE, NIGERIA

Macaulay A. Olagoke

SUMMARY

Chronic rice shortages have developed in Nigeria due to a domestic demand for rice that has outpaced the supply from domestic producers, coupled with a national ban on rice imports. Agriculturalists have been challenged to find ways to boost Nigeria's rice production to meet the growing domestic demand.

A study was conducted of resource use among smallholder rice farmers in the Uzo-Uwani Local Government Area of Anambra State, Nigeria, over the 1987-88 crop year to determine ways in which rice production might be increased through more efficient use of farming resources. A total of 45 rice farmers was randomly selected for the study, in such a way as to include an equal number of irrigated, swamp, and upland rice farmers. The production inputs and yield of one rice field per farmer were carefully monitored through field observations and farmer surveys.

Survey results indicate that land scarcity, financial constraints, unfavorable rainfall patterns, and the inefficient distribution of irrigation water limited the production of rice during the survey period.

A comparison of production costs, resource use, and returns by type of rice production system revealed that swamp rice fields netted the highest average return per hectare. Irrigated fields averaged the highest yields and the highest production costs per hectare, resulting in the second-highest, average net return per hectare. Lower yields and lower paddy prices caused upland rice to net the lowest average return per hectare. Despite these apparent differences, the only statistically significant difference in net returns revealed by the data was between swamp and upland rice fields.

To derive the marginal product of selected rice production inputs for the survey year, a rice production function was estimated using ordinary least squares. The dependent variable, paddy rice yield per hectare, was specified as a semi-logarithmic function of three independent

variables : (1) man-hours of household plus hired labor per hectare, (2) seed input per hectare, and (3) all other capital operating expenditures per hectare. Regression results using the pooled data indicate that 55% of the variations in yield among the sample fields are explained by the factor inputs included in the model. The signs of the coefficients estimated using the pooled data were all positive and significant at the 10% level or above. However, not all of the estimated coefficients were found to be statistically significant when individual regressions were conducted by type of rice production system. For example, the estimated coefficient for seed input was not significant for irrigated rice fields, possibly due to insignificant variation in the quantity of seed used per hectare. Similarly, the estimated coefficients for capital were not significant for swamp and upland rice production, possibly reflecting the uniformly low level of capital expenditures typical of these rice production systems.

Marginal physical products and marginal value products were calculated for each variable input for which a statistically significant coefficient was estimated. The marginal value products for each input were then divided by the input's unit price to determine whether the input was being used at efficient levels. All resulting ratios were greater than unity, indicating that these resources were underused on the sample fields during the survey year.

The finding that farm resources were underused is consistent with surveyed farmers' reports of being unable to obtain desired levels of financing. Most farmers reported that they would devote more land and resources to rice production if suitable land and financing were available at affordable rates. It is recommended, therefore, that the rural banking scheme and the credit delivery system be improved to accommodate smallholder farmers with varying credit needs, credit system knowledge, and literacy skills.

Study results also indicate the need for improved maintenance of irrigation pumps and canals, and the prevention of water hoarding by farmers whose plots are close to the distribution canals. Rice production on irrigation projects might also be enhanced by improving soil fertility through the use of rotation crops. Similarly, more land suitable for irrigation should be developed to allow for the selective fallowing of rice fields with relatively low soil fertility.

The relatively high net returns of swamp rice fields, and the fact that no statistically significant difference was found between the net returns of irrigated and nonirrigated rice fields, suggests the continuing importance and viability of nonirrigated rice production. Accordingly, researchers should not neglect this area of study. Among other research concerns, efforts are needed to develop fast-maturing and high-yielding rice varieties that are drought and disease resistant, acceptable to consumers, and affordable by smallholder farmers.

The rice-growing areas of southeastern Nigeria supply the nation with rice from irrigated, swamp, and upland rice production systems. Most of the rice produced is allocated to market sales, rather than home consumption (Nweke and Winch, 1980). Until the last two decades, there appears to have been a balance between Nigeria's domestic demand for rice and the supply of rice. More recently, due to the general shift in consumer preferences away from traditional foods, especially among Nigeria's fast-growing urban population, domestic demand for rice has increased without a proportionate increase in local production. This led to a steady escalation in rice imports, from 342,000 metric tons in 1976 to about 600,000 metric tons in 1982 (Kaung, John, and Alam, 1985).

By 1986, the drop in international oil prices had reduced Nigeria's foreign exchange earnings to the point that the government imposed a ban on rice imports. Domestic rice shortages resurfaced, challenging agriculturists to find ways to boost Nigeria's rice production to meet the growing demand.

One approach to solving Nigeria's rice production problem is to investigate the pattern of resource use among rice farmers, especially smallholder rice farmers, to determine what adjustments might be made to increase rice output. The several studies that have examined the efficiency of resource use among smallholder farmers in Nigeria appear to be inconclusive (Olayide and Atobatele, 1980) and may also be out of date, invoking the need for additional research.

This study is aimed at finding ways to increase the level of rice production in Nigeria by evaluating the efficiency of resource use among rice farmers in the Uzo-Uwani Local Government Area of Anambra State, Nigeria for the 1987-88 crop year. Specifically, field data and survey information are used to

1. determine farmers' socioeconomic characteristics

2. describe the three types of rice production systems

3. compare costs and returns among the three systems

4. determine the marginal products associated with various farm inputs

5. derive recommendations for ways in which rice production can be increased through more efficient use of farming resources

THE UZO-UWANI LOCAL GOVERNMENT AREA

The Uzo-Uwani Local Government Area is located in the northern part of Anambra State, in southeastern Nigeria. It was selected for study for three reasons:

- It is a major rice-producing area.
- The author is well-acquainted with the area and many of its inhabitants, facilitating the collection of reliable data.
- It is the only local government area in the state in which there are three rice irrigation projects in addition to swamp and upland rice farms, enabling a comparison of the three types of rice production systems.

Climate and Soils

Vegetation in the Uzo-Uwani Local Government Area is of the derived savannah type and is characterized by incomplete canopy cover. Soils are mainly reddish-brown, pale clay and gravel, and are subject to leaching of basic minerals such as phosphorous and potassium. The annual flooding of local swamps deposits very rich silt on adjacent lands, helping to restore soil fertility.

The climate is characterized by uniformly high temperatures and seasonal distribution of rainfall. The rainfall pattern typically begins with a steady increase in rain from March to July, followed by a lighter but more persistent rain through August, an intense rain during September, and decreasing rain in October and November. About 50% of the annual rainfall usually falls towards the end of the rainy season, in September and October (Ezedinma, 1976).

The rainfall pattern during the 1987-88 survey period was atypical. Rainfall was unevenly distributed, starting as traces in May, falling heavily between late July and early September, and ceasing abruptly by the end of September. Consequently, many of the farmers surveyed lost most of their crops through the floods that accompanied the heavy rainfall in August and September.

Adarice and Anambra Rice Irrigation Projects

The Adarice and Anambra rice irrigation projects are both owned by the Anambra state government. In 1962, the then Eastern state government of Nigeria established the Uzo-Uwani Farm Settlement Scheme in an effort to provide employment and increase food production. It was proposed that the scheme cover three settlement villages of 120 settlers each. However, only two villages with a

combined population of 190 settlers were established before the civil war began in 1967. After the war the scheme was discontinued and its assets were turned over to the East Central State Agricultural Development Authority.

In 1975, Adarice and Anambra Rice Projects were established with loan assistance from the World Bank and other banks. The Anambra Rice Project was allocated 400 ha of land suitable for irrigation 835 ha of swamp land. Adarice Rice Project was allocated about 720 ha of land suitable for irrigation. From their inception, the two rice projects have been administratively autonomous, although they share the same irrigation system. Both projects have been cultivating rice since 1976.

Irrigation is provided by a surface-gravity system with no external pumps. Water is provided by the Obinna River, which runs through a large part of the local government area. The main irrigation canal is 14.1 km long, the secondary canals are 7.4 km long and the length of the distribution canals total 52.1 km. The drainage canal, which is channeled through Okpu stream, is 52.7 km long.

Anambra/Imo River Basin Development Project

The Anambra/Imo River Basin Development Authority was established by a federal government decree in 1976, which was amended in 1979. The three main functions of the Authority have been to (1) develop both surface water and ground water resources for irrigation and domestic use, (2) control soil erosion and flooding, and (3) collect and collate hydrological and meteorological data for water resources and water management.

The irrigated rice project was started in 1982 with one crop produced per year. Since 1984, it has been possible to cultivate some of the 2,600 ha of developed land twice per year. At full development, it is expected that 3,850 ha of rice land will be cropped twice per year, yielding over 30,000 metric tons of paddy annually.

Irrigation is provided by a surface irrigation system that uses external pumps to introduce water from the Anambra River into the main canal as necessary. The irrigation system includes a 16.5 km long headrace, two main canals totaling 23.6 km in length, 102 secondary and tertiary canals totaling 64 km in length, and 784 distribution canals totaling 189 km in length.

METHODOLOGY AND DATA COLLECTION

Forty-five farmers were randomly selected from the villages of Adani, Ifite-Ogwari, and Omor in such a way as to provide 15 farmers from each of the three types of rice production systems. The villages are within about 30 km of each other, and to

facilitate comparisons, it was assumed that the survey area was homogeneous with respect to soil types, weather conditions, and human resources.

The author and trained enumerators living in the villages obtained data on field sizes, market prices, and input costs. This information was supplemented with survey information provided by the farmers. Each of the 45 farmers surveyed was interviewed at least two times per week to obtain information on the use of farm resources such as labor.

Although most of the farmers surveyed had more than one field devoted to the respective rice system for which they were selected, many of them reported that they cultivated only one of the plots due to financial constraints or unfavorable weather conditions. Therefore, in cases where multiple fields were farmed, one field was randomly selected per farmer to provide consistency in the number of fields evaluated per farmer. This approach also facilitated intensive data collection on each field selected, and prevented confusion during interviews conducted outside the field.

Field sizes were determined based on compass and tape measurements. Information on annual land rent was obtained directly from those farmers who rented land. If land was not rented, the current annual land rent in the village was assumed to be the cost of land.

Labor input was measured in man-hours, taking into account the total number of hours worked by household members and hired labor on the selected field on a specific day. Each worker's age, gender, and tasks were noted. Man-hour equivalents were calculated according to the system followed by Norman (1973) (see table 1). Adjustments in the determination of man-hour equivalents were made to take into account the effectiveness of the worker for the task at hand, relative to the effectiveness of a male adult under the age of 65. For example, children were considered to be as effective at bird scaring as adult males, and were, therefore, accorded a man-equivalent ratio of 1.0 in bird scaring. In other types of field work, children were generally accorded a man-equivalent ratio of 0.5.

The cost of hired labor was obtained through interviews. Family labor was expressed in monetary terms according to the current wage rate.

Both fixed and variable capital inputs were measured. Fixed inputs were taken to include farm buildings and tools such as hoes and cutlasses. Depreciation was charged using the straight-line method, assuming a useful life of 15 to 20 years for farm buildings and 5 to 7 years for farm implements such as cutlasses, wheelbarrows, and hoes. Variable capital inputs were defined to include the cost of hiring machines and the costs of rice seed, fertilizer, and other chemicals.

Cash returns were estimated by multiplying the unit sales price by the quantity of total output. The unit sales price was obtained through farmer interviews and from price data collected from local markets on a weekly basis. Total output was obtained by recording the daily output harvested from each field throughout the harvest period. Although enumerators visited each field frequently during the harvest period, they could not be present at each field simultaneously. Therefore, the literate children and relations of some of the farmers assisted in measuring output by keeping track of the number of bags sold between enumerator visits. Each bag weighed between 75 kg and 80 kg.

THE RICE FARMERS AND THEIR ENVIRONMENT

Approximately 93% of the 45 farmers surveyed were male. Of these, 10% had two or three wives each, 78% had one wife each, and the remaining 12% were unmarried. The high rate of monogamy is probably due to the influence of Christianity. Most of the farmers were Christian, one was Muslim, and a few practiced traditional religion.

The average age of the farmers surveyed was 42 years. On average, a household consisted of six members, including one husband, one wife, three children, and one relation. Most of the children were about 15 years old or younger. Older children were typically in the cities, either in school or engaged in commercial activities.

Farmers had received an average of 6.5 years of formal education, although the actual number of years of schooling varied considerable between farmers. About 24% of the farmers had received no formal schooling, 31% had received 10 years or more of formal education, and the remaining 45% had received from 1 to 9 years of formal schooling.

The most common form of housing was thatched roof, as each farm household surveyed had at least one thatched-roof house. In addition, about 60% of the households surveyed had one to three tin-roofed houses. Farmers used their own bicycles or motorcycles to travel the average distance of 6.5 km between their residence and rice field. Only 10% of the farmers had no bicycle or motorcycle. About 15% of the farmers surveyed owned one or two pickup vans or trucks, which they hired out to other farmers, especially during harvest times.

All of the villages had access roads at the time of the survey, but because most of these were not tarred, they became difficult or impossible to navigate during the rainy season. Each of the villages had a central market where farm products and items such as clothing were sold. None of the villages in the study had pipe-borne

water or electricity, but all had agro-service centers where such inputs as fertilizer and chemicals could be purchased. These agro-service centers were mostly small, privately owned businesses. In addition, the state government had a tractor-hiring unit in two of the three villages. The federal government had a tractor-hiring unit in the remaining village. This may explain the wide use of tractors for field plowing and harrowing among the farmers surveyed.

RICE-FARM MANAGEMENT

Land Tenure

All but one of the farmers surveyed owned or rented from two to five rice fields, the average being three. The remaining farmer claimed to have only one rice field. Not all of the rice fields were cultivated by the surveyed farmers who owned them; some were cultivated by relations, friends, or tenants during the survey year.

About 67% of the swamp and upland rice farmers had inherited their rice fields, while the remaining 33% leased their rice fields from others. Payment for the use of land, in cash or in kind, varied among the villages. The average rent paid was about ₦ 32 (32 naira) per year for the use of one hectare of land, although payment was not always based on field size.

Irrigated rice fields were allocated to selected farmers by government officials associated with the rice irrigation projects. Selection was based on the applicant's interview performance at the beginning of the crop year. Each of the farmers selected paid about ₦ 197 per hectare for irrigation water. Payment was made in cash or in kind, depending on project policy.

Soil Management

During the survey year, all but two of the farmers applied nitrogen fertilizers to their rice fields to maintain soil fertility. The two farmers who did not use fertilizers believed that their fields, which were located near streams, were sufficiently fertile without additional applications. In addition to using fertilizers, swamp and upland rice farmers improved soil fertility by providing for short fallow periods of one to two years. Increasing population pressures did not allow the farmers to leave land fallow for longer periods.

Soil erosion was controlled through the use of bunds built at the start of each crop season. These bunds were repaired as necessary, depending on the magnitude of erosion problems.

Sequence of Field Operations

In the area surveyed, irrigated rice fields supported a dry-season crop as well as a wet-season crop each year. Figure 1 shows the sequence of field operations for dry-season and wet-season irrigated rice as well as for swamp and upland rice.

Dry-season irrigated rice. Land was prepared for dry-season cropping between early January and late February. Nurseries were prepared on separate plots at about the same time as field preparations occurred. After about a month in the nurseries, rice seedlings were transplanted to the fields, typically in February or March.

Herbicide, if used, was applied about three weeks after transplanting. Farmers who did not rely on herbicides began manual weeding about six weeks after transplanting, when rice seedlings were fully established and the weeds were well emerged. In March or April, about a week after herbicide application or manual weeding was completed, the first nitrogen fertilizer was applied at an average rate of about 200 kg per hectare. Plant diseases were treated with any available insecticide, most commonly FURADAN.

Subsequent field operations varied among the farmers, depending upon factors such as the intensity of weed growth, which might necessitate a second or even third weeding, and the relative fertility of the soil, which might necessitate top-dressing with nitrogen fertilizers. Generally, however, weeding and fertilizing were followed by bird scaring, which lasted for about one month during mid-April and late June, until the rice was ready to harvest. Harvesting occurred from mid-May to late July, depending on the date of planting.

Wet-season irrigated cropping. Land preparation for wet-season cropping took place between early June and late July. Field operations followed the same sequence as in dry-season farming, with harvest occurring between mid-October and late December. Bird scaring was less rigorous during the wet season because the rains provided the birds with other plants to feed on.

Swamp and upland rice farming. The swamp and upland rice farming systems were similar in their timing and sequence of field operations. Rice was planted between early June and late July. Weeding, fertilizing, and bird scaring occurred between early August and late November in a sequence similar to wet season, irrigated rice farming. Most of the rice was harvested between late October and late December, although the harvest season extended into January of the next year for the farmers who planted late.

The main distinction between the swamp and upland farming systems is the soil type. Swamp soils are heavier, with a higher clay content and a high water-retention capacity. Upland soils are lighter and more porous. These soil differences have practical implications for water use and control in rice farming, as was made particularly evident during the survey year when the period of prolonged dryness was followed by a short but heavy period of rainfall. Also, most swamp rice farmers prepare nurseries from which they transplant seedlings into the main fields, whereas upland rice farmers plant directly into the main fields by seed drilling or broadcasting.

Production Constraints

Survey results indicate that certain factors, such as land scarcity, financial constraints, unfavorable rainfall patterns, and the inefficient distribution of irrigation water limited the production of rice during the survey period.

Land scarcity. Farmers' demand for irrigated rice land exceeded the amount of land suitable for irrigation had been developed by the rice irrigation projects. Also, many of the swamp and upland fields were equally suited to rice and yam production, forcing farmers with small landholdings to make trade-offs between rice and yam production. About 70% of the farmers surveyed reported that they would have produced more paddy rice if they had access to more land.

Financial constraints. The farmers cultivated rice mainly for cash income. On average, of total paddy output the farmers sold 82%, stored 9% for seed, consumed 5%, and gave away 4% as gifts. The farmers sold most of their paddy immediately after harvest to enable them to pay back the money borrowed for farm production and to meet family financial obligations. Cash was needed to pay for hired labor, improved seed varieties, chemicals, fertilizers, and other operating inputs. Most of the funds were borrowed from wives, husbands, or relations and carried little or no interest. Though eager, most farmers were unable to obtain loans from banks or other credit institutions during the survey year. About 80% of the farmers reported that they had limited their scale of operations due to financial constraints.

Absolute dependence on weather. The semi-aquatic nature of rice and its shallow root system make it imperative that adequate quantities of surface water be supplied to the plants in a timely fashion. For example, it has been reported that, although the number of tillers produced may be larger with a slight water stress, the proportion of barren tillers is higher than under adequate soil moisture conditions (Have, 1959; Chaudry and McLean, 1963; and Lal, Moomaw, and Fagbamiye, 1981). Unfavorable rainfall patterns, such as occurred during the survey year, reduce potential rice crop yields in the swamp and upland rice

production systems, which rely totally on rainfall to meet the plants' water requirements.

Inefficient distribution of irrigation water. Although water from natural sources was ample for irrigation purposes during the survey year, many of the farmers in the rice irrigation projects complained there was inadequate water supply to their plots. Distribution problems were traced to (1) irrigation canals that were blocked by weeds and debris, and (2) the actions of some farmers with fields near the distribution canals who intercepted the water flow to increase the water supply to their own plots, thereby denying other farmers an adequate water supply.

RESOURCE PRODUCTIVITY

Production Costs and Returns

Average production costs, input usage, and returns were compared for each rice production system (see tables 2, 3, 4, and 5). Field observations indicate that the highest rice yields per hectare were obtained on irrigated fields, which averaged 2.19 metric tons per hectare, nearly 0.5 tons per hectare more than the lowest average yield obtained from upland rice fields. Irrigated rice fields also averaged the highest total production costs, largely due to the cost of irrigation water and higher total labor and machine-use costs. These higher costs resulted in the fields averaging the second highest net returns of the three production systems.

Lower yields and lower paddy prices caused upland rice fields to net the lowest average returns per hectare, despite the lower variable and total costs attributed to upland rice production. Upland rice fields were provided with less fertilizer per hectare and less labor per hectare, the latter due partially to fewer packaging requirements for the lower yields and the lack of plant nurseries in upland rice farming. Farmers used more seed, and more-expensive seed, on upland rice fields.

The effect of weather conditions on the timing of planting and on the supply and demand of seed and paddy may partially explain the lower yields, higher seed prices, and lower paddy prices observed for upland rice. The delayed onset of rain during the survey period caused most farmers to make an initial decision not to cultivate upland rice. However, heavy rain in late July resulted in a general rush to cultivate upland rice, which may have caused an increase in the price of seed. The late planting of upland rice resulted in a late harvest. Most farmers sold their paddy immediately after harvest when irrigated and swamp rice was already in the market, thus lowering paddy prices. In addition, the OS6 rice variety planted by most of the upland rice farmers surveyed had a lower market value in the

survey area than the IR 1416 variety planted by most irrigated rice farmers and swamp rice farmers surveyed.

Weeding costs comprised the largest share of average total labor costs on upland and irrigated rice fields, accounting for about 35% and 28% of total labor costs, respectively. Average weeding costs for the swamp rice fields comprised 23% of total labor costs, and were second only to land preparation costs (24% of total). These results indicate the importance of weed control in rice cultivation. Flooding of rice plots in the irrigated and swamp systems reduces the level of weed growth relative to the upland system, which may explain the higher weeding requirement observed in the upland system.

Average net returns were highest for swamp rice fields, with a value of ₦ 568 per hectare. Net returns for irrigated rice fields averaged ₦ 413 per hectare, while net returns for upland rice fields averaged ₦ 249 per hectare. Despite these observed differences, t-tests conducted at the 5% level show that the only statistically significant difference in net returns revealed by the data were between swamp rice fields and upland rice fields. No statistically significant difference was found between the net returns from irrigated rice fields and either swamp rice fields or upland rice fields.

Estimation of Rice Production Function

To derive the marginal product of basic rice production inputs for the survey year, a rice production function was estimated using ordinary least squares. The model was specified as follows:

$$Y = f(X_1, X_2, X_3, U)$$

where

Y = The yield of paddy rice in metric tons/ha.

X_1 = Total labor input in man-hours/ha. This was defined to include household and hired labor used in land preparation, nursery making, planting, weeding, bird scaring, harvesting, threshing, winnowing, packaging, and any other rice operation performed prior to and including the packing of paddy rice into jute bags.

X_2 = Seed input in kg/ha. This includes the initial quantity of seeds planted and any additional quantity used for refilling.

X_3 = Operating expenses of other capital inputs in ₦/ha. This includes all cash expenditures for fertilizer, machine hire, irrigation facilities, and any other cash expenditures per hectare.

U = A random error term.

Input quantities and rice yields were expressed on a per-hectare basis, instead of using field size as a separate regressor. This was done because of the strong correlation observed between field size and labor input in the sample data (as high as 0.92), which would have resulted in multicollinearity.

Although Heady and Dillon (1961) have suggested that input factors, especially capital, should be disaggregated to help farmers know the exact resource-adjustment decisions to make, it was not possible to include more variables in this model due to the limited number of degrees of freedom associated with the study's small sample size. It is believed, however, that this model is sufficiently specific for farmers to use the results to make appropriate resource-adjustment decisions at the present level of technology.

The data was analyzed separately for each type of rice production system and for all three types of rice production systems together. The Cobb-Douglas and semi-logarithmic functional forms were tried for each group to determine which provided the better fit. The semi-logarithmic function was selected for use in the rest of the analysis based on a comparison of adjusted coefficients of multiple determination ($\bar{R}^2$), standard errors, and the statistical significance of the estimated regression coefficients (see table 6).

Regression results using the pooled data indicate that 55% of the variations in yield among the sample fields are explained by the factor inputs specified in the model. This is a reasonably high percentage considering that other important explanatory factors, such as differences in soil fertility, weather conditions, and farmers' management abilities, are not included in the model. The signs of the estimated coefficients are all positive. The coefficients for labor and capital are statistically significant at the 1% level, and the coefficient for seed is significant at the 10% level, which supports the hypothesis that these variables are important determinants of rice yields.

Seventy-three percent of the variations in yields from irrigated fields are explained by the specified factor inputs. The relatively high adjusted R^2 is typical of irrigated fields where many of the excluded inputs, such as water supply, are likely to be homogeneous, being subject to some form of central control. The coefficients for labor and capital are both positive and significant at the 1% level, but the coefficient for seed is not even significant at the 10% level. The seed coefficient's lack of significance may be due to insufficient variation in the quantity of seed used per hectare. This is a likely explanation because most of the farmers obtained seed and seed-use information from the same sources.

Regression results for the swamp and upland rice-production systems show that 53% and 49%, respectively, of the variation in yields can be explained by differences in the levels of the specified factor inputs. The relatively low adjusted R^2 reflects the omission from the model of other important explanatory factors, such as soil fertility, seed viability, water supply, and timeliness of cropping operations. The coefficient for labor input is significant at the 5% level for upland rice yields and at the 10% level for swamp rice yields. The coefficient for seed input is significant at the 10% level for swamp rice yields, but was not statistically significant for upland rice yields. Coefficients for capital inputs were not significant for either rice production system, possibly reflecting the uniformly low level of capital use in swamp and upland rice production.

Marginal Productivity of Rice Production Inputs

The marginal physical products (*MPP*) of labor, seed, and capital inputs were calculated as follows:

$$MPP_i = b_i / \bar{X}_i$$

where

MPP_i = the marginal physical product of input i

b_i = the estimated regression coefficient of input i

$\bar{X}_i$ = the geometric mean usage level of input i

The marginal value product (*MVP*) for each input was then calculated by multiplying the *MPP* of each input by the geometric mean price of one metric ton of irrigated, swamp, or upland paddy, as appropriate (see table 7).

The results for the pooled data suggest that, on average, and with all other factors held constant, an increase of one man-hour of labor would increase yield by 0.002 metric tons, and revenue by ₦ 2.38. Similarly, an additional kilogram of seed would increase yield by .01 metric tons and revenue by ₦ 11.88; and an additional ₦ 1 spent on capital inputs would increase yield by 0.001 metric tons and revenue by ₦ 1.19.

According to the *MVP* figures derived for each input by type of rice production system, an additional man-hour of labor would bring the highest return (₦ 3.01) in the swamp rice production system. The *MVP* of an additional kilogram of seed in swamp rice production was estimated at ₦ 16.85, and the *MVP* of an additional ₦ 1 of capital inputs in irrigated rice production was estimated at ₦ 2.42. *MVP*'s

were not calculated in cases where the estimated regression coefficients were not significantly different from zero.

To determine whether the resources for which *MVP*'s were calculated were being used at efficient levels, the *MVP*'s for each input were divided by the input's unit price (see table 8). All resulting ratios are greater than unity, indicating that these resources were underused on the sample fields during the survey year. Under the assumptions of the model, it is likely that yields and net revenues would have been higher if more of the examined resources had been used.

RECOMMENDED IMPROVEMENTS IN SMALLHOLDER RICE PRODUCTION

The foregoing analysis suggests that farm resources were underutilized on sampled fields during the survey year. In particular, marginal analysis reveals that labor was underused on swamp and upland rice fields, seed was underused on swamp rice fields, and capital was underused on irrigated rice fields. The underutilization of farm resources is consistent with surveyed farmers' reports of being unable to obtain desired levels of financing. The level of operation of most of the surveyed farmers was fixed by resource constraints, mainly financial. Most farmers reported that they would devote more land and resources to rice production if suitable land and financing were available at affordable rates. Therefore, there is a need to provide credit facilities to smallholder farmers to enable them to increase their level of resource use. The rural banking scheme should be intensified, for example, and the credit delivery system should be improved to accommodate smallholder farmers with varying literacy skills. In addition, there should be an effective network in place to guide and supervise farmers on the use of credit.

The physiology of rice is such that, to achieve maximum production, water is required in adequate quantities and also at appropriate times. Irrigation systems are most beneficial to rice production, therefore, when water control systems are functioning appropriately. Field observations indicate the need for the government to pay greater attention to the maintenance of the pumps and canals for more effective water control. Funds should be made available to project management to procure the equipment necessary for such maintenance work. In addition, the management should develop some means of preventing farmers whose plots are close to the distribution canals from monopolizing water use. This could involve the stipulation of some penalty for defaulters.

Rice production on irrigation projects might also be improved by introducing rotation crops, such as cowpeas and soybeans, to improve soil fertility. Similarly,

more land suitable for irrigation should be developed where possible, to allow for the selective fallowing of rice fields, especially in areas with relatively low fertility.

No statistically significant difference in net returns was found between irrigated and nonirrigated rice fields included in the study, indicating the continuing importance and viability of nonirrigated rice farming. Accordingly, research efforts should not neglect this area of study. In particular, such efforts should aim at developing fast-maturing and high-yielding rice varieties that are drought and disease resistant, while being acceptable to consumers and affordable for smallholder rice farmers.

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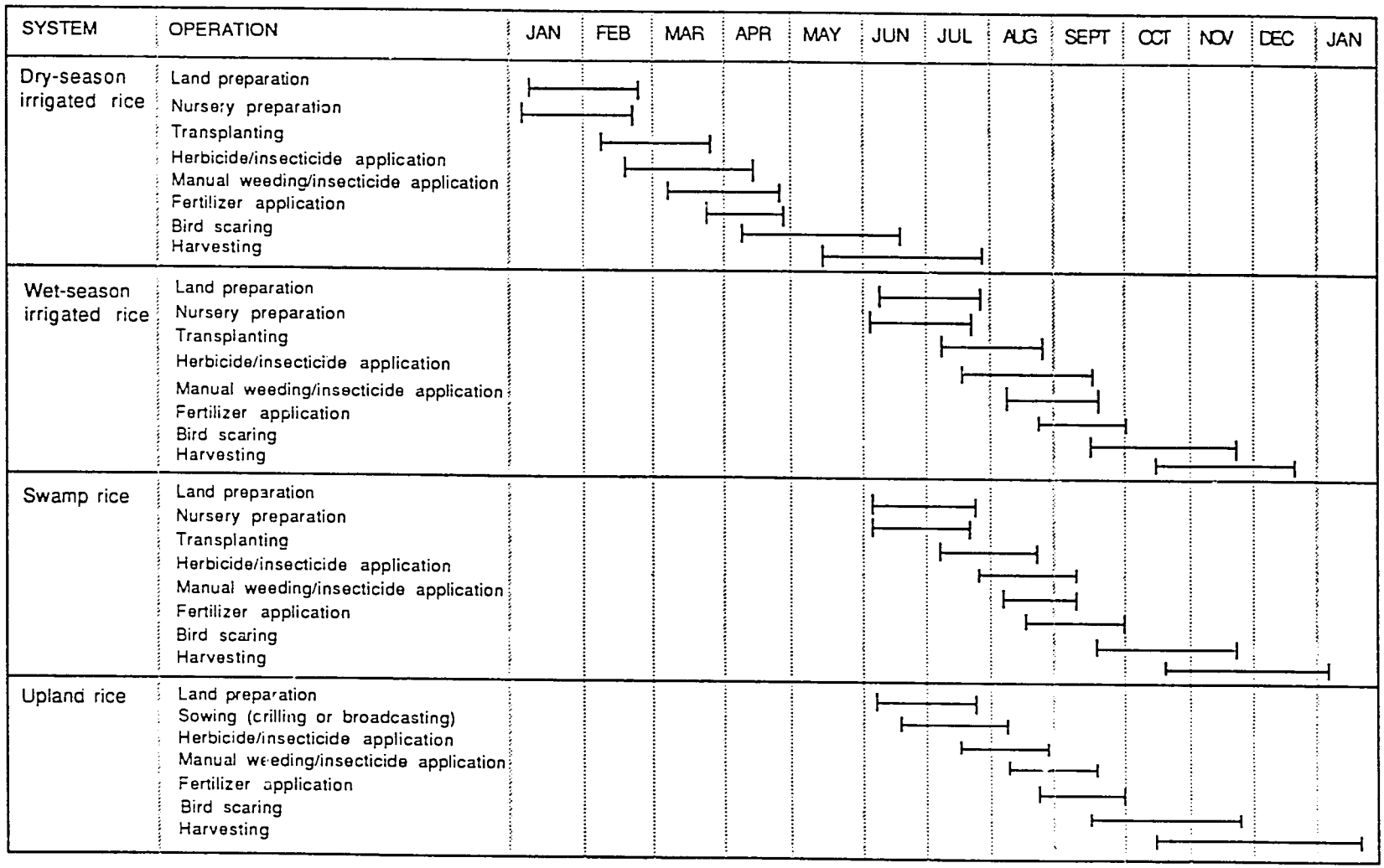

Figure 1. Calendar of field operations on rice fields at Uzo-Uwani Local Government Area, Anambra State, Nigeria, 1987-88.

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Table 1. Estimated labor man-hour equivalents.

Labor Class	Age (Years)	Male Adult Equivalent
Small child	Less than 7	0
Large child	7-14	0.5
Female adult	15-64	0.75
Male adult	15-64	1.0
Female adult	65 or more	0.5
Male adult	65 or more	0.5

Source: Norman, 1973.

Table 2. Average production costs, input usage, and returns per hectare for 15 irrigated rice fields.

Item	Unit Price (₦)	Units/ha	Value/ha (₦)
Rice output (RO) (paddy, metric tons)	1213.33	2.187	2653.55
Capital operating inputs			
Seed (kg)	1.05	99.87	104.86
Fertilizer (kg)	0.22	333.95	73.47
Machine-hire cost			307.62
Irrigation cost			197.02
Other capital operating costs			101.20
Total capital operating costs (TCOC)			784.17
Labor input (man-hours)			
Land preparation	1.04	234.78	244.17
Nursery	1.3	60.92	79.81
Planting	1.21	184.86	223.68
Weeding	1.25	305.53	381.91
Bird scaring	0.4	162.89	65.16
Harvesting	1.12	229.44	256.97
Threshing/winnowing	1.08	10.47	11.31
Packaging	0.69	62.17	42.90
Other	1.08	69.65	75.22
Total labor input (TLI)		1320.71	1381.13
Total variable costs (TVC=TCOC+TLI)			2165.30
Gross margin (RO-TVC)			488.25
Fixed costs			
Depreciation			48.60
Land rent			26.40
Total fixed costs (TFC)			75.00
Total costs (TC=TVC+TFC)			2240.30
Net return (RO-TC)			413.25

Source: Field study, Uzo-Uwani Local Government Area, Anambra State, Nigeria, 1987-88.

Table 3. Average production costs, input usage, and returns per hectare for 15 swamp rice fields.

Item	Unit Price (₦)	Units/ha	Value/ha (₦)
Rice output (RO) (paddy, metric tons)	1207.33	1.96	2371.20
Capital operating inputs			
Seed (kg)	1.05	98.38	103.30
Fertilizer (kg)	0.22	368.36	81.04
Machine-hire cost			185.31
Other capital operating costs			96.28
Total capital operating costs (TCOC)			465.93
Labor input (man-hours)			
Land preparation	1.11	268.82	298.39
Nursery	1.31	46.54	60.97
Planting	1.25	130.55	163.19
Weeding	1.28	222.55	284.86
Bird scaring	0.42	121.31	50.95
Harvesting	1.16	216.68	251.35
Threshing/winnowing	1.06	73.76	78.19
Packaging	0.67	48.55	32.53
Other	1.11	27.71	30.76
Total labor input (TLI)		1156.47	1251.19
Total variable costs (TVC=TCOC+TLI)			1717.12
Gross margin (RO-TVC)			654.08
Fixed costs			
Depreciation			52.93
Land rent			33.47
Total fixed costs (TFC)			86.40
Total costs (TC=TVC+TFC)			1803.52
Net return (RO-TC)			567.68

Source: Field study, Uzo-Uwani Local Government Area, Anambra State, Nigeria, 1987-88.

Table 4. Average production costs, input usage, and returns per hectare for 15 upland rice fields.

Item	Unit Price (₦)	Units/ha	Value/ha (₦)
Rice output (RO) (paddy, metric tons)	1151.33	1.711	1969.93
Capital operating inputs			
Seed (kg)	1.09	112.08	122.17
Fertilizer (kg)	0.22	281.95	62.03
Machine-hire cost			212.55
Other capital operating costs			71.52
Total capital operating costs (TCOC)			468.27
Labor input (man-hours)			
Land preparation	1.11	189.33	210.16
Nursery		0	0
Planting	1.21	110.03	133.14
Weeding	1.24	333.31	413.30
Bird scaring	0.37	120.98	44.76
Harvesting	1.17	243.77	285.21
Threshing/winnowing	1.09	39.95	43.55
Packaging	0.74	32.68	24.18
Other	1.06	16.06	17.02
Total labor input (TLI)		1086.11	1171.32
Total variable costs (TVC=TCOC+TLI)			1639.59
Gross margin (RO-TVC)			330.34
Fixed costs			
Depreciation			45.15
Land rent			36.30
Total fixed costs (TFC)			81.45
Total costs (TC=TVC+TFC)			1721.04
Net return (RO-TC)			248.89

Source: Field study, Uzo-Uwani Local Government Area, Anambra State, Nigeria, 1987-88.

Table 5. Comparison of average production costs, input usage, and returns per hectare for 15 irrigated rice fields, 15 swamp rice fields, and 15 upland rice fields.

Item	Unit Price (₦)			Units/ha			Value (₦)/ha		
	Irrigated	Swamp	Upland	Irrigated	Swamp	Upland	Irrigated	Swamp	Upland
Rice output (RO) (paddy, metric tons)	1213.33	1207.33	1151.33	2.187	1.964	1.711	2653.55	2371.2	1969.93
Seed input (kg)	1.05	1.05	1.09	99.87	98.38	112.08	104.86	103.3	122.17
Total capital operating costs (TCOC)							784.17	465.93	468.27
Weeding labor (man-hours)	1.25	1.28	1.24	305.53	222.55	333.31	381.91	284.86	413.3
Total labor input (TLI) (man-hours)				1320.71	1156.47	1086.11	1381.13	1251.19	1171.32
Total variable costs (TVC=TCOC+TLI)							2165.3	1717.12	1639.59
Gross margin (RO-TVC)							488.25	654.08	330.34
Total fixed costs (TFC)							75.0	86.4	81.45
Total costs (TC=TFC+TVC)							2240.3	1803.52	1721.04
Net returns (RO-TC)							413.25	567.68	248.89

Source: Field study, Uzo-Uwani Local Government Area, Anambra State, Nigeria, 1987-88.

Table 6. Regression results: Rice output (metric tons/ha) as a function of labor (hours/ha), seed (kg/ha), and other capital input costs (₦/ha).

Sample Fields	Sample Size	Functional Form	Estimated Parameters: Constant	Labor (X_1)	Seed (X_2)	Capital (X_3)	F-ratio	$\bar{R}^2$
All	45	Cobb-Douglas	-2.33133	0.59304*** (0.12725)	0.20183^{NS} (0.138832)	0.1456* (0.073129)	12.71	0.44
		Semi-log	-9.03416	2.43240*** (0.436582)	0.95686* (0.476321)	0.61279*** (0.250898)	18.84	0.55
Irrigated	15	Cobb-Douglas	-1.6749	0.29060*** (0.076464)	0.12811^{NS} (0.096457)	0.30042*** (0.108586)	11.34	0.69
		Semi-log	-7.62105	1.36545*** (0.338217)	0.65747^{NS} (0.426649)	1.5005*** (0.480300)	3.67	0.73
Swamp	15	Cobb-Douglas	-2.42395	0.65372^{NS} (0.41646)	0.36905^{NS} (0.21852)	-0.00865^{NS} (0.1252)	4.13	0.4
		Semi-log	-9.6949	2.83815* (1.38910)	1.3538* (0.7289)	0.11927^{NS} (0.4176)	6.3	0.53
Upland	15	Cobb-Douglas	-5.53242	0.61927** (0.278694)	1.76862^{NS} (1.379809)	0.09705^{NS} (0.197334)	3.52	0.35
		Semi-log	-22.5798	2.42396** (0.903175)	7.81986^{NS} (4.471600)	0.37433^{NS} (0.639508)	5.55	0.49

Source: Field study, Anambra State, Nigeria, 1987-88.
Notes: Figures in parentheses are standard errors.
*$P < 0.10$. **$P < 0.05$. ***$P < 0.01$. NS = not significant.

Table 7. Estimated marginal physical product (MPP) and marginal value product (MVP) of rice production inputs per hectare.

Sample Fields	MPP (metric tons of rice/ha)			MVP (₦/ha)		
	Labor (X_1)	Seed (X_2)	Capital (X_3)	Labor (X_1)	Seed (X_2)	Capital (X_3)
All	0.002	0.01	0.001	2.38	11.88	1.19
Irrigated	0.001	*	0.002	1.21	*	2.42
Swamp	0.003	0.014	*	3.01	16.85	*
Upland	0.002	*	*	2.3	*	*

Source: Regression results, field study, Anambra State, Nigeria, 1987-88.
Notes: * Estimate was not derived because regression coefficient was not significant.

Table 8. Ratio of estimated marginal value product (MVP) to factor price (P) of selected rice production inputs.

Sample Fields	MV P/P		
	Labor (X_1)	Seed (X_2)	Capital (X_3)
All	2.22	11.17	1.19
Irrigated	1.15	*	2.42
Swamp	2.79	16.05	*
Upland	2.13	*	*

Source: Regression results, field study, Anambra State, Nigeria, 1987-88.
Notes: * Ratio was not derived because estimated regression coefficient was not significant.

CAPTURE FISHERIES AND AQUACULTURE IN NIGERIA: A COMPARATIVE ECONOMIC ANALYSIS

Ade Olomola

SUMMARY

Nigeria has great potential to increase the availability of fish by supporting and expanding its capture fisheries and aquaculture. In 1984, less than 30% of the potential of the country's coastal fisheries was being attained. This study compared capture fisheries with aquaculture (fish farming) in Ondo State, Nigeria, to determine how efficiently the systems were utilizing resources and how production could be economically increased.

In the capture fisheries, the fishermen were largely illiterate but had an average of 30 years of experience in fishing in the Atlantic ocean. When larger, twin-engine boats are used, the operation is known as Double Engine Canoe Fishery (DECF); when smaller boats are used, it is called Single Engine Canoe Fishery (SECF).

Commercial aquaculture is a recent venture in Ondo State; 55% of the farmers interviewed had only about 2 years of experience, and 45% had about 6 years of experience. The inexperienced farmers were a little younger and better educated than their more experienced counterparts. They also had larger farms and invested more funds in constructing fish ponds. However, the experienced farmers used nondurable factor inputs (fingerlings, feed, fertilizer, and labor) more intensively than the inexperienced farmers.

To determine the efficiency of resource use, factor productivity, and returns to scale, production functions were estimated. For capture fisheries, estimates were made for both DECF and SECF in both wet and dry seasons; fish farmers were categorized as experienced or inexperienced. The higher level of resource endowment associated with DECF did not result in higher productivity of factor inputs. For instance, the marginal products of fuel and hired labor for DECF were less than those for SECF. Only with respect to fishing assets was DECF more productive than SECF. The factor inputs, except for fuel, tended to be more productive in the wet season than in

the dry season. The production function for DECF exhibited increasing returns to scale, whereas SECF was associated with decreasing returns to scale. Indeed, in terms of resource-use efficiency, hired labor, family labor, and fixed capital were inefficiently used in DECF. The use of hired labor and fixed capital in DECF was excessive. In SECF, the use of fuel was below the economic optimum. Fuel was underutilized during the dry season and used excessively during the wet season. An increase in the use of all the fishing inputs except for hired labor would lower rather than increase profits during the wet season under the prevailing prices and weather conditions.

The aquaculture production functions exhibited increasing returns to scale for the experienced fish farmers and decreasing returns to scale for the inexperienced fish farmers. Based on the magnitudes of the marginal value productivities, the experienced farmers used their fingerlings, fertilizer, feed, and fixed capital more productively than the inexperienced farmers. In terms of allocative efficiency, however, both the experienced and inexperienced farmers were efficient in the use of inputs.

An evaluation of the cost structures in capture fisheries and aquaculture revealed that aquaculture was more capital intensive. The share of the variable (cash) costs in aquaculture was 46% of total production cost and fixed costs constituted 46%. In the capture fisheries, the share of fixed costs was no more than 21%. Fuel costs were the largest component of operating expenses, constituting about 52% of total operating expenses under all conditions. In aquaculture, fingerlings were the largest component of operating expenses (47%), followed by feed (29%) and hired labor (21%).

Of the various components of production costs, only family labor was higher in capture fisheries than in aquaculture. Operating expenses, fixed costs, and total production costs were higher in aquaculture than in capture fisheries. Nonetheless, the short-term profitability of aquaculture is more promising than that of the capture fisheries. The operating profit associated with aquaculture exceeded that of capture fisheries by 99%.

Net profit was negative in both systems. In each system the returns generated were not sufficient to cover the fixed costs of production. This explains why investments in capture fisheries and especially in aquaculture were minimal in the study area.

If the fishing industries are to be viable, the government will have to institute policies that reduce the impact of the high cost of inputs. Inputs for fishing must be available at reasonable prices if fish production is to increase.

The Nigerian coastal waters are endowed with abundant fish stock. Output from the fishing sector, however, is still far below the potential. The fishing industries are characterized by disinvestment, even when the available fishery resources are far from being fully and profitably utilized. In 1984, less than 30% of the potential catch of the country's coastal fisheries was being harvested (Mabawonku, Olayemi, Ogunfowora, and Akinyemi, 1984), in spite of an unmet demand for fish. This unmet demand will continue to grow unless policy actions are geared toward augmenting domestic fish catch through exploiting the existing potential.

Mechanizing capture fisheries and developing aquaculture seem to be appropriate strategies for increasing fish production. However, by 1979 only 9% of the 133,728 fishing canoes in operation were motorized (Olomola, 1984). This indicates a low level of participation in off-shore fishing. The under-exploitation of capture fisheries has persisted, despite increases in public investment and the provision of fishing input subsidies, tax exemptions for industrial fisheries, and infrastructure (Mabawonku and Olomola, 1986). Although policies have increasingly recognized the nutritional potential of fish, public and private investment in aquaculture is still low. Public- sector investment has not moved beyond developing aquaculture technology and technical capability. The available technology has been adopted only by schools, colleges, government farms, and a few private individuals. The problem is to allocate resources between alternative modes of fish production while inducing higher levels of investment and management.

In spite of increasing biological research activity in the Nigerian fisheries, inadequate attention has been devoted to management and economic issues. For example, the profitability of fish farming in Nigeria has not been clearly demonstrated (Afinowi and Marioghae, 1987). Studies have not compared the economic aspects of capture fisheries with those of aquaculture.

Furthermore, before fishing operations can be modernized and mechanized, the existing patterns of resource allocation, degree of resource-use efficiency, productivity, and rate of return on investment must be known. This information will facilitate effective planning by determining what levels of financing, incentives, and infrastructure are needed to promote increased fish production.

SURVEY DESIGN

The study was conducted in Ondo State in western Nigeria, one of the country's seven maritime states. The fishery division of the state's Ministry of Agriculture

and Natural Resources has field offices in five zones within the state: Akoko, Akure, Ekiti, Ondo, and Owo.

Capture fisheries were studied only in the Ilaje/Ese-Odo Local Government Area of Ondo Zone. This LGA has a surface area of 2,132 sq km (10.6% of Ondo State), and it has 81 km of Atlantic coastline. The survey included 100 fishermen: Five were selected randomly from each of 20 fishing cooperatives.

Aquaculture was studied in all five zones. First, the number of fish farmers in each zone was determined through contact with zonal offices. Then 50% of the active fish farmers in each zone was randomly selected to participate in the survey. Thus, 45 fish farmers were included.

PRODUCTION TECHNOLOGIES

In capture fisheries, production depends not only on resource abundance, but also on the fisherman's quantity and type of gear, size and type of boat, type of boat propulsion, and fishing skills. Two basic types of nets were used: the gill net and the locally made shrimping net. The fishermen used three fishing techniques: bonga or ring netting, bottom-set netting, and shrimping. Bottom-set netting offers a better chance of catching different types of fish. The mesh size of bottom-set nets range from 5 cm to 15 cm. The most common mesh size was 7.62 cm. Of the 88 fishermen whose questionnaires contained complete information for analysis, 90% used nets of this mesh size.

The size of the fishing boats ranged from 12 m to 14 m. Boat size and type of propulsion differed among the fishermen. Larger boats used two engines of 25 horsepower each; smaller boats were powered by single engines. Fishing from a boat powered by two engines is here referred to as double- engine canoe fishery (DECF); fishing from a boat powered by a single engine is referred to as single-engine canoe fishery (SECF). Using twin engines lets the fishermen move faster and thus spend less time traveling and more time fishing. The larger boats of DECF also accommodates more fishing gear.

More resources were used in DECF than in SECF. For instance, DECF used 86% more of fuel and lubricants than SECF. The value of fishing gear used by the DECF fishermen exceeded that of gear used by SECF fishermen by 171%. Although the SECF fishermen appeared to have more family labor available, their total labor input was still less than that of DECF fishermen (see table 1).

The influence of management factors such as age, fishing experience, and educational attainment was not discernible. In these factors, the DECF

fishermen and the SECF fishermen were similar. The fishermen were largely illiterate but had an average of 30 years of experience fishing in the Atlantic.

The fish farmers surveyed were divided into two groups: experienced (those whose experience was greater than or equal to the sample mean) and inexperienced. The experienced farmers were older and less well educated than their inexperienced counterparts. They also had smaller farms and invested less in constructing fish ponds. However, they used all the nondurable factor inputs more intensively. For instance, stocking rates averaged 2,884 fingerlings per hectare for experienced fish farmers and 2,406 fingerlings per hectare for inexperienced farmers (see table 2).

The farmers practice polyculture involving tilapia, catfish, and the common carp. For a production season, labor use averaged 593 hr/ha and fertilizer use 325 kg/ha for the experienced farmers, in contrast to 344 hours/ha and 200 kg/ha for the inexperienced farmers. The amount spent on feed was ₦ 1,259 per hectare for the experienced farmers compared to ₦ 1,118 per hectare for the inexperienced farmers. This shows that feeding rates are higher for the former than the latter. The quantity of feed per hectare gives an indication of the technical ability of the farmer. Most farmers used groundnut cake, cotton seed cake, and rice bran as feed, while others used brewers waste, pawpaw, and poultry waste. The knowledge of the right quantity and combination of feed develops with experience and affects the profitability of the farm. Too much feed tends to increase production costs, pollute the environment, and cause diseases. On the other hand, too little feed causes slow growth and low yields.

CONCEPTUAL FRAMEWORK

The fishery production function combines both a biological unit and a technical and economic unit. The biological unit is represented by fish stock and the technical unit is represented by fishing effort. The output, or catch of fish, depends on the stock of fish and effort (Khaled,1985; Panayotou, 1985). This function is characterized by positive but diminishing marginal products of stock and effort.

A fishing unit is expected to continue operating as long as operating profit (gross revenue minus operating costs) is positive. Thus, as long as operating costs are covered, the unit will operate. However, unless all fixed costs are covered, the fishing operation is not tenable in the long run; it will terminate when the economic life of the existing fixed assets expires. Thus, net profit (gross revenue minus total costs) must not be negative if the fishing unit is to be viable in the long term.

In a number of Asian countries, production technology and economic efficiency of small-scale fisheries have been researched. Using cross-sectional data on the coastal fisheries of Thailand, one study (Tokrisna, Panayotou, and Adulavidhaya, 1985) found that it would be profitable, in terms of price efficiency, for fishermen with modern equipment to increase the size and engine power of their vessels, whereas those with more traditional equipment should increase their use of labor. Also, management ability was found to be a significant explanatory variable.

The application of a similar analytical framework by Fredericks and Nair (1985) to a sample of coastal fishermen in peninsular Malaysia found that fuel consumption was the most significant explanatory variable across mechanical types and locations. This suggests that fishing time, engine horsepower, or both, are limiting factors on catch.

Khaled (1985) found that the use of fewer or smaller nets, more labor, and larger boats would increase catch in the riverine fisheries of Bangladesh. Labor and boat size were found to be complements, whereas labor and nets and boat size and nets were substitutes within limits.

In Nigeria, little research has been done on the management and economic aspects of capture fisheries and aquaculture. Mabawonku (1978/79) found increasing returns to scale in Bendel, Cross River, and River states but found no evidence of scale economies in Ogun, Ondo, and Lagos. The factors in the production function were aggregated into capital and labor, and the issue of efficiency in allocating these resources was not addressed. Also omitted from this study were a number of social characteristics that might affect the management ability of fishermen.

For the purposes of this study, costs have been classified into variable costs (two types) and fixed costs. One type of variable costs -- operating expenses -- vary with the quantity of fish produced during the production period. In capture fisheries, variable costs include fuel and lubricants, repair and maintenance costs, and fish processing. In aquaculture, the main variable-cost items are fingerlings, feed, and hired labor. The other type of variable costs -- opportunity costs -- in the fish-production industries are the imputed costs of family labor.

Fixed costs do not vary with the level of output; they are incurred whether the fishing unit operates or not. Fixed costs are capital investments that cannot be retrieved at short notice without undue loss. They include the costs of building fish ponds and of obtaining fishing boats, outboard engines, and fishing nets. The costs associated with these assets are measured in terms of the flow of

services rendered during the production period. These rental costs are usually nonobservable; however, the purchase prices of the assets are observable and can be used to compute the rental as follows:

$$P_i = [(r + d_i)K_i - K_i']$$

where

P_i = rental price
d_i = rate of depreciation
r = rate of interest
K_i = price of asset i
K_i' = rate of inflation of the asset price

The nominal rate of interest was estimated as 15%, which was the prevailing rate charged by banks in the study area on agricultural loans. On an annual basis, the rate of depreciation is calculated as

$$d_i = 1/N_i$$

where N_i is the estimated life of an asset, i, in years. The rate of capital gain, K_i', has been calculated as

$$K_i' = (K_i^* - K_i) / n_i$$

where K_i^* is the current purchase price of the asset i and n_i is the current present age of the asset in years.

In capture fisheries, the rental price per season is $0.5P_i$. There are two fishing seasons in a year, each about 6 months long -- the wet season (April to September) and the dry season (October to March).

In the capture fisheries of this study, the stock of fish during a given fishing season was the same for everyone. There were no restrictions on fishing so it can be assumed that variations in catch were due to variations in level of effort. Thus, the general form of the fishery production function specifies catch as a function of effort.

The production unit in capture fisheries is a fishing team in an owner-operated boat. The fisherman who heads the team and owns the boat and gear is the focus of attention. Fishing effort is a composite index of inputs including labor, capital, material, time spent fishing, and the management ability of the fisherman. Capital includes fishing gear, outboard engine, and boat. Differences in managerial ability or skill may arise from such factors as age, education, and experience. Management ability is also reflected in the returns to scale and in the

allocative efficiency associated with the use of factor inputs. Theoretically, allocative efficiency stipulates that the use of each input be expanded until the value of its marginal product equals its unit cost.

The production function analysis also applies to aquaculture. The applicability of this concept has been demonstrated to be amenable to the traditional neoclassical technique (Smith, 1982; Chong and Lizarondo, 1982). The resource-use efficiency of the fish farmers can be evaluated through marginal analysis.

ESTIMATED PRODUCTION FUNCTIONS

Estimating production functions produces useful measures that include the marginal products of fishing inputs; the catch elasticity, which is the percentage change in catch due to a 1% change in the quantity of the input used; and the returns to scale, which indicate the increase in output resulting from a proportional increase in all inputs.

The production function for capture fisheries, in which variations in catch are hypothesized to be due to variations in level of effort and managerial ability, is specified in implicitly as follows:

$$Y = f(q_1, q_2, q_3, q_4, q_5, q_6, q_7)$$

where

Y = gross value of fish catch (₦)
q_1 = fuel and lubricant (₦)
q_2 = family labor (hrs)
q_3 = hired labor (hrs)
q_4 = rental price of fishing gear, engine, and boat (₦)
q_5 = education (yrs)
q_6 = age of fisherman (yrs)
q_7 = fishing experience (yrs $\geq$ average = 1, otherwise = 0)

Cobb-Douglas production functions were estimated separately for the wet and dry production seasons for both DECF and SECF using the following log-linear form:

$$\ln Y = \ln B + a_1 \ln q_1 + a_2 \ln q_2 + a_3 \ln q_3 + a_4 \ln q_4 + a_5 \ln q_5 + a_6 \ln q_6 + a_7 \ln q_7 + u$$

where B is a constant term, u is the error term, and a_i is the parameter associated with q_i.

The production function for aquaculture is specified implicitly as follows:

$$Q = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9)$$

where

Q = gross value of fish output (₦)
X_1 = labor (hrs)
X_2 = number of fingerlings stocked
X_3 = value of fertilizer (₦)
X_4 = value of feed (₦)
X_5 = rental price of fixed capital (pond) (₦)
X_6 = size of pond (ha)
X_7 = age of fish farmer (yrs)
X_8 = education (yrs)
X_9 = fish-farming experience (yrs ≥ average = 1, otherwise = 0)

Applying the Cobb-Douglas functional form, the model was estimated following the ordinary least-squares estimation technique. The models were estimated using the following log-linear form:

$$\ln Y = \ln A + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + b_9 \ln X_9 + u$$

where A is a constant term, u is the error term, and b_i is the parameter associated with X_i, which can be interpreted directly as elasticity.

The expectation regarding the capture fishery and aquaculture production functions is that each of the independent variables is positively related to the dependent variables. Since the dependent variables are expressed in value terms, the marginal value productivities of the inputs, following Heady and Dillon (1961) are expressed as follows:

$$MVPx_i = b_i (\bar{Q}/\bar{X}_i) \qquad i = 1, 2, \ldots 9$$

and

$$MVPq_i = a_i (\bar{Y}/\bar{q}_i) \qquad i = 1, 2, \ldots 7$$

where $\bar{Q}/\bar{X}_i$ or $\bar{Y}/\bar{q}_i$ is the average product of q_i or x_i evaluated at the geometric means of each variable and b_i or a_i is the regression coefficient (or output elasticity) of x_i or q_i. The $MVPx_i$ indicate the naira returns from spending another naira on the acquisition of input x_i.

Capture Fisheries Production Functions

For capture fisheries, Cobb-Douglas production functions were estimated for both DECF and SECF (see table 3). The variables included in the production functions explained 17% of the variation in reported catch for DECF and 38% for SECF. Fuel and age made a significant positive contribution to fish catch in DECF; fuel was the only significant explanatory variable in SECF. The differences in catch between DECF and SECF could not be explained by level of labor used or capital investment. Among the management factors included in the model -- fisherman's education, age, and fishing experience -- only age appeared to be a significant explanatory variable.

The higher level of resource endowment associated with DECF did not result in higher productivity for all the relevant factor inputs. The marginal products of fuel and hired labor for DECF were less than those for the SECF. Only with respect to fishing assets did DECF appear to be more productive than SECF, but this result was not statistically significant (see table 4).

Production functions were estimated for each season to determine whether resource productivity varied seasonally. The variables included in the estimated functions explained 19% of the variations in catch for the wet- season model and 78% for the dry-season model. Hired labor and age were the significant explanatory variables for the wet-season model; fuel and family labor significantly explained variations in catch during the dry season. However, family labor was negatively related to catch, indicating overuse of this input (see table 5). The factor inputs, except for fuel, tended to be more productive in the wet season than in the dry season.

Aquaculture Production Functions

For aquaculture, production functions were estimated by farm and by hectare. However, because the results were similar, only the by-farm results have been interpreted. Of the nine explanatory variables in the model, three -- fingerlings, fixed capital, and fish-farming experience -- contributed significantly to fish output (see table 6). The variables included in the model explained 61% of the variation in fish output.

The output elasticity of each of the inputs was less than unity. This indicates diminishing marginal returns to the inputs. For instance, a change of 1% in fingerlings, fixed capital, or fish-farming experience, holding other factors constant, was associated with a change in the gross value of fish of 0.24%, 0.10% and 0.32% respectively. Apparently, experience had the greatest impact on fish output among the sampled fish farmers.

The fish farmers were categorized as experienced or inexperienced, based on the average number of years of experience. The variables included in the model explained 68% of the variations in the gross value of fish output for experienced farmers and 74% for inexperienced farmers. For experienced farmers, fingerlings and experience were the significant explanatory variables; only labor was significant for inexperienced farmers.

The results revealed that experienced farmers used a number of factor inputs more productively than their inexperienced counterparts (see table 7). As indicated by the marginal productivities, the experienced farmers used fingerlings, fertilizer, feed, and fixed capital more productively. The inexperienced farmers, however, realized a higher marginal productivity of labor. This finding implies that technical knowledge is fundamental to increased productivity in aquaculture production systems.

Returns to Scale

In capture fisheries, only DECF was associated with increasing returns to scale. A 1% increase in all the inputs was associated with about a 1.18% increase in the output of fish. The sum of the elasticities for each of the remaining production functions fell below unity, indicating decreasing returns to scale.

The aquaculture production functions exhibited increasing returns to scale for all farmers combined (1.229) and for experienced farmers (1.923). Inexperienced farmers exhibited decreasing returns to scale (0.406).

PRODUCTION EFFICIENCY

Allocative efficiency is measured by determining the ratio of marginal value products to marginal factor costs (Singh, 1975; Olomola, 1988). If the ratio is not significantly different from unity, resources have been used efficiently; if the ratio is less than unity, resources have been used excessively; if the ratio is greater than unity, resources have been underused.

Technical efficiency -- which is an input-output relationship -- has to do with the estimated production functions. The Chow test of equality was conducted between the sets of coefficients in the two fitted equations. Under this test, if the coefficients of the fitted equations are equal,there is no significant difference between the underlying production processes.

The results of the Chow tests accepted the hypothesis of equal technical efficiency for DECF and SECF, and for experienced and inexperienced fish farmers. It is

therefore inferred that the overall production relationships for the two sets of fishermen and fish farmers did not differ significantly. The wet-season and dry-season production functions, however, did not exhibit similar relationships. The corollary is that the underlying fisheries production process changes by season.

If the fishermen and fish farmers exhibit allocative efficiency, they use the resources at their disposal in a manner consistent with maximizing profit. Allocative efficiency in input use is assessed by comparing the marginal value product (MVP) of each input to its price or marginal factor cost (MFC). MFC is the unit cost of the factor at market price or its opportunity cost.

To ascertain whether the farmers were efficient in allocating factor inputs, the ratios of MVPs to MFCs were computed. For each input, the regression coefficient required to obtain the MVP/MFC ratio of unity was also computed. The coefficient from the fitted equation was then tested (using the t-statistic) for a difference from the one required to obtain a ratio of unity. The MVP/MFC ratios for all the inputs were not significantly different from unity. Each of the calculated t-values was less than the tabulated value (2.306) at the 5% probability level. It therefore appears that labor, fingerlings, feed, fertilizer, and fixed capital were used efficiently by experienced fish farmers. A similar evaluation indicates that inexperienced farmers also were efficient in allocating these inputs.

The allocation of resources in capture fisheries was less efficient than in aquaculture. The labor cost was estimated as ₦ 13 a day for DECF and ₦ 10 a day for SECF, while the cost of fuel was ₦ 0.60 a liter. The opportunity cost of capital was based on the prevailing interest rate of 15%. Using these prices, the MVP/MFC ratio for each of the inputs was computed and tested for a difference from unity. Two of the inputs, hired labor and fixed capital, were used efficiently in SECF; only fuel was used efficiently in DECF.

In SECF, fuel and family labor were used inefficiently; in DECF, hired labor, fixed capital, and family labor were used inefficiently. Family labor was used excessively in both DECF and SECF as evidenced by the MVP/MFC ratio, which was significantly less than unity in each case. The use of hired labor and fixed capital in DECF also was excessive. Using more of these inputs under the prevailing prices would reduce rather than increase profits. The MVP/MFC ratio for fuel in SECF was significantly greater than unity, indicating that the use of fuel was below the economic optimum. Profits could be increased if fuel were used for longer or more frequent trips into the Atlantic. Fuel tended to be underused during the dry season and used excessively during the wet season.

The seasonal analysis showed that profits could be increased if more fuel were used during the dry season. It also showed that using more labor and fixed capital during the dry season might reduce profit rather than increase it. A further increase in the use of all the inputs except hired labor would lower rather than increase profits during the wet season under prevailing prices.

The negative marginal products of labor (and capital in the case of SECF) may have been due in part to weather and other hazards of marine fishing. A number of fishermen claimed to have lost some of their fishing gear to trawlers. Fishermen often stayed at home when the sea was rough. If the sea became turbulent while they were fishing, they returned home with empty boats. Fuel and other costs were incurred without a corresponding increase in catch.

COSTS AND PROFITABILITY

One of the objectives of this study is to compare the profit levels of marine capture fisheries with those in aquaculture.

Cost Structure: Capture Fisheries

Operating expenses, fixed costs, opportunity costs, and total costs were estimated for capture fisheries (see table 8).

Variable costs consisted of cash costs (operating expenses) and imputed costs (opportunity cost of family labor). Variable costs constituted a substantial proportion of total production cost, indicating a low level of capital intensity in the capture fisheries. For instance, variable costs' share of total fisheries production costs, during the dry season, was about 79% for DECF and 89% for SECF. The proportion was of similar magnitude during the wet season -- about 82% for DECF and 79% for SECF.

Operating expenses had a greater share of total production cost than imputed costs. Operating expenses were as high as 53% during the dry season and 47% during the wet season. During the dry season, fuel costs were 52% of total operating expenses and as much as 28% of total production costs. Fuel costs were 52% of total operating expenses during the wet season and 24% of total production costs. Other important costs during the dry season were engine repair (16% of total operating expenses) and hired labor (9%). Fish-processing costs constituted about 14% of total operating expenses during the wet season followed by engine repair (12%) and hired labor (8%).

The contributions of the activities and factor inputs to the total operating costs did not vary significantly between seasons in percentage or monetary terms. The shares of fuel, hired labor, and boat and engine repairs were higher in the dry season than in the wet season; shares of transportation and fish processing were higher in the wet season. However, the only seasonal difference that was statistically significant was in fish-processing costs.

Fuel costs accounted for the highest proportion of total operating expenses. Fuel contributed as much as 29% to total cost for DECF and 21% for SECF. Other variables with large proportions of total operating expenses were hired labor (15%), engine repair (11%), and fish processing (10.5%) for DECF and engine repair (18%) and fish processing (about 13%) for SECF. The differences between DECF and SECF in total operating expenses and the components such as fuel, hired labor, net repair, and fish processing, were statistically significant.

Rising fuel costs will adversely affect the profitability of capture fisheries. So will the rising cost of spare parts for engines.

Cost Structure: Aquaculture

Aquaculture production costs comprised operating expenses, fixed costs, and the opportunity cost of family labor (see table 9). The capital intensity of aquaculture was higher than that of capture fisheries. Fixed costs constituted 46% of total production costs in aquaculture, whereas they constituted less than 21% of total production costs in capture fisheries.

The percentages of total variable costs varied widely among the factor inputs. Fingerlings had the highest share (about 47%) followed by feed (29%) and hired labor (about 21%). Increases in the costs of these inputs, especially fingerlings and feed, would reduce profits and thus discourage investments in aquaculture. So, policies affecting the prices of these inputs would affect the profitability of the industries.

Profitability: Capture Fisheries

Profitability of capture fisheries varied with season and type of boat. As expected, the value of catch (gross revenue) was higher for DECF than for SECF in both seasons (see table 10). Both operating profit and net income were positive during the dry season. The net income of SECF (₦ 986) was nine times as large as that of DECF (₦ 109). During the wet season, the operating profit of SECF (₦ 2,612) was more than twice that of DECF (₦ 1,204).

Since the fishermen were able to cover their operating costs, fishing activities will continue in the short run. However, they were not able to cover their total costs, as evidenced by the largely negative net profits. Theoretically, nonnegative net profit is a prerequisite for the long-term viability of a fishing unit. When fixed costs are not totally covered, operations tend to be terminated when the economic life of the existing fixed assets expires or when an acceptable resale value can be obtained, whichever comes first.

The fishermen have fewer alternatives for employment; therefore, terminating their fishing operations is not feasible, even in the long run. The escalating cost of fishing gear, boats, and outboard engines, is one of the main problems. For instance, an outboard engine that sold for ₦ 1,000 in 1982, sold for ₦ 3,000 in 1985 and ₦ 8,000 in 1988. Unless policies are instituted to help fishermen meet the rising costs of equipment, the long-term viability of capture fisheries will be limited.

In addition, fishermen face seasonal problems. For instance, large numbers of certain fish species, such as the bonga fish, are caught during the wet season; but because the processing facilities cannot handle such large catches, the fish bring low prices. The value of the fish output is also higher in the dry season. Weather conditions are less favorable during the wet season, so the fishermen are unable to fish at all during some trips out to sea. For these and other reasons, fishing is generally more profitable during the dry season than during the wet season. Operating profit and net income of dry season exceed those of the wet season by ₦ 162.

Profitability: Aquaculture

For aquaculture, operating profit, defined as gross revenue minus variable cost, was ₦ 4,183 per farm, ₦ 5,107 per hectare of pond area, and ₦ 6.2 per kilogram of fish (see table 11). Net income, defined as operating profit minus fixed cost, was about ₦ 292 per farm, ₦ 985 per hectare, and ₦ 1.1 per kilogram. Net profit, or return to management, defined as gross revenue minus total cost, was about at ₦ -374 per farm, ₦ 420 per hectare, and ₦ 0.4 per kilogram. The negative net profit obtained per farm shows that aquaculture would not be economically viable on the average farm in the long run. However, the farmers could cover the variable costs at the present level of operation.

Though the outlook for aquaculture on the average farm was not good, aquaculture was profitable for experienced farmers (see table 12). Their operating profit was ₦ 4,900 per farm, ₦ 6,599 per hectare, and ₦ 8.2 per kilogram. Their net income was ₦ 2,041 per farm, ₦ 1,513 per hectare, and ₦ 3.9 per kilogram. Their net profit was positive: ₦ 1,275 per farm, ₦ 746 per hectare,

and ₦ 3.0 per kilogram. These results indicate that experienced farmers have better prospects for long-term viability of their farms than do inexperienced farmers.

Comparative Analysis of Costs and Profitability

The costs of capture fisheries were higher than those of aquaculture except for the opportunity cost of family labor. Therefore, capture fisheries were more labor intensive than aquaculture. The imputed cost of family labor in capture fisheries (₦ 1,083) exceeded that of aquaculture (₦ 666) by about 63%.

The operating expenses associated with the aquaculture (₦ 3,889) exceeded those of capture fisheries (₦ 3,878) only slightly (0.2%). However, the fixed costs of aquaculture (₦ 3,891) exceeded those of capture fisheries (₦ 1,603) by about 143%. Therefore, aquaculture was more capital intensive than capture fisheries. The total cost of aquaculture (₦ 8,443) exceeded that of capture fisheries (₦ 6,564) by about 29%.

The short-term profitability of aquaculture is more promising than that of capture fisheries. The gross revenue, or value of fish output, associated with aquaculture (₦ 8,069) exceeded that of capture fisheries (₦ 5,978) by about 35%. Similarly, operating profit or gross economic profit associated with aquaculture (₦ 4,183) exceeded that of capture fisheries (₦ 2,100) by 99%.

Nonetheless, net profit was negative in both systems, indicating that capture fisheries and aquaculture are not economically viable in the long run. The returns being generated are not sufficient to cover the fixed costs of production. It appears unlikely that the level of p[illegible]ate investment in feed production in the study area will increase much unl[illegible] programs are created to assist the fishermen and fish farmers in meeting part of the investment capital requirements.

CONCLUSIONS AND POLICY RECOMMENDATIONS

For the long term, neither capture fisheries nor aquaculture is economically viable. These findings are due to the high prices of fishing assets (boats, gear, and outboard engine) and pond construction costs, which shot up rapidly in the wake of the structural adjustment program in 1986.

The capture fisheries deserve policy attention not only to take advantage of their potential for providing employment, but also to ameliorate the negative effects on the fishing subsector of recent structural adjustment policies. The withdrawal of

fuel subsidies (which led to a 200% increase in fuel prices between 1985 and 1989), increases in the tariff on imported fishing inputs, and the devaluation of the Naira (which makes imports expensive) have combined to limit the profitability of capture fisheries. The future economic viability of capture fisheries and aquaculture depends on the government creating policies to provide fishery infrastructure, credit, and modern inputs at subsidized prices.

More-effective extension services must be provided to inexperienced fish farmers. Experienced farmers used factor inputs more productively than their inexperienced counterparts. They also had more-extensive contacts with zonal fishery officers; some even engaged the services of aquaculture specialists from the fishery division of the Ministry of Agriculture and Natural Resources for fish harvesting. Inexperienced farmers also need the benefits of such expert advice. Capture fishermen need better support from the extension system, too. Although Nigeria has three research institutions that are engaged in research on fisheries, their findings are not being effectively transferred to fishermen.

The fishermen allocate fishing inputs inefficiently despite the fact that fisheries have a long history. Those interviewed claimed not to have had contact with any extension agent. Extension workers should work with the fishermen both in the fishing villages and at sea to demonstrate improved gear, equipment, machinery, and techniques. The workers also could help control mesh sizes and enforce other regulatory measures aimed at preventing the depletion of immature fish and the overexploitation of fish species.

The aquaculture technology currently in use has limited potential for sustained growth of fish production in the study area. Pond capacity is currently being underused because the supply of fingerlings is inadequate. Besides a small quantity of fingerlings obtained from the wild, the aquaculture section of the state's fishery division has been the major source of supply, but it has not been able to cope with the recent level of demand. Therefore, the state government should expedite the completion of the two hatchery projects that have been initiated. Fingerlings should be sold to fish farmers at subsidized prices. The subsidy would enhance the profitability of aquaculture and induce greater participation in the business by the private sector. Fish feeds are scarce and expensive. The locally obtainable feed materials such as wheat offal, rice bran, pawpaw, and poultry waste are not effective substitutes for commercial feeds because supplies are inadequate and irregular. Ondo State does not have commercial production of fish feed. Considering the financial and logistical difficulties of constructing ponds, the Owena River Basin and Rural Development Authority should provide technical services for pond excavation at moderate charges.

In the capture fisheries, the crucial inputs such as nylon fishing nets and outboard engines are still being imported into the country; but because of the current policy of exchange-rate deregulation, prices are high. Fishermen can no longer purchase these inputs. If the government provides the inputs at subsidized prices, the long-term viability of capture fisheries will be assured.

Fishermen cannot compete in the input market because they lack the financial resources. The state should seek funds from the Nigerian Agricultural and Cooperative Bank to lend to fishermen and fish farmers: the availability of credit will be an important incentive to enter the business.

If these recommended policies are implemented, poverty in the fishing communities will be reduced and protein intake will be increased. Instead of using foreign exchange to import fish, it could be used to import inputs that would let Nigeria produce its own supply of fish.

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Table 1. Mean resources used in capture fisheries, Ondo State, Nigeria, 1987-88.

Resources and management factors	Double engine canoe fisheries	Single engine canoe fisheries	All capture fisheries
Fishing boat (₦)	297.48	89.31	177.34
Fishing net (₦)	861.73	317.74	547.77
Outboard engine (₦)	1,102.95	712.43	877.56
Fuel and lubricant (₦)	2,753.82	1,479.93	2,018.61
Family labor (hrs)	415.29	572.21	505.86
Hired labor (hrs)	160	6.29	71.29
Fishing team (number)	4	3	3
Education (yrs)	2.32	3.15	2.8
Fishing experience (yrs)	31	29	30
Age (yrs)	48.22	48.7	48.49

Note: The values shown for fishing boat, net, and outboard engine represent rental prices, not purchase prices.

Table 2. Mean resources used per farmer in aquaculture, Ondo State, Nigeria, 1987-88 production season.

Resources and management factors	Experienced fish farmers	Inexperienced fish farmers	All fish farmers
Pond size (ha)	0.83	1.09	0.98
Fingerlings (number)	2,394	2,623	2,520
Feed (₦)	1,045.00	1,219.45	1,140.95
Labor (hrs)	492.5	374.82	427.77
Fertilizer (₦)	53.88	41.36	47.00
Fixed assets (₦)	2,858.50	4,736.05	3,891.15
Age (yrs)	47.11	43.04	44.87
Education (yrs)	5.22	7.81	6.65
Fish-farming experience (yrs)	5.88	2.27	3.9

Table 3. Results of production functions estimated for capture fisheries, Ondo State, Nigeria, 1987-88 production season.

Regressors	Double engine canoe fisheries	Single engine canoe fisheries	All fisheries: Wet season	All fisheries: Dry season
Constant	2.879	4.703	4.845	2.867
Fuel	0.207*	0.508**	-0.017	0.987**
			(0.04)	
Family labor	-0.006	-0.101	-0.01	-0.168**
	(0.113)	(0.069)	(0.045)	(0.065)
Hired labor	0.01	0.003	0.055*	-0.05
	(0.034)	(0.113)	(0.025)	(0.037)
Fixed capital	0.049	-0.058	0.066	-0.081
	(0.063)	(0.154)	(0.052)	(0.082)
Age	1.025*	0.321	0.922**	0.004
	(0.484)	(0.906)	(0.373)	(0.148)
Education	0.106	-0.082	-0.098	0.004
	(0.248)	(0.17)	(0.373)	(0.148)
Experience	-0.209	-0.009	-0.169	0.022
	(0.211)	(0.333)	(0.143)	(0.222)
R^2	0.17	0.38	0.19	0.78

* $p < 0.05$ (one-tailed test). ** $p < 0.01$ (one-tailed test).
Note: Numbers in parenthesis are standard errors.

Table 4. Factor-product elasticity (FPE), average product (AP), and marginal product (MP) in capture fisheries, by fishery type, Ondo State, Nigeria, 1987-88 production season.

Factor inputs	Double engine canoe fisheries: FPE	AP	MP	Single engine canoe fisheries: FPE	AP	MP
Fuel	0.207	2.905	0.601	0.508	4.097	2.081
Family labor	-0.006	22.524	-0.135	-0.101	8.319	0.84
Hired labor	0.01	-60.774	1.608	0.003	1,732.811	5.198
Fixed capital (fishing asset)	0.049	4.223	0.207	-0.058	4.826	-0.279

Table 5. Factor-product elasticity (FPE), average product (AP), and marginal product (MP) in capture fisheries, by season, Ondo State, Nigeria, 1987-88 production season.

Factor inputs	Wet season			Dry season		
	FPE	AP	MP	FPE	AP	MP
Fuel	-0.017	3.884	-0.066	0.987	3.228	3.186
Family labor	-0.01	13.762	-0.138	-0.168	11.664	-1.959
Hired labor	0.055	957.667	52.672	-0.05	417.841	-20.892
Fixed capital (fishing asset)	0.066	4.92	0.325	-0.081	4.224	-0.342

Table 6. Results of production functions estimated for aquaculture, Ondo State, Nigeria, 1987-88 production season.

Regressors	Experienced fish farmers		Inexperienced fish farmers		All fish farmers	
	Per farm	Per hectare	Per farm	Per hectare	Per farm	Per hectare
Constant	3.963	3.093	6.806	6.731	4.505	4.309
Pond size	0.179		0.423		0.337	
	(0.343)		(0.376)		(0.216)	
Fingerlings	0.259**	0.321*	0.144	0.143	0.235*	0.291*
	(0.155)	(0.144)	(0.2)	(0.188)	(0.113)	(0.111)
Feed	0.028	-0.003	-0.264	-0.255	0.066	0.026
	(0.1)	(0.097)	(0.229)	(0.189)	(0.078)	(0.076)
Labor	0.089	0.193	0.69**	0.678*	0.042	0.109
	(0.257)	(0.238)	(0.397)	(0.397)	(0.156)	(0.156)
Fertilizer	0.038	0.026	-0.024	-0.025	-0.034	-0.042
	(0.087)	(0.087)	(0.081)	(0.076)	(0.051)	(0.052)
Fixed capital	0.155	0.153	0.051	0.051	0.102*	0.096*
	(0.102)	(0.102)	(0.077)	(0.072)	(0.052)	(0.053)
Age	-0.007	-0.038	-0.231	-0.21	0.303	0.211
	(0.513)	(0.513)	(0.789)	(0.705)	(0.364)	(0.371)
Education	-0.058	-0.035	-0.078	-0.078	-0.139	-0.128)
	(0.157)	(0.153)	(0.199)	(0.187)	(0.102)	(0.105)
Experience	1.240*	1.429*	-0.305	-0.298	0.317*	0.361*
	(0.675)	(0.653)	(0.434)	(0.401)	(0.177)	(0.18)
R^2	0.68	0.58	0.74	0.49	0.61	0.47

* $p < 0.05$ (one-tailed test). ** $p < 0.01$ (one-tailed test).
Note: Numbers in parenthesis are standard errors.

Table 7. Factor-product elasticity (FPE), average product (AP), and marginal product (MP) in aquaculture, Ondo State, Nigeria, 1987-88 production season.

Factor inputs	Experienced fish farmers			Inexperienced fish farmers		
	FPE	AP	MP	FPE	AP	MP
Fingerlings	0.259	3.034	0.786	0.144	4.032	0.581
Feed	0.028	11.599	0.325	-0.264	671.423	-16.144
Labor	0.089	19.796	1.762	0.69	19.484	13.444
Fertilizer	0.038	560.764	21.309	0.024	671.423	-16.144
Fixed capital	0.155	4.587	0.711	0.051	13.621	0.695

Table 8. Production costs per fisherman in capture fisheries, Ondo State, Nigeria, 1987-88 production season.

	Wet season		Dry season	
	SECF	DECF	SECF	DECF
Operating expenses				
Fuel and lubricant	1,317.57	2,977.03	1,645.54	2,530.62
Engine repair	392.41	575.68	656.92	582.29
Net repair	187.37	247.16	151.46	240.22
Boat repair	144.35	164.03	201.12	182.49
Hired labor	15.14	751.14	15.36	825.19
Transportation	145.98	199.19	128.64	148.14
Fish processing	379.61	778.51	347.86	328.05
Total	2,582.43	5,692.74	3,146.90	4,837.00
	(1,015.63)	(2,706.51)	(2,141.15)	(2,919.12)
Fixed costs (rental price)				
Outboard engine	712.28	1,102.95	712.28	1,102.95
Fishing net	292.57	861.73	292.57	861.73
Fishing boat	49.82	297.49	49.82	297.49
Total	1,054.67	2,262.17	1,054.67	2,262.17
	(516.24)	(1,787.64)	(516.24)	(1,787.64)
Opportunity cost of family labor	1,368.81	4,824.24	5,140.32	3,761.05
	(1,815.06)	(3,930.46)	(2,925.09)	(2,137.16)
Total costs	5,005.91	12,779.15	9,341.89	10,860.22
	(1,938.21)	(9,449.32)	(2,909.99)	(2,139.16)

Note: Numbers in parenthesis are standard deviations.

Table 9. Production costs (₦) in aquaculture, Ondo State, Nigeria, 1987-88 production season.

	Per farm	Per hectare of pond area	Per kilogram of fish
Operating expenses			
Fingerlings	1,817.20	2,128.41	3.66
Feed	1,140.95	1,099.29	1.63
Hired labor	820.83	786.72	1.19
Fertilizer	47.00	52.28	0.11
Transportation	60.63	56.63	0.08
Total	3,885.83	4,122.84	6.66
	(3,215.51)	(2,821.12)	(8.43)
Fixed costs (rental price)			
Pond	3,891.15	4,122.08	5.11
	(9,154.17)	(11,280.61)	(10.53)
Opportunity cost of family labor	665.95	564.44	0.62
	(1,066.13)	(813.65)	(0.79)
Total costs	8,442.93	8,809.36	12.53
	(10,437.01)	(12,339.39)	(14.73)

Note: Numbers in parenthesis are standard deviations.

Table 10. Revenue and returns (₦) in capture fisheries Ondo State, Nigeria, 1987-88 production season.

	Wet Season		Dry Season	
	SECF	DECF	SECF	DECF
Gross revenue	5,194.06	6,896.27	5,187.62	7,208.27
	(1,670.42)	(2,554.36)	(1,576.94)	(3,620.88)
Operating profit	2,611.63	1,203.54	2,040.72	2,371.27
	(1,943.97)	(3,317.27)	(2,319.39)	(3,745.77)
Net income	1,556.96	-1,058.62	986.05	109.11
	(2,096.98)	(3,914.12)	(3,460.77)	(4,303.12)
Net profit	188.15	-5,882.86	-4,154.27	-3,651.95
	(2,371.59)	(10,094.55)	(28,877.97)	(2,144.25)

Note: Numbers in parenthesis are standard deviations.

Table 11. Average revenue and returns (₦) in aquaculture Ondo State, Nigeria, 1987-88 production season.

	Per farm	Per hectare of pond area	Per kilogram of fish
Gross revenue	8,068.70	9,229.56	12.82
	(5,655.19)	(5,024.53)	(11.55)
Operating profit	4,182.87	5,106.72	6.16
	(4,667.87)	(4,888.25)	(5.49)
Net income	291.72	984.64	1.05
	(255.19)	(1,045.72)	(1.35)
Net profit	-374.23	420.20	0.43
	(1,038.76)	(248.45)	(2.21)

Note: Numbers in parenthesis are standard deviations.

Table 12. Revenue and returns (₦) in aquaculture by level of farming experience, Ondo State, Nigeria, 1987-88 production season.

	Per farm	Per hectare of pond area	Per kilogram of fish
Gross revenues			
Experienced fish farmers	8,687.44	11,152.18	15.91
Inexperienced fish farmers	7,562.45	7,656.50	10.29
Difference	1,124.99	3,495.68*	5.62
Operating profit			
Experienced fish farmers	4,899.78	6,598.67	8.21
Inexperienced fish farmers	3,596.31	3,886.01	4.49
Difference	1,303.47	2,712.66	3.72
Net income			
Experienced fish farmers	2,041.28	1,513.42	3.85
Inexperienced fish farmers	-1,139.74	552.00	-1.24
Difference	3,181.02	961.42	5.09
Net profit			
Experienced fish farmers	1,275.28	746.41	2.95
Inexperienced fish farmers	-1,723.82	153.31	-1.88
Difference	2,999.10	593.10	4.83

*$p < 0.01$.

THE CONTRIBUTION OF RURAL NONFARM ENTERPRISES TO RURAL EMPLOYMENT IN SOUTHWEST NIGERIA

Olufemi Oludimu

SUMMARY

Small, rural nonfarm enterprises have typically received scant attention from policy-makers in developing countries such as Nigeria. Recent evidence supplied by this and other studies suggests that economic development policies that ignore or impede the growth of the rural nonfarm sector may be misguided.

Nonfarm occupations are a primary source of income for much of the rural labor force in most countries and provide important secondary sources of earnings for smallholder and landless farmers. Available evidence suggests that most of those employed in Nigeria's rural sector work at least part time in nonfarm occupations. Such occupations are diverse, ranging from manufacturing, trading, and repairing farm tools and consumer goods to processing and marketing agricultural products.

A survey was conducted in southwest Nigeria to examine the contribution of nonfarm enterprises to the local rural economy. Twenty-five entrepreneurs from each of four rural villages were interviewed from July to October 1987. Each of the 100 respondents was asked specific questions regarding his or her business, household characteristics, and the adequacy of local resources and social and economic infrastructure. Most of the randomly sampled entrepreneurs were married men between the ages of 20 and 50 and had one spouse and more than one child. Just over half of the respondents had received some formal education, compared to about 20% of the local farm population. More than two-thirds of those surveyed had more than 10 years of experience in nonfarm occupations, and half of those surveyed had more than 20 years' experience in their stated business. While some had begun their current occupations as youths, others turned to nonfarm occupations to supplement or replace low or fluctuating agricultural incomes.

One-third of those interviewed were engaged in trade. Smoking fish, carpentry, and bricklaying each occupied another 11% to 16% of respondents. The remaining 26% of respondents were

employed in tailoring, painting, grinding, teaching, baking, or welding and tinkering. Most of the businesses were inherited or started with nominal financial investments. Only one of the 100 businesses had ever been granted a bank loan. The rest relied on personal savings, informal loans, and assistance from friends and relatives.

These small-scale, rural nonfarm businesses relied on hand tools and apprentice labor. Ninety-seven of the 100 respondents reported employing only one or two additional workers, and at least half of these workers were unpaid apprentices at the time of the survey. Less than one-fourth of those surveyed used power-driven machines, and only a few businesses relied upon electricity from the national grid.

The four villages offered some, though not all, of the physical and social infrastructure desired by local residents. Respondents complained about a shortage of storage and transportation facilities, poor road and waterway systems, a lack of social and recreational facilities, poor access to bank credit and business development funds, and an inconsistent supply of electricity from the national grid. Other problems mentioned included a shortage of affordable skilled workers and scarcity and high cost of improved tools and raw materials. The lack of infrastructure, high-paying jobs, and adequate social amenities in Nigeria's rural areas is blamed for the steady migration of young rural workers to urban areas.

Despite these obstacles, most of the respondents appeared to be receiving a reasonable return for their efforts. Nearly half of those interviewed estimated that they grossed more than ₦ 5,000 in 1986, while a few that operated on a consistently large scale earned more than ₦ 10,000 in gross revenues -- the equivalent of a university lecturer's annual salary in Nigeria. In addition to enhancing rural income levels, nonfarm industries help to stabilize the rural economy by providing consumer goods and services to the rural populace, producing inexpensive farm tools and equipment, transporting goods between rural and urban markets, storing and processing farm products, and providing jobs and training for the rural population.

Principal component analysis and stepwise, variable-inclusion, multiple regression analysis techniques were used to gauge the relationship between various factors measured in the field study and the size and success of nonfarm enterprises. The availability of funding sources and electrical energy were positively linked with the size of enterprises' physical production; trade-group membership was more closely associated with firms that had a smaller output. The availability of electricity was also positively associated with the 1986 financial returns of nonfarm enterprises. The cost of equipment was negatively tied to that year's financial returns, which reflected, in part, the scarcity and high cost of improved tools, equipment, and spare parts needed for some nonfarm operations.

The findings of this study support the argument that further development of the nonfarm sector would increase rural income levels and living standards and thus reduce interregional inequalities in income and opportunities. Because of the role of off-farm employment in

stabilizing and enhancing the rural economy, any future policies aimed at food security and rural development must consider rural nonfarm enterprises. Therefore,

- Rural, nonfarm firms -- particularly those that assist agriculture by providing necessary farm tools, services, or markets for farm products -- should be encouraged to grow and develop.
- Adequate social, physical, and economic infrastructure should be provided in rural areas.
- Nonfarm firms should form cooperatives to facilitate the extension of credit.
- Banks and lending institutions should provide capital to small, rural nonfarm businesses.

In the rush to spur economic development and obtain food security in developing countries such as Nigeria, attention has centered on urban industrial growth and expanding farm output. Small, rural nonfarm enterprises have typically been overlooked by development strategists and have suffered from discriminatory government policies. Recent evidence supplied by this and other studies suggests that development policies that ignore or impede the growth of the rural nonfarm sector may be misguided.

Developing countries commonly apply the surplus generated from agricultural production strategies disproportionately to the urban industrial sector. Rural-urban income differentials and limited rural employment opportunities have encouraged a steady migration of workers from rural to urban areas. So policies are needed that can help create and support rural nonfarm enterprises and thus boost and stabilize the rural farm economy.

Following an overview of the status of rural employment in developing countries, this paper examines the nature and extent of nonfarm employment in four rural villages in southwest Nigeria to evaluate the contribution of such employment to the rural economy and to determine ways in which job and investment opportunities can be improved in rural areas.

IMPORTANCE AND STRUCTURE OF RURAL NONFARM EMPLOYMENT

Nonfarm occupations are a primary source of income for much of the rural labor force in most developed and developing countries, and they provide important secondary sources of earnings for smallholder and landless farmers. For example, Meyer and Larson (1978) reported that in Taiwan, Japan, and South Korea, between 1960 and 1975, income earned from employment in small, rural nonfarm firms accounted for 50% to 90% of total income for families with farms of less than 0.5 ha, about 30% to 50% of total income for families with farms of 0.5 ha to 2.0 ha, and 15% to 30% of total income for families with farms over 2.0 ha.

Although Nigeria's rural nonfarm sector has only recently been singled out as a distinct economic sector for development analyses, available evidence suggests that most of those employed in the rural sector work at least part time in nonfarm occupations. Full-time farmers find it necessary to participate in one nonfarm activity or another to make ends meet. In a study of western Nigeria, the International Labor Organization (1970, pp. 117-118) found that the primary occupations of as much as 20% of the rural labor force may be nonagricultural. ILO's study results indicated that rural industries were usually family owned and labor intensive and used largely family labor, traditional technologies, and few purchased capital goods. Similarly, Dennis and Mark (1978) cited a study by Norman that found that adult males in the major village of Mahawanyi in the Zaria region of Nigeria spent an average of 47% of their working time on nonfarm occupations.

Dennis and Mark (1978) also found that, apparently, rural areas and towns provided over two-thirds of all nonfarm employment opportunities in African countries, as compared with half to two-thirds in South and East Asia and one-third in Latin America. The wider dispersion of nonfarm activities in most African countries likely results from having a larger proportion of the populace engaged in agriculture. In Asian and West African regions, where 70% to 90% of the total labor force resides in rural areas, more than one-third of all new workers that have stayed in rural areas have opted out of farming (Dennis and Mark, 1978). Rural nonfarm activities have thus become increasingly important as a source of employment in rural areas.

Rural nonfarm enterprises are diverse as well as widespread. They commonly include such activities as the manufacturing, trading, and repairing consumer goods; processing and marketing agricultural products; and manufacturing agricultural inputs such as hand tools. For example, as jobs have become more specialized in rural Nigeria, more rural women have found employment in areas

such as processing food, trading, textiles, making clothes, and providing medical and personal care. The dyeing industry, which uses both synthetic and vegetable dyes, is widely diffused throughout northern and western Nigeria. The Awka people of eastern Nigeria are well known for their woodworking industry. Transportation, construction, and blacksmithing also are important industries in rural Nigeria.

Rural nonfarm enterprises have many societal benefits. In contrast to the larger, more modern enterprises common to urban areas, small, rural nonfarm firms typically

- employ substantial unskilled and uneducated labor
- rely on local resources
- are less capital intensive
- require little foreign exchange
- reduce inter-regional inequalities in income and services
- encourage agricultural investments
- help to link the product and labor markets to small farms

Rural nonfarm enterprises can play an important role in stabilizing the rural economy by providing needed off-farm employment, farm-related services, and consumer goods and services demanded by the rural populace. These firms also produce some goods for export and provide essential training in nonfarm work to rural inhabitants.

The growth and well-being of rural nonfarm industries, in turn, depend largely upon the well-being of the agricultural sector they support. As pointed out by Byerlee and Eicher (1972), sufficient labor, capital, and raw materials must be available to operate a nonfarm industry, and satisfactory markets must exist for finished products and services. Dennis and Mark (1978) maintained that the level, composition, and growth of rural nonfarm employment is derived from the effective demand for three types of nonfarm goods and services:

- nonfood goods and services, the demand for which rises as rural incomes increase

- inputs and services to agriculture such as transportation, processing, and equipment manufacture and repair

- manufactured goods and handicrafts, the demand for which stems largely from markets in other regions or countries

Several authors have stressed the importance of improving rural infrastructure to enhance the growth of markets for rural products (Fei and Ranis, 1964; Meyer and Larson, 1978; Anderson and Leiserson, 1980; Chadha, 1983; Khuda, 1985). Rural infrastructure (such as roads) and educational and health facilities are commonly cited as major potential contributors to rural nonfarm development. Also of great importance is access to modern technology such as electricity, motorized equipment, and improved tools and mechanical devices.

One of the most critical problems faced by the rural sector is an acute shortage of working capital with which to start up or improve nonfarm enterprises. As Ramakrishna (1962, p.5) explained, adequate financing is a prerequisite to properly organizing production, purchasing raw materials, and investing capital in manufacture. It will affect the ultimate profit of a venture. Meyer (1980) stressed that nonfarm rural enterprises depend largely on informal sources of credit, which are often found to be more costly and less stable than formal ones. Similarly, Kilby (1981) emphasized the important relationship between small rural enterprises and the short-term capital market, noting that lack of capital is a major constraint to rural development and that capital markets have poorly served the rural nonfarm sector.

Three distinct strategies were offered by Meyer and Larson (1978) for improving rural credit:

- revise commercial-bank credit policies

- increase services of development banks to small, rural nonfarm firms

- establish specialized financing institutions for small, rural nonfarm firms

These authors also suggested that increased farm mechanization would release labor that could then be used to increase both farm and nonfarm work, and they recommended study of the broader, long-term consequences of promoting small, rural nonfarm firms.

SOUTHWEST NIGERIA CASE STUDY: DATA COLLECTION AND RESULTS

A survey was conducted in four villages in southwest Nigeria to gain a better understanding of the contribution of nonfarm activities to rural employment in the area. The villages were selected from four local government areas (LGAs) in two of Nigeria's 21 states. Two of the villages, Okeluse (Epe LGA of Lagos State) and Oriba (Ilaje/Ese Odo LGA of Ondo State), were selected from riverine areas, where occupations tend to be water related. The other two villages selected for study, Abule-Eko (Ikorodu LGA of Lagos State) and Igbo (Owo LGA of Ondo State) are land-bound, agriculturally based communities. The State Ministry of Agriculture and Natural Resources assisted in identifying and selecting of the villages for the study.

Twenty-five people with nonfarm occupations were randomly selected from each of the four villages and interviewed, for a total of 100 survey respondents. Structured questionnaires were administered from July to October 1987.

The respondents were questioned about household socioeconomic and cultural characteristics, the operation of nonfarm businesses, and the availability of natural resources, modern technology, physical and social infrastructure, and financial assistance in the local area.

Socioeconomic Profile of Survey Respondents

Of the 100 individuals interviewed, 72% were male and 28% were female. Nearly 80% of the female respondents were from the river communities of Okeluse and Oriba. In Nigeria most farmers are either under 20 or over 50 years of age; but most of those interviewed with nonfarm occupations were in their productive middle years. Eighty-two percent of the respondents were 20 to 49 years of age; the modal age bracket was 20 to 29 (see table 1). Indeed, all of the randomly selected respondents from the village of Igbo were between 20 and 49 years old. This augurs well for the continued productivity of nonfarm labor and may indicate a gradual shift of the rural population from farming to nonfarm activities.

Almost all of those surveyed were married or had been married at some time. Seventy-five percent of the male respondents were currently married, as were 68% of the female respondents. The 19 married female respondents had one husband each, while 24 of the 54 married male respondents had two or three wives each. Half of the respondents had fewer than five children. Most of those respondents with five children or more belonged to polygamous families. On average, households included more female children than male children. This

may have contributed to the survey finding that occupations requiring manual labor received little assistance from the family's children and instead used apprentices or hired laborers. Nearly half of the respondents' spouses were engaged in trading. About 22% processed food, 14% farmed, 10% were teachers, and the remainder either fished or were employed as tailors or religious workers (see table 1).

Fifty-three percent of survey respondents described themselves as Christians; 45% described themselves as Muslims. The survey sample also included one atheist and one individual who worshipped Ogun, the god of iron.

A majority of the individuals surveyed had received some formal education, although only 11 had attended secondary, postsecondary, or vocational schools. Only 46% had no formal schooling, whereas about 80% of the farmers in the study area have no formal education. The survey results indicate, therefore, that while formal schooling is not a prerequisite for nonfarm occupations, a nonfarm worker is more likely to have received formal schooling than is a farmer in the study area. Schooling has been found to positively affect off-farm work by operators (Summer, 1982). For example, as Sander (1984) pointed out, schooling has a positive effect on off-farm hours for farm women because it increases the value of time in the women's work.

Characteristics such as the respondent's amount of formal education and annual number of visits to urban centers may indicate his or her ability to operate an enterprise successfully. Visits to urban centers could broaden occupational horizons and expose visitors to innovations. All but two of those surveyed made at least one trip to a nearby urban center in 1986 to sell their products, buy raw materials, or visit relatives. Although most respondents made only one or two trips to urban centers in 1986, 40% of those interviewed traveled to urban centers five or more times during the year. Establishing a definite relationship between visits to urban areas and success in nonfarm occupations is beyond the scope of this study; however, a number of those interviewed reported that they benefited from observing the management techniques of similar small-scale operations and from discovering new market outlets while on such excursions.

Almost all of the respondents appeared to be committed to remaining in their respective communities: All but two of the respondents said they expected to reside in their current villages for at least the next 5 years. Fifty-six of the respondents believed the nature of their jobs would not permit them to leave, 24 expressed satisfaction with village life, 15 reported family hindrances to leaving, 6 felt their advanced age prevented them from leaving, and 2 felt compelled to remain because they were village chiefs. The two individuals who said they were willing to leave their villages complained of a lack of capital to pursue their

occupations. One was a carpenter and the other a tailor. Both said the opportunities for their businesses might be better in the city.

In a largely illiterate population, experience is crucial. More than two-thirds of the respondents had more than 10 years of experience in nonfarm occupations at the time of the survey; half had more than 20 years of experience; 18% had more than 40 years of experience. Some respondents had been engaged in nonfarm enterprises since their youth or had inherited such enterprises from parents or other relatives. Others reported that they had stopped farming many years ago because agricultural incomes were too low. Still others began their nonfarm occupations in an effort to stabilize fluctuating farm incomes.

Characteristics of Nonfarm Occupations

Almost all of the nonfarm occupations encountered in the survey can be classified as trading/retailing or processing/manufacture. One-third of those interviewed were engaged in trading. Smoking fish, carpentry, and bricklaying each occupied another 11% to 16% of respondents. The remaining 26% of respondents were employed in tailoring, painting, grinding, teaching, baking, or welding and tinkering (see table 2).

The overwhelming majority of firms operated on a small scale. Equipment was limited to hand tools for more than three-fourths of the firms surveyed, although 22 respondents used power-driven machines. Only a few businesses relied upon electricity from the national grid.

Most of the respondents started their nonfarm ventures with nominal financial investments. As many as 36 respondents started with less than ₦ 200 each, many years ago. Sixty-six of the respondents started with ₦ 400 or less, and only two respondents started with investments greater than ₦ 800. Personal savings and gifts from relatives were the principal sources of initial investment capital (see table 2). Only 22 respondents reported receiving loans of any kind to start their nonfarm enterprises, and only one respondent reported receiving a loan from a formal institution such as a bank. Most of those who did not borrow money believed their trades or occupations were too small to require or allow for the use of borrowed funds. Some respondents who had wished to obtain bank loans to finance a larger initial capital outlay found they had insufficient collateral to back such loan requests. Others mentioned that the problems they encountered when they sought formal loans encouraged them to remain self-reliant.

The small-scale nature of the rural nonfarm businesses surveyed is further typified by the small number of workers employed in each enterprise. Ninety-

seven of the 100 respondents reported employing only one or two additional workers. The remaining three respondents, all from the village of Oriba, each employed four workers.

At least half of the workers employed by respondents were unpaid apprentices at the time of the survey. Ninety percent of those interviewed reported that at least one of the workers they employed was unpaid, and 62% of those surveyed reported spending no money on employees in 1986. Respondents mentioned that in the past it was common to employ more than two apprentices, but this practice has become less typical as more rural youth have elected to attend formal educational institutions rather than serve apprenticeships. An apprentice typically signs an agreement to understudy the employer for a defined period of time, usually 3 years. Although most apprentices are not paid regularly, some receive food allowances and an occasional cash gift.

On average, respondents spent more money on raw materials than on employees in 1986, although the amounts spent in each category were low. Only 22% of the respondents spent more than ₦ 100 on employees, whereas 64% of the respondents paid more than ₦ 100 for raw materials. Similarly, none of the respondents devoted more than ₦ 400 to employees, and only 12% of those surveyed spent more than ₦ 400 for raw materials.

Information obtained from field work was insufficient to determine precisely the net revenues earned from each enterprise. A number of respondents refused to provide full and accurate answers to questions on business costs and returns out of concern that such answers might be used to assess taxes. However, judging from the amounts spent on raw materials, depreciation of fixed equipment, and payments to labor vis-a-vis gross returns, it appears that most of the respondents were receiving reasonable returns to managerial effort. Gross returns for 1986 were estimated to exceed ₦ 5,000 for 46% of those interviewed (see table 2). The few that operated on a consistently large scale received annual amounts of ₦ 10,000 and above, earnings comparable to a university lecturer's annual salary in Nigeria. Although such figures do not prove that off-farm employment contributes to a more equitable distribution of income, rural households participating in such work would clearly be worse off in the absence of such employment opportunities.

Resource Availability in Rural Areas

As expected, farmland was found to be abundant in the two land-based communities and scarce in the two riverine communities. No major farm-related activities were conducted in the riverine areas. Although streams were readily available in both land-based and riverine villages, the riverine villages depended

more than land-based villages on fishing and other water-related activities. Rivers and streams also provided local inhabitants with drinking water, wash water, and transportation.

Rainfall followed conventional patterns in the study area (see Agboola, 1979). The riverine communities lie in the rain-forest zone of Nigeria, where annual precipitation is generally higher than in outlying areas. Local fishermen complained that irregular rainfall had often adversely affected their catch and, therefore, their income. This in turn adversely affected the income of fish smokers. Cement-block makers, bricklayers, and painters also reported that untimely rainfall was detrimental to their work.

Modern technology -- improved tools, mechanical devices, and motorized equipment -- were present in the villages studied, but respondents reported that such items were scarce. Improved tools and mechanical and motorized equipment that were observed by interviewers or that respondents said were in use included Yamaha 80 engines for driving fishing boats, electric grinders for processing pepper and cassava, wood mallets for carpentry, "Owin" needles for repairing damaged fishing nets, block-making machines, compressors, and electric sewing machines. When asked how important the use of modern tools and machines were to nonfarm occupations, 51% of the respondents said they were very important; 18%, important; 4%, not very important; 8%, not at all important; 19%, not relevant to their trade. Not all of those who claimed these modern tools were important had access to them, particularly in the riverine areas.

The adequacy of a community's physical and social infrastructure also affects local business development. A reliable system of roads and transportation and access to markets, credit institutions, storage facilities, raw-material providers, energy sources, processors, and repair facilities are all necessary for sustained business growth and development. Additional infrastructure such as social, recreational, educational, and health-care facilities are important to attract and retain an adequate work force. Much of the migration of rural nonfarm workers to the cities has been attributed to the disparity in rural and urban amenities.

The four villages studied offered some, though not all, of the physical and social infrastructure desired by local residents. Respondents complained of a shortage of storage and transportation facilities, poor road and waterway systems, a lack of social and recreational facilities, poor access to credit or other business development funds, and inconsistency in the supply of electricity from the national grid. Other problems mentioned included a shortage of skilled labor, scarcity and high cost of raw materials, and protracted procedures for obtaining any necessary licenses.

Contribution of Nonfarm Occupations to the Rural Economy

The 100 individuals surveyed were asked what they felt was the most important contribution of nonfarm occupations to the rural economy. More than one-third named increased jobs and rural income; 28%, provision of processed foods; 10%, provision of affordable housing materials; 7%, provision of markets for agricultural and industrial products (see table 3).

When asked how the government could assist nonfarm enterprises, most of the respondents spoke of the need for financial aid or credit. Because some profitable businesses require large capital investments to get started, which are beyond the means of would-be local entrepreneurs, respondents felt the entire local economy would benefit if the government offered start-up funds. Respondents also proposed that the government formulate policies that would increase the availability of inputs necessary to develop nonfarm trades and occupations. Only four of the individuals surveyed had no response to the question.

ANALYSIS OF FACTORS CONTRIBUTING TO ENTERPRISE SUCCESS

Business success can be measured in many ways. In this case, it is convenient to measure business success by two standards: size of operation and annual revenues produced. The field survey highlighted many factors, ranging from family size and level of education to natural resource availability and number of employees, that could affect the success of a nonfarm enterprise. However, every variable examined in the field study could not be included in one regression equation: The number of independent variables would be so large and intercorrelated that the analysis would fail for lack of adequate degrees of freedom aggravated by problems of multicollinearity. Therefore, the technique of principal component analysis was used to reduce the number of explanatory variables used in the regression equation to a reasonable number of important, essentially independent, composite variables.

Principal Component Analysis

As authors such as Kleinbaum and Kupper (1978) and Nie, Hall, Jenkins, Steinbrenner, and Bent (1975) point out, the single most distinctive characteristic of principal component analysis is its data reduction capability. Given an array of correlation coefficients for a set of variables, this technique

reveals any underlying pattern of relationships that makes it possible for the data to be rearranged or reduced into a smaller set of factors or components that can then be used as variables in a standard multiple regression analysis. Principal component analysis thus provides a method by which a given set of variables can be transformed into a new set of composite variables or principal components that are essentially orthogonal, or uncorrelated, with each other.

The three basic steps involved are as follows:

- Prepare the correlation matrix using the entire set of observations on the original variables.
- Extract the initial factors, which will ideally be few and essentially independent.
- Rotate the matrix axes to achieve conceptually meaningful factors for use in further regression analysis.

The first principal component is selected as that weighted linear combination of the variables that accounts for the largest amount of total variation in the data. The second principal component is then selected as that weighted linear combination of the variables that is orthogonal to the first principal component and that accounts for the maximum amount of the remaining total variation in the data. Subsequent components are similarly defined until all the variance in the data is exhausted. Frequently, economic and social data is so highly intercorrelated that a small number of components account for a large proportion of the total variation in the data.

When principal component analysis techniques were performed on the 32 original field study variables, using an orthogonal rotation of the matrix axes, 11 factors loaded highly and distinctively, accounting for over 74% of the total variation in the data. The variables that provide high individual contributions to factors give such factors name and meaning. In this case, most variables loaded both highly and distinctively, leaving their mark on a particular factor. One exception was factor 05, where two variables -- number of spouses and spouse's occupation -- loaded highly and almost equally. Their combined effect is termed "number of spouses assisting in the respondents' business." The 11 principal components, or factors, were as follows:

Factor 01	number of male children
Factor 02	years of marital experience
Factor 03	financial returns
Factor 04	trade-group membership
Factor 05	number of spouses assisting in respondents' business

Factor 06	number of employees
Factor 07	source of funds
Factor 08	raw materials
Factor 09	cost of equipment
Factor 10	electric power availability
Factor 11	size of physical production

Multiple Regression Analysis

Two of the factors that loaded distinctively -- size of financial returns and size of physical production -- were used as the dependent variables in the multiple regression analysis. The regression models were thus expressed as

$$F_{11} = f(F_1, F_2, F_3, F_4, F_5, F_6, F_7, F_8, F_9, F_{10}, U)$$

and

$$F_3 = f(F_1, F_2, F_4, F_5, F_6, F_7, F_8, F_9, F_{10}, F_{11}, U)$$

where F_1 through F_{11} are the 11 principal components defined above and U is the independent error term.

Linear, semi-logarithmic, and double-logarithmic algebraic forms of the models were tested using the stepwise, variable-inclusion, regression technique. Coefficients of the resulting regression equations were tested, and lead equations were derived (see table 4).

Of the equations that best explain the size of physical production, the linearized, double-logarithmic equation exhibits the highest F-value and the highest value for the adjusted coefficient of multiple determination (R^2). Moreover, three of its variables -- trade-group membership, sources of funds, and availability of electricity -- were found to have coefficients that were significant at the 5% level. The fourth variable, marital experience, did not produce a statistically significant coefficient. Thus, while marital status was not found to contribute significantly to the size of physical production among the nonfarming activities studied, linkage was found between the size of physical production and respondents' sources and uses of funds.

The results of the field study indicated that respondents' ability to obtain credit was related to their personal savings levels and loan objectives. Borrowers were typically expected to have personal savings of their own or to rely on assistance from close relatives and friends. Such initial contributions were seen as indicating the determination of the respondent to succeed in the chosen enterprise and provided some positive reassurance to potential future lenders.

Contrary to expectations, trade-group membership was negatively related to the size of nonfarm enterprises' physical production. Presumably, respondents with high output levels did not feel as compelled to form or join trade groups. Possibly trade groups are primarily of help to new and small-scale entrepreneurs who are still learning the business or who are otherwise dependent on the larger group. Although Adeyemo and Malone (1984) found that members derived benefits from their cooperatives, Okuneye (1985) showed that membership in trade groups did not improve the flow of funds to its members and was of limited assistance in providing information on alternative ways to solve entrepreneurs' financial management problems.

The variable representing the availability of electrical energy produced a positive and significant regression coefficient, supporting the claim that enterprises benefit from access to electric power. Certainly, electrically powered tools and equipment permit a higher rate of production. The field study revealed that an increasing number of nonfarm activities engaged in by the respondents, such as welding, grinding, and baking, relied on the use of electric power.

The coefficient for electrical energy supply was also positive and significant in the linear regression equation where level of financial returns was specified as the dependent variable, indicating a positive relationship between the use of electric power and enhanced financial returns.

The highest R^2 for the financial return equations tested was produced using a semi-logarithmic function with marital experience, cost of equipment, and raw materials specified as the independent variables. In this case, all of the coefficients were negative, and only the coefficients for marital experience and cost of equipment were significant at the 5% level. One conclusion is that higher expenditures on equipment do not immediately or necessarily manifest themselves in higher financial returns to the enterprise. However, because nonfarm occupations tend to require a sizeable investment in machines, tools, and accessories, the issue may revolve more around the high cost of such items and the difficulty in maintaining and repairing them than in the advisability of their purchase. The field survey found machines and improved tools and equipment to be both scarce and costly. Furthermore, it was difficult to obtain spare parts for machines.

POLICY IMPLICATIONS

Field survey results indicate that rural nonfarm enterprises play an important role in providing jobs, income, and goods and services to rural communities in southwestern Nigeria. Most such enterprises are small scale, relying primarily on

hand tools, local materials, and family and apprentice labor. Gender, religion, and marital status do not appear to provide a barrier to participating in nonfarm occupations. Similarly, lack of education is not a visible barrier to nonfarm entrepreneurship.

Only small amounts of capital are needed to start most of the nonfarm occupations surveyed, although such small investments are apt to limit an operation's production possibilities. Bank loans are rare and have been difficult for small rural businesses to obtain, forcing most rural entrepreneurs to rely on personal savings and informal local funding sources. Credit should not be allowed to be the limiting factor to the expansion and progress of rural nonfarm activities.

Rural nonfarm enterprises are also hampered by inadequate social and economic infrastructure, insufficient access to markets, and the scarcity and high cost of labor, spare parts, and improved tools and machines. The lack of rural infrastructure, high-paying jobs, and social amenities has encouraged a steady migration of youthful workers from rural to urban settings, exacerbating the rural economic dilemma. Rural nonfarm enterprises employed younger workers than farming, which indicates that additional rural nonfarm job opportunities would help to stem the migration of younger workers to cities.

Study results clearly indicated that the development of the nonfarm sector would increase the income levels and raise the living standards of the rural populace, reducing interregional inequalities in income and opportunities. Toward this end, the following recommendations are offered.

- The establishment of small and medium-sized nonfarm industries, especially those that manufacture farm tools and equipment or that use agricultural produce as raw materials, should be encouraged.

- Nonfarm firms should form cooperatives to facilitate the extension of credit.

- Adequate social, physical, and economic infrastructure should be provided in rural areas to reduce the rate of migration to the cities and to provide necessary support to rural entrepreneurs. Roads and educational and health facilities merit particular consideration. Access to modern technology, such as electricity, improved tools, modern mechanical devices, and motorized equipment, is also important.

- Banks and other formal lending institutions should extend more credit to operators of rural nonfarm businesses. The opening of rural branches

should be accelerated and a greater percentage of deposits collected in such areas should be distributed as loans to the rural populace.

The findings of this study indicate that off-farm employment can influence the welfare of the rural population and should, therefore, be considered an important aspect of rural development policy.

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Table 1. Socioeconomic characteristics of survey respondents, southwest Nigeria, 1987-88.

Characteristic	No. of respondents				Total
	Okeluse	Abule-Eko	Oriba	Igbo	
Sex					
Male	12	21	16	23	72
Female	13	4	9	2	28
Age					
< 20 years	2	2	4	0	8
20-29	7	9	8	16	40
30-39	10	5	6	7	28
40-49	2	6	4	2	14
50+	4	3	3	0	10
Religion					
Christian	19	6	6	22	53
Muslim	6	19	17	3	45
Traditional	0	0	1	0	1
Atheist	0	0	1	0	1
Education					
No schooling	14	7	20	5	46
Primary school	1	5	4	7	17
Modern school	7	11	1	7	26
Secondary school	1	2	0	1	4
Postsecondary school	0	0	0	1	1
Vocational school	2	0	0	4	6
Marital status					
Married	18	21	19	15	73
Never married	2	2	3	0	7
Widowed, separated, or divorced	5	2	3	10	20
Number of male children					
0	2	2	3	0	7
1-2	7	13	8	7	35
3-4	5	5	6	2	18
5-6	2	1	1	3	7
7-8	1	0	1	1	3
9-10	8	4	5	12	29
11+	0	0	1	0	1

Table 1. Socioeconomic characteristics of survey respondents, southwest Nigeria, 1987-88 (continued).

Characteristic	No. of respondents				Total
	Okeluse	Abule-Eko	Oriba	Igbo	
Number of female children					
0	2	2	3	0	7
1-2	7	6	7	6	26
3-4	6	6	7	3	22
5-6	1	3	2	0	6
7-8	1	0	0	1	2
9-10	8	8	5	15	36
11+	0	0	1	0	1
Number of wives (To married male respondents)[a]					
1	5	11	6	8	30
2	3	5	7	4	19
3	0	2	0	3	5
Occupation of spouse(s)[b]					
Farmer	2	7	1	4	14
Food processor	4	7	8	3	22
Fisher	0	0	0	2	2
Teacher	0	3	3	4	10
Religious worker	0	0	0	1	1
Trader	13	13	13	11	50
Tailor	2	0	1	0	3
Years of experience					
≤10 years	2	5	4	18	29
11-20	3	8	7	3	21
21-30	3	5	6	2	16
31-40	11	2	1	1	15
41-50	5	5	7	1	18
51+	1	0	0	0	1

[a]Nineteen married women each had one husband at the time of the survey.
[b]Multiple wives, in some cases.

Table 2. Description of nonfarm enterprises surveyed, southwestern Nigeria, 1987-88.

Description	No. of enterprises to which description applies				Total
	Okeluse	Abule-Eko	Oriba	Igbo	
Type of enterprise					
Trading	10	11	7	5	33
Bricklaying	0	4	4	3	11
Painting	0	0	0	4	4
Fish smoking	9	0	6	1	16
Welding/tinkering	2	0	0	2	4
Tailoring	0	3	1	3	7
Carpentry	3	4	4	3	14
Grinding	1	1	0	2	4
Teaching	0	2	1	1	4
Baking	0	0	2	1	3
Initial business capital, in naira (₦)					
≤200	14	7	11	4	36
201-400	6	9	11	4	30
401-600	0	7	2	11	20
601-800	4	2	1	5	12
801-1000	1	0	0	1	2
Source of initial capital					
Personal savings	4	10	11	8	33
Gifts from relatives	7	9	7	7	30
Loans from informal sources	6	1	0	5	12
Bank loans	0	0	1	0	1
Personal savings + gifts from relatives	5	4	6	0	15
Personal savings + loans from informal sources	3	1	0	5	9
No. of employees[a]					
1	8(6)	6(2)	3(3)	8(8)	25(19)
2	17(17)	19(19)	19(19)	17(15)	72(70)
3	0	0	0	0	-
4	0	0	3(1)	0	3(1)

[a]The number of unpaid employees (apprentices) is shown in parentheses.

Table 2. Description of nonfarm enterprises surveyed, southwestern Nigeria, 1987-88 (continued).

Description	No. of enterprises to which description applies				Total
	Okeluse	Abule-Eko	Oriba	Igbo	
Total expenditures on employees in 1986 (₦)					
0	17	16	14	15	62
1-100	3	2	7	3	15
101-200	4	3	2	2	11
201-300	0	1	0	1	2
301-400	1	3	2	4	10
Equipment used					
Hand tools	23	17	18	19	77
Power-driven machines	2	8	7	5	22
No response	0	0	0	1	1
Cost of materials in 1986 (₦)					
≤100	8	13	9	6	36
101-200	9	6	7	6	28
201-300	2	4	5	6	17
301-400	2	2	1	2	7
401-500	1	0	3	0	4
501-600	2	0	0	5	7
601+	1	0	0	0	1
1986 gross returns (₦)					
1-5,000	10	13	9	22	54
5,001-10,000	13	10	15	3	41
≥10,001	2	2	1	0	5

Table 3. The most important contributions of nonfarm enterprises to the rural economy, as reported by survey respondents, southwestern Nigeria, 1987-88.

Contribution	No. of respondents reporting
Provides processed food to rural areas	28
Increases rural income levels	19
Creates jobs	18
Provides cheap housing materials	10
Provides markets for rural agricultural and industrial products	7
Provides additional leisure and leisure-time activities	5
Provides cheap tools and other materials for farm use	5
Transports goods from urban to rural areas	5
Preserves and stores unused farm produce	1
Extends medical care to rural areas	1
Provides furniture to rural residents	1
Total	100

Table 4. Key multiple regression results using stepwise, variable-inclusion, regression techniques and various function forms, with "size of physical production" and "financial returns" as dependent variables, performed on data collected in survey, southwestern Nigeria, 1987-88.

Functional form	Estimated regression equation	$\bar{R}^2$	F
	Size of physical production		
Linear	$Y_1 = 0.10602 - \underset{(0.13918)}{0.22125X_4} - \underset{(0.14089)}{0.14596X_2}$	0.062	2.032
Semi-log	$Y_1 = 0.09608 - \underset{(0.05302)}{0.15025\log Y_6}^* + \underset{(0.06000)}{0.17170\log X_5}^* - \underset{(0.03783)}{0.04243\log X_4} + \underset{(0.07963)}{0.08373\log X_2}$	0.300	4.327
Double-log	$\mathrm{Log}Y_1 = -0.34115 + \underset{(0.12082)}{0.33755\log X_{10}}^* - \underset{(0.08531)}{0.26933\log X_4}^* + \underset{(0.14179)}{0.34278\log X_7} - \underset{(0.10165)}{0.14258\log X_2}$	0.398	6.129
	Financial returns		
Linear	$Y_2 = 0.02711 + \underset{(0.15957)}{0.33593X_{10}}^*$	0.100	4.432
Semi-log	$Y_2 = -0.13340 - \underset{(0.04991)}{0.12906\log X_9}^* - \underset{(0.06263)}{0.12073\log X_2}^* - \underset{(0.05063)}{0.07320\log X_8}$	0.213	3.803
Double log	$\mathrm{Log}Y_2 = -0.76572 - \underset{(0.19320)}{0.26024\log X_1} + \underset{(0.23741)}{0.26822\log X_5}$	0.016	1.254

Notes: Figures in parentheses are standard errors. Y_1 = size of physical production, Y_2 = financial returns, X_1 = no. of male children, X_2 = years of marital experience, X_4 = trade-group membership, X_5 = no. of spouses assisting in respondents' business, X_6 = no. of employees, X_7 = source of funds, X_8 = raw materials, X_9 = cost of equipment, and X_{10} = electric power availability.
* $p < 0.05$.

PRODUCTION PERFORMANCE OF SMALL RUMINANTS IN SOUTHEASTERN NIGERIA

Daniel S. Ugwu

SUMMARY

Nigeria is facing a shortage of animal protein. Although cattle, pigs, and poultry are produced in Nigeria, small ruminants, especially sheep and goats, have the greatest potential to meet Nigeria's protein needs. Sheep and goats are particularly suited to the environment of southeastern Nigeria. In the absence of low-cost feed, they can be fed materials that would otherwise go to waste.

A survey of 100 sheep and goat farmers was carried out in six areas of Anambra State, Nigeria, in 1988. The results indicated that sheep and goat farmers also engaged in crop production and other economic activities such as hunting, crafts, trading, and tailoring. They also raised poultry, pigs, and rabbits.

About 13% of these farmers used extensive production systems to raise sheep and goats; the remainder used semi-intensive systems. The major reasons the farmers gave for raising small ruminants were that the animals could be sold for income, consumed directly, and used in ceremonies and that owning them conferred prestige. The problems the farmers cited concerned disease, feeding, accommodation, veterinary services, and management.

A multiple regression analysis showed that two biological variables -- initial herd size and age at first parturition -- were consistently significant and positively influenced the total herd size of small ruminants. For sheep, litter size was also a significant variable.

A separate regression analysis examined socioeconomic factors influencing herd size. Among the socioeconomic factors, family size and cash expenditure were consistent and outstanding in their positive influence on small-ruminant production in terms of total herd size.

The results of gross margin analysis showed that sheep and goat production was profitable under the traditional management system. The gross margin of the average farmer was ₦ 67.37 for sheep and ₦ 104.07 for goats in 1988.

To improve the performance and increase the output of farmers engaged in small-ruminant production in southeastern Nigeria, a number of steps should be taken. Veterinary clinics should be established to alleviate the problems with small-ruminant diseases. The extension network should be expanded and improved to teach technical skills to farmers. Credit should be made available to farmers and pastures should be provided at token cost. Further research on genetic improvements will also benefit small-ruminant farmers.

The shortage of animal protein is acute in Nigeria. Whereas Nigerians were getting an average of about 10 g of animal protein a day in 1980-82, their counterparts in Somalia and Mauritania were getting 32 g and 34 g respectively (FAO, 1985). The mean daily animal-protein intake of 10 g per person in Nigeria is about one-third of the requirement; thus, Nigeria has a serious shortfall in animal protein production.

Nigeria's population is over 109 million (Abdulkadir, 1985). Successive Nigerian governments have attempted to provide adequate food for the expanding population. Nonetheless, there is still a deficit of food and food prices are escalating. Animal protein not only is palatable but also is essential for normal physical and mental development of people. Thus, its deficit exerts adverse effects on the economic development of the country. Not only is human productivity reduced due to abnormal development from the lack of protein, but also the incidence of infant mortality, malnutrition, and related diseases is high. This underscores the importance of livestock farming as a means of meeting human nutritional needs and improving farmers' incomes and living standards.

To ensure adequate supplies of protein to the rapidly growing population of Nigeria, the supply of animal products must rise. The mean annual increases in the demand for animal products were estimated to vary from 7.9% to 9.1% for beef, goat meat, and mutton; 10.4% to 12.6% for poultry; and 8.7% to 10.5% for fish, eggs, milk, and cheese. This pattern of demand for livestock products necessitates increased output (Agboola, 1979).

Although cattle, pigs, and poultry provide some of the animal protein in Nigeria, small ruminants, especially sheep and goats, are better suited to the environment.

Local grain production has continued to fall short of the feed industry's demands due to drought and poor storage and processing technologies. The result has been the escalation of grain prices from ₦ 120 per metric ton in 1975 to ₦ 650 per metric ton in 1985 and of oilseed-cake prices from ₦ 80 per metric ton in 1976 to ₦ 500 in 1985. These two feed ingredients together account for at least 70% of compound feeds by weight. The scarcity and high cost of these ingredients have made it increasingly uneconomical to include them in animal diets. An average mixed feed using conventional feedstuffs at normal inclusion rates costs at least ₦ 500 per metric ton (Obioha, 1986).

For small ruminants, alternative sources of feedstuffs are virtually limitless (Obioha, 1986). The advantage of ruminants is that they can consume bulky wastes and forage materials during the growing season and silage, brewers' wet grains, and low-potency concentrates during the dry season. They can subsist on low-quality roughage with mineral supplements.

Because of their small body size, sheep and goats can be consumed by small families and communities before the meat spoils, even when refrigeration and adequate transportation are absent. Sheep and goats are more prolific and have shorter generation intervals than cattle, which makes it possible to increase their population more rapidly.

Because of the limitations of low grain production on the production of monogastric animals such as pigs and poultry and the inhibitory effect of trypanasommiasis on cattle production in southern Nigeria, the greatest opportunity for increased production of animal protein in southern Nigeria is with sheep and goats.

SMALL RUMINANTS IN NIGERIA

Sheep and goats are distributed throughout Nigeria, but the distribution is skewed, with over 70% of the total population concentrated in the Guinea and Sudan Savannah zones of the country (Adu, 1980). However, small ruminants are also raised among the rural population of southern Nigeria.

The small ruminants in southeastern Nigeria are predominantly of the indigenous breeds popularly known as West African Dwarf (WAD) sheep and goats. Their major characteristics are small size and low body weight. Matthewman (1979) noted that the WAD sheep and goats are small by evolution or adaptation and are not true dwarfs. Dwarfs, he argued, are not normally vigorous and are of a lower reproductive efficiency, whereas the WAD sheep and goats are vigorous, fertile, and resistant to climatic stress and the scanty, irregular supply of water. He

pointed out that they exhibit a form of dwarfism that is an adaptation to adverse conditions.

Goats have been estimated to outnumber sheep by a ratio of 3:1 in southern Nigeria (Matthewman, 1979). Population data for WAD sheep and goats under traditional management in villages shows that females greatly outnumber males in postweaning age groups, indicating high male offtake for sale or home consumption (ILCA, 1981).

West African goats vary in size from the dwarf variety of the more humid areas to the large animals kept in the semidesert regions, with a number of intermediate types (Mason, 1951). Most studies on dwarf sheep and goats show that they breed throughout the year (Devendra and Burns, 1970). These animals are highly prolific. Dettemers, Igochie, and Akinkule (1976) recorded a fertility rate of 145% and prolificacy of 172%.

The characteristics of small-ruminant production systems are determined largely by external forces. In southeastern Nigeria, traditional husbandry systems are being modified by high human-population density and increasing pressure on agricultural land. As land use becomes more intensive, free-roaming animals pose an increasing threat to crops. In many locations, free-roaming animals have been banned; sheep and goats are now kept in pens or tethered (Lagemann, 1977; Mack, Sumberg, and Okali, 1984). Lagemann noted that with increasing population pressure, compound gardens become smaller and more intensively managed while the number of goats kept per household decreases.

Sheep and goats are usually fed household refuse and crop by-products such as cassava, yam, and plantain peels (ILCA, 1977; Matthewman, 1977). According to Mecha and Adegbola (1980), the common browses in humid southern Nigeria provide the mineral and vitamin requirements of these ruminants, and the animals show no obvious signs of nutritional deficiencies.

ILCA (1981) noted that the mean age at first parturition is 531 days for ewes and the mean growth rate is 76 g/day for lambs. Reports on the sexual development in the male Nigerian dwarf sheep (Aire, 1973; Orji, 1976) showed that, with good management and feeding, the lambs could attain puberty at the age of 4 to 6 months at a mean body weight of about 10 kg. The other breeds of sheep in Nigeria are larger than the Nigerian dwarf sheep and generally have larger body weight at puberty.

The gestation period for the native Nigerian dwarf sheep is 142 days to 153 days (Orji and Steinbark, 1980). Orji (1976) reported a birth weight of 2.03 kg and lambing interval of 234 days for these sheep.

A mean age at first parturition of 545 days and a mean growth rate of 35 g/day for kids have been recorded for the indigenous goats of Nigeria (ILCA, 1981). For goats raised in subtropical environments, physiological age, which is closely related to growth rate, is more important than absolute age in relation to sexual maturity (Epstein and Herz, 1964). Wilson (1976), in studying the production traits of goats, noted that the growth rates of twin and single kids were similar, but the rates for triplet kids were slower.

Kirkpatrick and Akindele (1974) noted a gestation period of 139 days to 149 days for WAD goats and birth weight of 1.59 kg for the kids. The parturition interval for the indigenous goats was about 260 days (Nuru, 1985).

Josserand and Ariza-Nino (1982) classified three levels of small-ruminant markets in West Africa -- primary, secondary, and terminal. The primary markets are in rural areas and function as collection markets where small producers bring animals for sale. The secondary markets are concentration markets in urban areas, especially large cities. Terminal markets are those in rural or urban areas in which a majority of purchases are intended for consumption. Small ruminants are usually sold in a section of the general market rather than at a specialized market. In 1968, Thody noted that primary markets for small ruminants usually lacked facilities for storing animals. This situation had not changed significantly at the time of the survey, 20 years later. In these primary markets, small ruminants are pegged together in a corner of the market and watched by a gathering of sellers (Josserand and Ariza-Nino, 1982).

Transportation from primary markets to secondary markets involves a variety of means, including trucks, cars, motorcycles, and bicycles (Josserand and Ariza-Nino, 1982). Transportation between domestic secondary and terminal markets, which may be 50 km to 1,500 km apart, is usually by truck and railroad.

SURVEY RESULTS

Five Local Government Areas (LGAs) -- Aguata, Udi, Anambra, Ishielu, and Igbo-Eze -- were selected from Anambra State, which typifies the biophysical and socioeconomic conditions in southeastern Nigeria. From each of the 5 LGAs, 20 sheep and goat farmers were sampled for the study. Of the 100 farmers surveyed, 13 owned only sheep, 19 owned only goats, and 68 kept both sheep and goats.

Socioeconomic Characteristics of Farmers

About 72% of the sheep and goat farmers surveyed had no formal education, about 20% had primary school education, 7% had secondary school education, and only 1% had university education. About 86% of the surveyed farmers were Christian, 2% were Muslim, and 12% practiced traditional religions.

The average household had about 10 members, including the husband and wife or wives, children, and extended family members. Ninety-four percent of the respondents were married. Only 7% of the farmers who kept sheep and goats were women.

About 25% of the surveyed farmers had thatched-roof houses; about 79% had tin-roofed houses. Only about 3% of the respondents owned cars, 37% owned motorcycles, and about 42% owned bicycles. About 18% of the farmers owned radios.

The age of the surveyed farmers were distributed as follows:

under 25	2%
26 to 35	9%
36 to 45	27%
46 to 55	40%
56 to 65	17%
over 65	5%

Thus, most of the farmers were mature. The farmers' years of husbandry experience averaged 14.5.

Seventy-two percent of the farmers said they had no secondary occupation. About 7% were also traders, 4% were hunters, 3% were craftspeople (producing wood carvings, woven baskets, or chairs), and 3% were carpenters. Other occupations each involved less than 2% of the farmers: tailoring, masonry, painting, bicycle repair, butchering, herbalism, wine-tapping, and welding.

Production Practices of Farmers

The proportion of households that owned sheep or goats ranged from 75% of all households in Aguata to 16% in Udi. The median was 52% in Igbo-Eze. Aguata had the highest number of sheep -- 59,000 during the survey period -- followed by Ishielu with 45,000, Anambra with 33,000, Udi with 11,000, and Igbo-Eze with 10,000. An average of 15% of sheep in the selected LGAs were males and 85% females. About 28% of the farmers reported their sheep averaged one lamb per

litter, 69% averaged two lambs per litter, and only about 3% averaged three lambs per litter. The average litter size was estimated to be 1.75.

Aguata also had the largest number of goats -- 786,000 -- followed by Igbo-Eze with about 110,000, Ishielu with about 48,000, Udi with 37,000, and Anambra with about 23,000. On average, 31% of the goats were males and 69% were females. About 47% of goats in surveyed households had only one kid per litter, about 49% had two kids, and only about 4% had three kids. The average litter size for goats was 1.57 kids during the survey period.

Production systems. Nigerians use two major types of production systems for sheep and goats. In the extensive-management system, animals are not housed nor fed but are allowed to graze on natural pastures and browse. They scavenge domestic food wastes in the compounds. Only about 13% of the farmers surveyed used this system. In many communities, this system is restricted, especially during the growing season, to prevent the animals from eating crops.

The semi-intensive-management system is more common; it was used by 87% of the surveyed farmers. It involves restricting or confining the animals at some times of the year. About 14% of the surveyed farmers that used this system kept their animals confined at all times. Another 13% kept them confined all day and night only during the rainy season.

Production objectives. Farmers gave a number of reasons for choosing to raise sheep and goats. Ninety-seven percent said they did so to provide themselves with an income; 84% for home consumption or entertainment; 41% to produce animal products such as leather, manure, wool, and bone. Some farmers mentioned prestige, ceremonial activities, interest, and security.

Breeds used. WAD sheep and goats are the predominate variety in Anambra State because they are well suited to the farming systems of southern Nigeria. About 83% of the sheep and 89% of the goats raised by the surveyed farmers were WAD breeds. Only 1% of the farmers raised the northern breeds of sheep, Ouda and Yankasa; about 7% raised the northern breeds of goats, Bornu Red and Kano Brown. These northern varieties were introduced by traders. About 15% of the sheep and 5% of the goats were crosses between the northern and southern breeds.

Sources of supply. About 45% of the farmers purchased sheep in the market; 32% raised them themselves; 6% borrowed them from neighbors; 9% received them as gifts; and 8% received them for taking care of someone else's stock. To obtain additional goats, 33% of the farmers relied on stock born within their households, 10% on gifts, 6% on borrowing, and 6% on payment for taking care of someone else's stock.

Feeds used. Most of the surveyed farmers carried feed for the sheep and goats. This cut-and-carry system was common during the crop-growing season, when the sheep and goats were restrained. The animals were tethered in the nearby bush by 35% of the farmers; 8% of farmers allowed their sheep and goats to graze on natural pastures. On average, farmers or their family members spent 13 hours a week during the growing season cutting fodder for their animals.

About 87% of the farmers provided supplementary feed to their small ruminants. Thirty-nine percent used cassava and yam chips; 42% used kitchen food wastes; 19% used grain by-products. About 51% of the feed supplements came from the farm compounds; about 49% were found in the outlying fields.

Marketing. One of the major reasons that the farmers kept sheep and goats was to provide an income to meet their household needs. About 71% of the farmers sold sheep and goats in their local markets in 1988; 29% marketed their animals from their home or farm. The average sales price during the survey period for a ram was ₦ 73.90, for a ewe ₦ 61.70, and for a lamb ₦ 34.23. A buck goat was sold for ₦ 95.86, a doe ₦ 78.85, and a kid ₦ 42.01. The animals were transported to market by trucks, motorcycles, and bicycles and on foot. The most common times to market sheep and goats were during the Christmas and Easter celebrations.

About half of the farmers sold their sheep and goats to traders or agents, 25% sold animals directly to other households, and 19% sold animals to butchers. The remainder sold animals to hotels, supermarkets, and others.

Production problems. Farmers face a number of constraints in raising sheep and goats in southeastern Nigeria. Both the difficulty of providing food for the animals and the high incidence of diseases were identified by 88% of the surveyed farmers as serious constraints. In addition, 32% identified a lack of pens as a constraint; 23%, management problems; 13%, a lack of veterinary services; 14% the destructive habits of goats; 13%, predators; 9%, inadequate capital; and 2%, a lack of water.

Feeding small ruminants was most problematic during the dry season, when most of the pastures dried up and became coarse, lignified, nonnutritious, and unpalatable to the animals. During this period, animals were fed browse of palm frond and fig leaves. During the rainy season, even though plenty of pasture was available, community laws did not permit the animals to graze freely and farmers did not have time to cut and carry fodder for them, due to their other farming activities.

Many small ruminants died of diseases in Anambra state. Although farmers knew that their animals were ill, they were not able to identify the diseases by name. However, with the help of veterinary assistants in the field, some of these diseases were identified. About 25% of the farmers reported that their sheep and goats had diarrhea; 13%, bloat; 12%, Caprine pneumonia; and 7%, still birth/Toxoplasmosis. About 5% of the farmers lost animals through accidents, such as snake bites, and 5% lost animals due to scabies or mange.

The shortage of land constrained grazing and pen construction. The farmers' low capital base made it difficult for them to purchase additional stock or to build appropriate pens for the small ruminants. The farmers also lacked the technical knowledge to manage small ruminants well. The lack of veterinary services contributed to their helplessness in controlling animal diseases.

MULTIPLE REGRESSION ANALYSIS

Two regression analyses were run to determine which factors influenced the herd sizes of farmers in Anambra State. The first examined biological variables (see table 1); the second examined socioeconomic variables (see table 2). Three types of equations were tried: the linear equation, the semi-log equation, and the double-log equation. The analysis was carried out independently for sheep and goats.

Biological Variables

The model that examined biological variables was of the form

$$HS_t = f(HS_i, GR, SR, PI, MR, AG_p, LS)$$

where

HS_t	=	Herd size after one year
HS_i	=	Initial herd size
GR	=	Growth rate of the kid or lamb
SR	=	Sex ratio
PI	=	Parturition interval per adult female sheep/goat
MR	=	Mortality rate
AG_p	=	Age of one female sheep/goat at first parturition
LS	=	Litter size

Sheep. Using the linear equation, the variables of initial herd size, mortality rate, and age of the ewe at first parturition were significantly and statistically related to herd size at the 5% level; litter size was significant at the 10% level. About 58% of the total variation in herd size was explained by the combined influence of all of the explanatory variables in the equation.

Using the semi-log equation, initial herd size and litter size were significant at the 5% level; age at first parturition was significant at the 10% level. About 56% of the total variation in herd size was explained by the combined influence of all of the explanatory variables in the equation.

Finally, using the double-log equation, similar results were attained. Initial herd size, age of ewe at first parturition, and litter size were significantly and statistically related to total herd size. About 54% of the total variation in the herd size was explained by the combined influence of the variables in this equation.

Initial herd size and litter size were positively related to herd size, while the relationship between age of ewe at first parturition and total herd size was negative. In all of the equations, growth rate, sex ratio, and parturition interval were consistently insignificant at both the 5% and 10% levels. It was expected that these variables would influence herd size. It is possible that their values did not vary enough in the sample; thus, the estimated variances of their coefficients were large, and the coefficients could not pass the significance test.

On average, about 56% of the variation in total herd size per household was explained by the combined effect of all the explanatory variables in all the equations. The remaining 44% may have been due to breed differences, gestation period, mothering ability, disease resistance, and other biological characteristics. The result gives a reasonably good fit. The F-values of all the equations were significant at the 5% level.

Goats. Using the linear equation, initial herd size and sex ratio were significantly and statistically related to total goat herd size per household. About 58% of the variability in herd size was explained by the effects of all the explanatory variables in the equation.

Using the semi-log equation, initial herd size, mortality rate, and age of doe at first parturition were significantly related to herd size at the 5% level; sex ratio was significant at the 10% level. About 62% of the total variation in herd size was explained by the combined influence of the independent variables specified in the equation.

The results of analysis using the double-log model indicated that initial herd size, sex ratio, mortality rate, and age at first parturition were significantly related to herd size at the 5% level. About 56% of the total variation in herd size was explained by the combined effects of all the explanatory variables in the equations.

The initial herd size was positively related to herd size, while the other significant variables were negatively related.

The explanatory variables of growth rate, parturition interval, and litter size were not significant in any of the equations. Even though it was expected that they would affect herd size, it is possible that their values did not vary enough in the sample. About 59% of the total variation in herd size per household was explained by the combined effects of all the variables in all the equations. The result gives a reasonably good fit. The F-values of all the equations were significant at the 5% level. The remaining 41% may have been due to breed differences, gestation period, mothering ability, disease resistance, and other biological factors.

Socioeconomic Determinants of Small-Ruminant Herd Size

The multiple regression model used to determine the effect of socioeconomic variables on total herd size was of the form

$$HS_t = f(FY_s, AG_f, HE, CE, MD, P, ON)$$

where

HS_t = Herd size of sheep/goat after a period of one year
FY_s = Family size
AG_f = Age of the farmer
HE = Farmer's livestock husbandry experience in years
CE = Cash expenditure on sheep/goat production (₦)
MD = Distance from the farmer's house to the central market (km)
P = Market price of sheep/goat (₦)
ON = Offtake number

Sheep. Using a linear equation, two variables were significant in determining the size of the sheep herd. The variable of cash expenditures was significant at the 5% level and family size was significant at the 10% level. About 39% of the variation in herd size per household was explained by the variables specified in the equation.

Family size, age of the farmer, and cash expenditure were significantly related to herd size per household using a semi-log equation. About 38% of the variation in herd size was explained by the combined effects of all the socioeconomic explanatory variables in the equation.

Using a double-log equation, family size, age of the farmer, and cash expenditure were significantly related to total herd size. About 41% of the total variation in herd size per household was explained by the combined effects of all the independent variables in the equation.

All of the significant variables in the equations were positively related to herd size. Thus, as the family size, farmer's age, or cash expenditure increased, the herd size increased.

The result of the analysis showed that explanatory variables such as husbandry experience, market distance, market price of the animal, and offtake number were consistently not significant at either the 5% or 10% level. Possibly their values did not vary enough in the sample or they did not have an important influence during the sampling period.

On the average, 39% of the variation in herd size per household was explained by all the socioeconomic variables in the equations. The F-ratios were significant in all the equations, indicating that all the variables in the socioeconomic model were important in explaining the total variation in herd size per household.

Goats. A greater number of socioeconomic variables played a role in determining the herd size of goats. Using a linear equation, husbandry experience, cash expenditure, market distance, and the market price of goats were significantly related to herd size at the 5% level; family size was significant at the 10% level. About 31% of the variation in herd size was explained by the combined influence of all the explanatory variables.

Using a semi-log equation produced similar results. Family size, husbandry experience, cash expenditure, market distance, and market price of animal were significantly related to herd size per household. The market distance was negatively related to total herd size; the other variables were positively related. Only 27% of the variation in herd size was explained by the combined effect of these explanatory variables.

The double-log equation indicated that only family size and cash expenditure were significant at the 5% level; husbandry experience and offtake number were significant at the 10% level. Offtake number was negatively related to herd size; the other variables were positively related. About 28% of the variation in herd size was explained by the combined effects of family size, age of farmer, husbandry experience, market distance, cash expenditure, market price of animals, and offtake number.

On average, about 29% of all the variations in herd size were explained by the integrated influences of all the explanatory variables in all the equations. The F-values of all the equations were significant at the 5% level, which implies that all the explanatory variables in the socioeconomic model explained the variations in the total herd size per household.

Conclusions. The overall R^2 values for sheep (39%) and goats (29%) appear to be relatively low, perhaps because most of the important socioeconomic variables that affect herd size of small ruminants are nonparametric and therefore cannot easily be quantified or fitted into a multiple-regression equation. The socioeconomic variables that may be responsible for the remaining variation in herd size include land-tenure systems, farmers' education, extent of contact between farmers and extension workers, and nutrition of the animals.

GROSS MARGIN ANALYSIS

Gross margin analysis was used to estimate the costs and returns to the average farmer during the survey period because fixed or overhead costs are minimal using the extensive or semi-intensive systems. Thus, net and gross margins are considered to be the same. Gross margin analyses were done separately for sheep and goats.

In computing gross margins, the prevailing market prices of these animals at the time of the study were used. Labor costs were computed by using the estimated costs of labor at the peak period of agricultural production. Labor for small-ruminant management was primarily used to provide feed or fodder for the animals using the cut-and-carry system. Labor was provided mainly by the members of the household. The cost of labor was based on the premise that an average farmer cut fodder for 3.27 hr/day, 4 days a week, for 5 months a year. An 8 hour worker day was valued at ₦ 20.00 during the time of the study, or ₦ 2.5 per hour. Thus, 261.6 worker hours expended on cutting fodder were valued at ₦ 654.40. Because fodder and natural feed supplements were not purchased, the cost of feed consisted only of the cost of the labor involved in collecting the feed. The feed itself had no market value and therefore was not costed.

An average farmer received returns from sheep sold, consumed, and given away. Dead animals were assumed to be valueless and therefore were excluded from the computation of gross margins. The income from manure sales was included. Manure sales were computed by estimating the value of 50-kg bags of manure turned out by an average farmer in one year.

Sheep

In 1988, the average farmer sold six sheep, consumed two, and gave two away. The amount realized from the sale of sheep was ₦ 443.40. The sheep consumed were valued at ₦ 147.80; the ones given away were valued at ₦ 113.22. The average farmer realized ₦ 51.99 from the sale of manure in 1988. Thus the total revenue from all these items totaled ₦ 756.41.

Farmers' expenditures were for veterinary drugs (₦ 34.64) and labor (₦ 654.40). The total variable cost was ₦ 689.04. Thus, the gross margin for sheep was estimated to be ₦ 67.37 (see table 3).

Goats

In 1988, the average farmer sold five goats, consumed one, and gave two away. The amount realized from the sale of five goats was ₦ 479.30. The value of the goat slaughtered or consumed was ₦ 95.86; that of two goats given away amounted to ₦ 144.48. The total amount realized from manure sales was ₦ 69.50. The total revenue for the average farmer from goat production in 1988 was ₦ 789.14.

Expenditure on veterinary drugs was estimated at ₦ 30.67; that of labor at ₦ 654.40; the total variable cost involved in the production of goats under traditional management in 1988 was ₦ 685.07. The gross margin for goat production was therefore computed as ₦ 104.07 (see table 4).

Goat production resulted in higher gross margins than sheep production. This appears to be one of the key reasons for the farmers' preference for goats. The reason for the higher gross margins was primarily that goats attracted higher market prices.

RECOMMENDATIONS

To improve the performance and increase the output of farmers engaged in small-ruminant production in southeastern Nigeria, a number of steps should be taken.

Veterinary clinics should be established in a variety of locations. These clinics must be well equipped with drugs, vaccines, and staff. This will help to alleviate the problem of small-ruminant diseases.

The extension network should be expanded and improved to reach the 29% of farmers who said that they lacked technical knowledge of modern husbandry methods. Large numbers of extension workers should be trained to improve the ratio of extension workers to farmers. These workers must take on the responsibility of educating the farmers on modern husbandry techniques and the use of improved breeds and other inputs. For maximum effectiveness, they should be provided with incentives such as good accommodations and a transportation allowance.

Cash expenditure was consistently significant in the regression equations. Thus, credit should be made available to small farmers to improve their herds of small ruminants.

Land should be acquired to establish suitable pastures for sheep and goats. The pastures should be fenced into paddocks, and sheep and goat farmers should be allowed to graze their animals at a token cost.

Genetic improvements of local breeds of small ruminants in southeastern Nigeria, especially selection for large litter size, should be explored. Further research toward improving the reproductive potential of small ruminants should also be intensified.

If these recommendations are implemented, the performance of small ruminants will improve and the herd size per household will increase among sheep and goat farmers in southeastern Nigeria.

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Table 1. Estimated multiple regression equations for biological determinants of small-ruminant herd size, southeastern Nigeria, 1988.

Type of equation	Constant	Explanatory Variables[a]							R^2	F
		HS_i	GR	SR	PI	MR	AG_p	LS		
Sheep										
Linear	-4.0864	2.488*	0.214	-2.142	-0.0946	-0.134*	-0.267*	-3.0697**	0.582	14.538
		(0.286)	(0.263)	(2.398)	(0.361)	(0.0743)	(0.146)	(1.862)		
Semi-log	-59.681	29.298*	38.227	-3.725	-1.238	-1.1398	-7.599**	12.093*	0.563	13.453
		(3.481)	(37.191)	(3.445)	(7.570)	(1.756)	(5.560)	(6.787)		
Double-log	0.715	0.775*	0.04001	-0.1004	-0.146	-0.0212	-0.284*	0.368*	0.539	12.212
		(0.098)	(1.0465)	(0.0969)	(0.213)	(0.0494)	(0.156)	(0.196)		
Goats										
Linear	9.952	1.186*	0.0619	-3.447*	-0.205	-0.369	-0.130	0.169	0.578	15.482
		(0.123)	(0.0791)	(1.917)	(0.279)	(0.0583)	(0.118)	(1.546)		
Semi-log	8.941	23.447*	4.009	-3.982**	-5.574	-2.588*	-11.325*	4.883	0.621	18.523
		(2.268)	(8.312)	(2.577)	(5.900)	(1.154)	(3.889)	(5.117)		
Double-log	1.0783	0.589*	0.0509	-0.141*	-0.171	-0.101*	-0.199*	0.111	0.561	14.433
		(0.0659)	(0.241)	(0.0748)	(0.171)	(0.0334)	(0.113)	(0.149)		

Note: Figures in parentheses are standard errors of coefficients.
[a] See text for meaning of abbreviations.
*$p \leq 0.05$ **$p \leq 0.1$

Table 2. Estimated multiple regression equations for socioeconomic determinants of small-ruminant herd size, southeastern Nigeria, 1988.

Type of equation	Constant	Explanatory Variables[a]							R^2	F
		FY_s	AG_f	HE	CE	MD	P	UN		
Sheep										
Linear	2.781	0.481** (0.294)	0.0806 (0.116)	0.0400 (0.140)	0.0731* (0.0131)	-0.120 (0.1503)	0.0044 (0.0151)	-0.0292 (0.0522)	0.393	6.757
Semi-log	65.857	18.716* (7.027)	27.585* (12.356)	2.318 (4.470)	8.822* (1.776)	1.343 (1.851)	2.156 (7.222)	-2.271 (2.029)	0.379	6.360
Double-log	0.971	0.518* (0.188)	0.625* (0.331)	0.0223 (0.1199)	0.249* (0.0476)	-0.0164 (0.496)	0.0120 (0.194)	0.0611 (0.0544)	0.405	7.100
Goats										
Linear	-3.398	0.379** (0.241)	0.0130 (0.10076)	0.296* (0.125)	0.055* (0.0120)	0.274* (0.141)	0.123* (0.0516)	-0.0405 (0.0429)	0.306	4.980
Semi-log	-47.652	12.760* (5.982)	4.570 (10.737)	7.112* (3.606)	6.575* (1.504)	-2.664* (1.604)	15.321* (9.025)	-2.599 (2.556)	0.268	4.126
Double-log	-0.482	0.355* (0.160)	0.205 (0.287)	0.157** (1.629)	0.186* (0.0402)	-0.0385 (0.043)	0.292 (0.241)	-0.0946** (0.0603)	0.281	4.414

Note: Figures in parentheses are standard errors of coefficients.
[a] See text for meaning of abbreviations.
*$p \leq 0.05$ **$p \leq 0.1$

Table 3. Gross margin analysis for sheep production by an average farmer, southeastern Nigeria, 1988.

Item	Unit	Quantity	Price/ unit (₦)	Total amount (₦)
Revenue:				
Sheep sold	number	6	73.90	443.40
Sheep slaughtered/consumed	number	2	73.90	147.80
Sheep given away	number	2	56.61	113.22
Manure sales	kg			51.99
Total revenue				756.41
Variable costs:				
Veterinary drugs				34.64
Labor	worker-day	80	20.00	654.40
Total variable costs				689.04
Gross margin (GM)				67.37

Table 4. Gross margin analysis for goat production by an average farmer, southeastern Nigeria, 1988.

Item	Unit	Quantity	Price/ unit (₦)	Total amount (₦)
Revenue:				
Goats sold	number	5	95.86	479.30
Goats slaughtered/consumed	number	1	95.86	95.86
Goats given away	number	2	72.24	144.48
Manure sales	kg			69.50
Total revenue				789.14
Variable costs:				
Veterinary drugs				30.67
Labor	worker-day	80	20.00	654.40
Total variable costs				685.07
Gross margin (GM)				104.07

THE ROLE OF RURAL WOMEN AS FARMERS IN EASTERN NIGERIA

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SUMMARY

Agriculture has a crucial role to play in the social and economic development of Nigeria. In recent years, however, productivity in the agricultural sector has not satisfied the nation's requirements for food, fiber, and other raw materials. This situation calls for the immediate reappraisal of rural education systems, notions of agricultural development, and plans for achieving the national goal of self-sufficiency in food and fiber production.

This study investigated the roles of rural women as farmers in four states of eastern Nigeria. A total of 880 women from 220 rural villages were interviewed. The main objectives were to analyze the farming activities performed by rural women; to identify the women's problems; and to suggest measures for improving the productive capacity of farm women in the region.

The average age of the women farmers was 42 years, and 88% of the women farmed full time. The older the rural woman was, the more likely it was that she was a full-time farmer.

To document changes in farm-labor patterns, the surveyed women were asked to report which farming operations they performed before 1970 and which they performed in 1987. The results showed that women have become increasingly involved in producing tree crops, food crops, and livestock since the end of the Nigerian civil war in 1970. Shortages of male labor and the high cost of hiring farm hands pushed rural women to assume additional farming duties.

One-third of the women now take part in clearing and preparing land; one-tenth reported that they did so before 1970. About 20% of the farm women did not consider any farming operation to be only a man's task or too strenuous for a woman to perform. Rural women continued to perform such tasks as removing burned sticks; planting crops; weeding; harvesting; and transporting, processing, and marketing farm produce.

Most of the women said they liked farming; however, 82% said that, given the opportunity, they would choose nonfarm occupations.

Although over two-thirds of the surveyed women did not know the agricultural station or office nearest to them and 83% had never contacted the extension office for advice, the women had a moderately favorable attitude toward the Ministry of Agriculture. Their involvement and participation in organized agricultural extension and rural development programs was poor. Only 7.5% participated in the homemaker programs designed for rural women. This suggests that the agricultural extension program in the eastern region has been ineffective at reaching women. Two-thirds of the nonparticipants, however, indicated that they would like to take part in at least one of the programs. Only 18% of the surveyed women -- mostly the older, uneducated women -- said they were not interested in the programs. This suggests that if extension programs were directed at women in these rural areas, the women would be eager to participate.

When asked about constraints to their productivity, 85% of the women said lack of capital was the most limiting factor. This concern was echoed when the women were asked to suggest ways to reduce the constraints -- 37% of the women said small loans and credit should be granted to their families. Others said that farm inputs should be made available at subsidized prices. This also indicated that capital was limited.

An additional constraint that the surveyed women mentioned was that the Ministry of Agriculture's male extension workers did not work with women. The women suggested that the Ministry of Agriculture design separate extension programs for rural women.

Thus, the systems of the rural education and training, including the agricultural extension services, have not taken into account the importance of women in agriculture. Women's productivity has remained static, while men have benefitted from extension programs that have provided them with modern techniques for growing cash crops. Future development will be enhanced by recognizing the role of women in rural farm labor and agricultural production and by making women more productive in these capacities.

Agriculture is crucial to the social and economic development of Nigeria. For the nation's economy to grow, food supplies must meet the needs of the growing population. The agricultural sector must provide an adequate, cheap supply of raw materials for cottage industries. Increased export earnings from rubber, cocoa, palm oil, and cotton would help finance capital projects and other social investments in the face of declining oil revenues. However, since 1970, the agricultural sector of the Nigerian economy has not been able to satisfy the national requirements for food, fiber, and other raw materials. Under the

traditional bush-fallow system of farming, which prevails throughout the country, farm productivity levels are low; and most farmers appear unwilling to adopt new ideas recommended by the extension services of the Ministry of Agriculture.

During the 1970s, Nigerians witnessed a decline in all aspects of agricultural production. Revenue from exported farm products fell from 83% of the GDP in 1960 to less than 10% in 1978 (Floyd, 1980). The national food-import bill rose in real terms from ₦ 88 million in 1970 to about ₦ 300 million in 1980 (OFN, 1979). Prices of local food items have continued to rise, and Nigeria is becoming one of the nations that cannot feed its people.

Many scholars blame the continuing decline in Nigerian agricultural production on the emergence of oil as a key source of earnings and the consequent neglect of agriculture. Other writers maintain that, while factors such as land tenure, adult illiteracy, poor attitudes about farming, ineffective extension services, lack of capital, and inappropriate technology constitute formidable barriers to increased agricultural production, the situation is likely to worsen as the rural farm population ages and as potential agricultural workers in the villages continue to migrate to urban centers in search of more lucrative nonagricultural employment (Olatubosun, 1975; Williams, 1978; Olayide et al., 1980).

During the last 25 years, the federal and state governments have reacted to food-supply shortages by initiating special programs to promote agricultural production and alleviate food shortages. The programs include the National Accelerated Food Production Program (1974), the River Basin Development Authorities (1976), Operation Feed the Nation (1976-1979), the Green Revolution (1979), and the agricultural development projects (1979).

In spite of these programs, the agricultural situation in Nigeria has not improved. Shortages of farm labor, a disproportionate number of old people among the farming population, and the absence of effective village-level programs of practical agricultural education for rural youth remain serious obstacles to increased agricultural production in rural eastern Nigeria (Uwakah, 1979). Nigeria cannot achieve self-sufficiency in food production without resolving these problems.

Awareness is growing that development, especially rural and agricultural development, would be enhanced if the integral role of women in the process were recognized. One way to increase rural farm labor and agricultural production would be to make rural women more productive as farmers.

Women constitute over half of the economically active population of rural Africa. They share responsibility for sustaining their families by participating in all aspects of rural labor. In Nigeria, women have traditionally participated in farming and other rural development activities; however, their contributions have remained largely uncounted and underrated. They are involved in preplanting operations such as clearing land, tilling by hand, and ridging. They are also involved in planting, weeding, harvesting, and processing crops.

Women account for about 60% to 80% of the agricultural labor force in rural Nigeria (Kisekka, 1980). Women in northern Nigeria feed and care for livestock and collect and process dairy products. Especially in western Nigeria, women account for 80% of the trade in foodstuffs and basic commodities in rural communities (Igben, 1980). The role and participation of women in agricultural development differs among localities and regions depending on religious, economic, and other sociocultural factors.

Since political independence was obtained in 1960, industrialization and urbanization have accelerated rapidly in Nigeria. This process has drawn many working-age men from rural areas into the cities in search of high-paying jobs. In addition, the Universal Primary Education Scheme has emphasized formal education for the rural masses. These developments have set two trends in motion:

- Most rural children and adolescents, who previously helped their parents willingly with farm work, now go to school and are no longer available as farm hands.

- Even semiliterate, unskilled primary school leavers prefer white-collar jobs and see farming as dirty, tedious, and good only for their illiterate parents (Uwakah, 1979).

The net effect is that rural areas now have a preponderance of women. Much of the rural labor force comprises older men and women who are no longer able to till the soil and produce enough food and fiber for the nation (FDA, 1974).

With the shortage of agricultural labor, rural women throughout Africa appear to be working longer hours and are performing many of the strenuous operations that were traditionally ascribed to men (Monstead, 1977). These changes have had an impact on the farming systems. In Ghana, for example, as men have migrated from rural areas, yams have been abandoned as a major food crop in favor of cassava, which requires less labor (Bukh, 1977). In a rice-development scheme in Sierra Leone, MacCormack (1978) observed that while tractors replaced men's labor -- doing jobs like clearing, logging, and tilling -- the vastly increased

hectarage that was planted increased the demand for women's labor for weeding, harvesting, and threshing.

PREVIOUS RESEARCH ON WOMEN IN AGRICULTURE

Since 1975, the contribution of women to national development has been a major area of interest and the focus of a considerable amount of research activity. The main concern has been to identify factors that determine, promote, or constrain women's participation in the labor force. Although some research has been done on the role of women in traditional economies, further attention needs to be given to studying the productive involvement of rural women in the various sectors of the economy.

The earliest investigations in Africa on women's roles were anthropological, seeking to discover and understand the social status and economic roles of women in traditional economies. Important among these was Baumann's review (1928), which focused on the division of labor between sexes. Riegelman et al. (1974), using case studies from seven developing countries including Nigeria, presented a composite report on the current and potential development roles of women. They concluded

- Women have fewer social, legal, and cultural restrictions than in the past.
- In general, women will be integrated into the rural economy more quickly if integration is pursued in the context of a development project.
- Women's behavior changes faster through activities relating to agricultural production and home care projects.

Lele (1975) noted that in the West Region of Tanzania, women worked long hours in agriculture while the men relaxed in the houses drinking. Boserup (1970) showed that the number of rural women engaged in farm work is increasing faster than the number of men. For younger women, agricultural work is usually combined with the exhausting processes of frequent pregnancy, childbirth, and breast-feeding.

In recent years, research on women's roles has shifted from anthropological approaches to the development and planning context. This approach seeks to understand the dynamic role women can and have played in changing the rural community. Baba (1980), in a study of the Kano River Irrigation Project and women's participation in the labor force in Hausaland, concluded that official

policies have not recognized the need to integrate women into ongoing development projects as a means of achieving greater balance in rural welfare.

Pala (1979) attempted to provide a historical rationale for women's role in rural development. She concluded that the historical facts of women's roles in traditional economies point to the need to involve them in all national development strategies, regardless of the prevailing economic and political ideologies.

The agricultural development projects have started to have a positive educational impact on Nigerian farmers. Greater success will be achieved if women are specifically involved in this extension system. The noninvolvement of women in these projects is due to the ignorance of the policy-makers, their advisors, and those who implement the policies, according to Igben (1980).

Ilori (1975) reported that, in the forest areas of southern Nigeria, virtually all planting, weeding, harvesting, and transporting of farm produce was done by women. Among the Ekpenyan in Cross River State of southeastern Nigeria, men did little or no farm work. They cleared the land, then spent the rest of their time hunting and producing palm oil.

Most of the research on women in Africa indicates that they are overworked as they combine domestic, procreative, and other activities to ensure the survival of their families. In many economies, women's contributions to national development have not been fully recognized and adequately remunerated. In some countries, women are consciously discriminated against -- they are denied formal participation in development programs or they are not allowed to share in program benefits. With the continuing shortage of rural labor and the increasing number of old people among the farming population, self-sufficiency in food production cannot be achieved without involving additional skilled and competent farmers. These new farmers must be drawn from among the youth and rural women.

In discussing the nature of role theory, Parsons (1951) and Isaak (1975) defined "role" as "what society expects of an individual occupying a given status position." Roles are, therefore, the results of persons engaging in purposive behavior within an interactive context governed by group norms and taking place within a social system.

Forty years ago, in the traditional rural Nigerian setting, occupational roles were rigidly defined by gender. A man had absolute responsibility to be the breadwinner and fend for his family. The woman was responsible for home management, child care, and other light duties, leaving the more strenuous farm activities to the men. At that time, communities were relatively self-sufficient.

Men dominated most agricultural production; roughly 75% of men performed farm work in the eastern region (Sokolski, 1965).

Today, the situation in rural Nigeria has changed. In addition to working in the home, women are now actively involved in transforming and developing the economy. Men and women share the responsibility for sustaining their families, jointly participating in all aspects of rural labor.

However, some traditional roles persist. Women in eastern Nigeria generally do not inherit land or have land allocated to them as do the men. Instead, women farm their husbands' or families' plots. Certain crops, such as yams, are regarded as men's crops; others, such as cocoyams, maize, and beans, are considered women's crops. Women rarely form cooperative associations themselves but may be expected to contribute financially toward their husbands' memberships in agricultural cooperative societies.

STUDY FORMAT AND METHODOLOGY

This study systematically investigated the role and contribution of women farmers in agriculture production in selected agricultural communities of the four eastern states of Nigeria -- Anambra, Imo, Cross River, and Rivers. Women farmers from 220 rural villages those states were interviewed

- to assess the general attitudes of rural women toward farming
- to determine which farming operations were performed by women and what help women needed from the Ministry of Agriculture extension services
- to assess the extent to which rural women were aware of and participated in organized agricultural extension and rural education and development programs
- to identify factors that promoted and constrained women's productivity as farmers and their participation in agricultural development programs

A 30-item structured interview was developed and used as the main instrument for gathering data. Statistical validation was based on the split-half technique for estimating reliability (Tate, 1970). The reliability coefficient of r_w=.7847 obtained was considered satisfactory.

A multistage sampling design was used to select 880 subjects. Out of 71 local government areas (LGAs) in the four states, a 50% random sample of 35 LGAs was selected in the first stage. From the 35 LGAs, 44 agriculturally important communities were selected with the assistance of the local agricultural extension officers. In the third stage, four villages were randomly selected from each community, for a total of 176 villages. From each village or compound, five households were randomly selected from an alphabetical list of households. The woman of each selected household was interviewed.

Two other considerations influenced the selection of rural women -- their willingness to cooperate in the study and their accessibility to the data collector. Most of the women interviewed willingly provided responses to the questions. Twenty-seven subjects who were not available for interview were replaced with others who were randomly selected.

To compare the interstate involvement of women in specific farming operations as well as to determine comparative differences between states, single degree of freedom analysis was built into a planned comparison of the type

$$\text{Anambra} = \mu\text{Imo and } \mu\text{Cross River} = \mu\text{Rivers}$$

$$1/2\ (\text{Anambra} + \text{Imo}) = 1/2\ (\text{Cross River} + \text{Rivers})$$

where μ is the population mean. This approach made it possible to calculate a standard error of difference between means for variables such as age group (S.E. = 0.33).

Data having binomial structure, such as women's reactions and attitudes toward farming, were analyzed using the chi-square goodness-of-fit test. The degree of association between attributes was estimated by determining contingency coefficient (Minium, 1970). Confidence interval estimates were calculated for states based on the proportion of farmers who said they liked farming.

A paired t-test was used to compare the percentages of women who said they were involved in tree crop, food crop, and livestock operations "before 1970" and "now." This was followed by a multiple comparison of means using a two-way analysis of variance. Wherever a significant F-test was obtained, Fisher's least significant difference (F-LSD) at the 5% level of probability was applied to detect significant differences between effects means.

Two major problems were encountered in collecting accurate information for this study.

- Many of the respondents could not speak English. As a result, the data collectors spent time translating the questions into the local dialect. They also used indirect indicators to assess the respondent's age and income when the women failed to give such information.

- It was often difficult to find the respondents at home; thus, repeated and odd-hour interviews were required.

STUDY AREA

The eastern region of Nigeria covers approximately 30,000 sq mi of land and has an estimated population of 16 million people distributed in four states as follows: Anambra 5.3 million, Imo 3.7 million, Cross River 3.6 million, and Rivers 3.1 million (1979 projections, Federal Office of Statistics). Roughly 80% of the people are farmers, and about half are women. The region has the highest population density in Nigeria, ranging from 400 people per square mile in Abakaliki zone of Anambra State to over 800 people per square mile in Okigwe, Orlu, and Owerri zones of Imo State. The national average is less than 300 people per square mile.

This population encompasses many ethnic groups with a variety of customs, traditions, loyalties, and languages or dialects. All the inhabitants in Imo and Anambra states are Ibo; most of the inhabitants of Cross River are Efiks and Ibibio; those in Rivers State are Ijaw.

The primary economic activity is farming, although people are also involved in petty trading, lumbering, fishing, tapping palm-wine, carpentry, and tailoring. The staple crops include rice, yams, cocoyams, corn, cassava, beans, and other vegetables. Palm oil, palm kernel, cocoa, iron ore, limestone, and crude petroleum are also produced in commercial quantities in eastern Nigeria. Some livestock are kept -- mostly poultry, sheep, and goats -- but neither the goats nor the few cows are milked. Fishing and hunting are important occupations in Cross River and Rivers states.

The system of farming is a variant of shifting cultivation known as the traditional bush-fallow system. Using only basic tools -- the hoe and machete -- a farmer clears small, isolated plots of land totaling about 1 ha to 2 ha per year, early in the dry season. When the bush is dry, it is set on fire. The land is multicropped for 2 yr to 3 yr; then the farmer moves to another site some distance away. Field observations and research show that, in certain areas of Imo and Anambra states, crop yields are declining as the increasing population pressure reduces the amount of land available for cultivation and consequently reduces the fallow period.

Results of extension studies (Uwakah and Osuji, 1981; Nweke et al., 1983) show that the sociocultural circumstances of the average farmer in the study area are not impossible barriers to change and progress. The farmers have limited economic resources, only a few hectares of land, inefficient hand tools, and little or no education or technical knowledge. Many lack adequate nutrition, good water supplies, electricity, motorable roads, and other essentials. In spite of these limitations, the people of eastern Nigeria are alert and they have a deep-rooted faith in the value of education as a means of personal advancement and improvement. Since the end of the civil war in 1970, most communities in the area have undertaken development projects such as building schools, roads, market stalls, and village halls. Traditional rulers, elders, age-grade groups, social clubs, traders' associations, community councils, and government agencies have played important roles. Generally, the traditional institutions and social organizations do not reject innovations and interaction with outsiders. Instead, they accommodate progressive changes, such as planned rural education and agricultural development projects.

CHARACTERISTICS OF FARM WOMEN

A total of 880 farm women were interviewed, comprising 240 from Anambra, 200 from Imo, 260 from Cross River, and 180 from Rivers states. The difference in distribution of the subjects by state was not statistically significant and therefore did not distort the results (see table 1).

The subjects were classified according to whether they farmed full time (those who spent at least half of their time on farm work and realized most of their income from the farm) or part time (all others).

Based on this operational definition, 88% of the subjects were full-time farmers. They tended to be the older, illiterate women. The part-time farmers tended to be younger and semiliterate. They frequently combined farming with other occupations, such as petty trading, weaving, sewing, and plaiting hair. The preponderance of full-time farmers in the sample reflected the bias of selecting communities in which agriculture was especially important.

Most of the farm women (84%) were 30 yr to 60 yr of age; the average age was 42. Only 3.5% were over 60 yr old. The differences between states' mean ages for the farm women were not statistically significant. Age was strongly associated with full-time status (r = .43); thus, the older the rural woman was, the more probable it was that she was a full-time farmer.

Over one-third of the farm women surveyed had never been to school; 47% had attended primary schools; 10% had attended secondary school. Less than 2% of the women had received any vocational training. The younger women, who were generally better educated, preferred more lucrative, nonfarm occupations available in the urban areas, hence the negative relationship between education and full-time status (r = -.38).

About two-thirds of the farm women were married and living with their husbands; 23% were widows; a few were single; the rest were divorced. Less than half of the surveyed women (44.3%) were married to farmers. This suggests that there were more women than men on the farms.

Half of the women had been farming for 15 yr to 20 yr, and 20% had been farmers all their lives. The majority (61%) had one to four children living with them and helping them with farm work. Approximately 90% of the farm women hired labor for farming operations such as clearing the bush, making ridges and mounds, planting, weeding, and harvesting.

Over half of the family income (68%) was earned through farming. Of the farm women, 94% spent less than ₦ 100, or (US $40) weekly to purchase food for a family of six. Since a significant portion of family income is spent on food, any family that spends less than ₦ 100 a week to feed six people probably is poor. Most of the land in the region was owned and inherited by members of the same family. The survey indicated that the average farm family had about six farm plots, sometimes situated miles apart, totaling 3 ha to 5 ha. Three or more of these plots might be cultivated during a season. Most of the farm families were unable to expand their land holdings due to sectional overpopulation and traditional land-tenure limitations.

Personal savings and family members provided the capital for farm work for 83% of the farm women; 17% borrowed money from other sources. Thus, financing farm operations from external sources of capital is not a common practice for rural women in eastern Nigeria. Cultural inhibitions and the lack of rural lending institutions are major factors restricting farm women's borrowing.

WOMEN'S ATTITUDES ABOUT FARMING

The women were questioned about their attitudes about farming (see table 2). They were asked, "Do you like farming?" Most (86%) said yes. The ratios, by state, of women who liked farming to those who did not were Anambra 4.7:1, Imo 7.7:1, Cross River 6.2:1, and Rivers 8.5:1.

The women gave a variety of reasons for liking farming, including that they could produce their own food (60%), they could earn an income (31%), and they had no better job (10%). The main reasons given for not liking farming were that farm work was tedious and dirty (42%), farmers were generally poor (28%), the land was infertile and fragmented (18%), and they had more profitable employment (10%).

One-third of the surveyed women said they were already doing a significant amount of farm work, and about the same proportion complained that they were being overworked. Only 40% were satisfied with the level of assistance their husbands provided on the farm. One-half said farm labor was scarce and expensive to hire; one-half said farm labor was readily available and relatively cheap. The discrepancy was caused by variations in availability of labor between the states.

Given the opportunity, 82% of the rural women said they would choose nonfarm occupations, including teaching and nursing (26%), large-scale business and trading (23%), and civil service jobs (15%). The main reasons given by the subjects for preferring other occupations included personal interest (36%), potential to earn an adequate income (36%), more time for rest (16%), and social status and prestige (13%). These findings suggest that the majority of rural women in eastern Nigeria were farmers because of circumstances beyond their control, such as poor educational exposure, limited family resources, and other sociocultural factors.

The extent to which a farmer is aware of and in contact with the Ministry of Agriculture and its change agents is usually a general indicator of the level of success of that farmer. Two-thirds of the surveyed women did not know the agricultural station or office nearest to them; 73% did not know the extension worker in charge of their community; and 89% had never tried to contact the ministry. These results imply either that extension workers in eastern Nigeria are ineffective or that they do not work with rural women.

Fifty-eight percent of the women stated that the Ministry of Agriculture was not helpful to farmers. This finding also indicates that the ministry's efforts to involve rural women in agricultural development in the region have been ineffective. According to the chief agricultural officer in Enugu, Anambra State, the major problem is that, since the civil war ended in 1970, the ministry has been unable to reactivate, hire, and train sufficient numbers of women to run the home economics extension programs of the ministry.

FARMING OPERATIONS PERFORMED BY WOMEN

The number of rural women who performed specific farming operations before 1970 was compared with the number who performed them at the time of the survey in 1987. Detailed information was collected on tree crops, food crops, animal production, and the entire spectrum of cultural operations from clearing land to processing and marketing farm produce. The food crops investigated included yams, cassava, maize, rice, vegetables, cocoyams, and plantains. The tree crops included were oil palm, citrus, cocoa, and cashew.

Greater numbers of rural women reported that they were involved in virtually all of the tree-crop operations at the time of the survey than before 1970 (see table 3). Twenty years ago, men dominated in all activities relating to farmland preparation and tree- or cash-crop production. Only about 20% of the surveyed women said they took part in clearing land, and only about 12% removed stumps, burned sticks, and made ridges or mounds for planting. In 1987, 35% of the women reported that they cleared farmland, and over 30% stumped, burned, and made ridges or mounds in preparation for planting tree crops.

The pattern was similar for food-crop production; however, the degree of rural women's involvement in food-crop farming operations was much higher than that for tree crops (see table 4). In 1987, women were involved in clearing land (57%), burning (43%), and other preparatory operations (50%) that were traditionally ascribed to men; women continued to dominate in gathering burned sticks for firewood, planting crops, weeding and maintaining the farm, harvesting, caring for stored produce, and transporting, processing, and marketing crops.

The eastern region is not noted for livestock production. One in every three or four farm families kept a few local hens; one in ten families kept one or two goats or sheep and some ducks. All of the animals ranged freely. Less than 5% of the farm women had intensively managed poultry flocks of 10 or more.

In all of the states, the differences were positive and significant between the number of rural women who reported that they performed specific animal husbandry operations before 1970 and those who did them at the time of the survey (see table 5). Reports indicated that 24% of women prepared the sites for animals in 1987, as compared with 14% before 1970; 11% were involved in slaughtering and processing poultry and small stock in 1987, as compared with 2% before 1970. Women reported that they were also involved in building animal pens (31%), feeding animals (40%), and composting animal wastes (31%).

As in crop production, women have become involved in the livestock business, taking on land-preparation operations in addition to their traditional

responsibilities of obtaining feed, collecting eggs, feeding and watering the animals, cleaning the pens, marketing products, and composting the animal wastes.

The surveyed women gave the following reasons for becoming more involved in agriculture:

- It was expensive to hire farm hands, 36%.
- The husband was absent or the family had a shortage of men's labor, 29%
- The husband needed assistance, 11%.
- They wanted to increase the family's food and income, 13%.
- The men were unwilling to help, 12%.
- These farm tasks were no longer left for the men, 19%.

The overall trends are clear. Rural women in eastern Nigeria have become increasingly involved in agriculture; in some Ibo-speaking areas, women have dominated the agricultural scene since the end of the civil war. The lack of male labor and the high cost of hiring farm labor have forced rural women to take on extra farming duties. Many women no longer regard any farming operation as being exclusively a man's task.

WOMEN'S PARTICIPATION IN DEVELOPMENT PROGRAMS

Significantly more rural women from the mainland states of Imo and Anambra were aware of organized rural development programs than from the riverine states of Rivers and Cross River (Anambra 58%, Imo 63%, Cross River 44%, and Rivers 22%). Field observations indicated that transportation and communication problems and ineffective extension contact may have contributed to low awareness of government programs among rural women, especially in the riverine states.

About half of the women in Anambra and Imo states and three-quarters of those in Cross River and Rivers states did not know about the homemaker extension programs that teach women sanitation, improved nutrition, family management, gardening, and dressmaking. Only 7.5% of the women reported that they had participated in these programs.

Imo State had the highest mean percentage of women participating in organized agricultural extension and other development programs (19%), followed by Anambra State (15%). Participation levels in both states were statistically the same, but they differed significantly from those of Cross River (8%) and Rivers

(6%). Generally, the level of women's participation in these programs throughout the region was extremely low.

Two-thirds of the women who had not participated in government development programs said they would like to take part in one or more government and rural development programs. Their areas of interest were tree- and food-crop production programs (68%), family-planning programs (60%), adult-education and homemaker programs (66%), poultry-development schemes (69%), and agricultural cooperatives (70%). However, about 18% of the surveyed women -- mostly the older, uneducated women -- said they would not like to be involved in any of the programs.

Those who did not take part in any of the programs explained their behavior in a number of ways. Some of the explanations involved personal factors, including that they were not interested, their families opposed their involvement, they were too old, they did not need the program, they did not have time to attend, they were too tired after working all day, and not enough land was available for farm work. Other answers were related to the programs: Participating was too expensive, and programs were not available locally.

CONSTRAINTS TO WOMEN'S PRODUCTIVITY IN AGRICULTURE

One of the objectives of this study was to identify the major constraints limiting women's productivity and participation in organized agricultural development programs in the region. Lack of capital was the most crucial limiting factor, according to 85% of the women. This is not surprising: The farm women were mostly smallholders with little or no family resources to invest in farm work. Local moneylenders, commercial banks, and the Ministry of Agriculture Supervised Agricultural Credit Scheme never gave loans to farm women, nor to their husbands who had no collateral to back the loans.

Other major constraints identified by the surveyed women included processing, transporting, and marketing problems (64%); lack of incentives from government (63%); shortage of farm labor (59%); strenuousness of farm work (57%); unavailability of programs (56%); shortage of land (55%); lack of basic education and training (45%); and lack of infrastructure in the villages, such as good roads (25%). Seventy-four percent of the women said that male extension workers do not work with women (see table 6).

When asked to suggest ways in which the constraints could be reduced to enhance rural women's contribution to agricultural and national development, 44% of the

women wanted the Ministry of Agriculture to design separate extension programs for rural women; 37% said that small loans and credit should be granted to their families; 25% requested cheap or free supplies of farm inputs, such as fertilizers and maize seed.

About one-third of the farm women said that difficult agricultural operations should be mechanized; one-fourth wanted basic-literacy education programs to be provided for rural women. The difficulty of working with male extension workers was addressed by 13% of the women: They said the government should hire female extension workers or, if it could not, then the male extension workers should change their attitudes and provide support to the women in the communities. One-fifth of the women wanted marketing and storage facilities to be provided; 9% suggested that the traditional land-tenure system be modified to enable women and farm families to own enough land for farming.

CONCLUSIONS AND POLICY RECOMMENDATIONS

Women's role in farming is progressively increasing, and their contributions to agriculture have become crucial to Nigeria's national development. Both the government and the people are taking steps to arrest the deteriorating food-supply situation. Rural women -- individually and in groups -- are taking the lead in meeting this national challenge by filling the agricultural labor gap created by the out-migration of more-active, better-educated men. The majority of the farm women are either middle-aged or too old to be effective farmers. Administrative changes must ensure an improvement in the productivity and conditions of farm women and reverse the trend of rural-to-urban migration.

The results of this investigation showed that systems of rural education and training, including agricultural extension services, have failed to take into account the important role that women play in agriculture. Until recently, although more women than men were involved in agriculture, agricultural extension services were directed almost totally toward men and toward export-crop production. The programs directed toward women focused on their roles as housewives and mothers, rather than on their roles as agricultural producers. Because of this disparity in the agricultural training system, men learned modern techniques of growing cash crops, while women continued to cultivate food crops by traditional methods. Thus, men's labor was better remunerated by higher farm yields and income, while women's productivity remained static.

Considering the role that women now play in agriculture and in the economic lives of their communities, they must be given proper training in scientific farming methods. Rural development demands knowledge of agricultural innovations and

technology. Failure to teach women modern farming techniques will inhibit agricultural development, depress rural incomes, and perpetuate poverty and underdevelopment.

At the community, local government, state, and federal levels, appropriate agricultural policies must be determined, and legislation must be aimed at developing the productive capacity of both men and women.

Greater attention must be given to the development of the home economics branch of the Ministry of Agriculture extension services. Large numbers of women must be trained as extension workers so they can effectively reach women in the rural areas. Special extension and rural education programs should be designed to help women and girls to see the links between the home, garden, and farm and to recognize the economic importance of their role in agricultural development.

Rural women also need basic-literacy education. A significant proportion of these women have never had the opportunity to go to school. Literacy could change the outlook of rural women and increase their ability to use new techniques. Moreover, literate mothers could play a beneficial role in the preschool education and socialization of their children.

Rural families must be given greater access to capital so they can take advantage of new developments in farming techniques. For example, a revolving loan scheme could be established to grant small seasonal loans in cash or kind to needy farm families. The loans could be repaid in farm produce as soon as the crops were harvested, and farmers who promptly repaid their loans could qualify to receive another.

Through a chain of agroservice centers, the government should make available fertilizers, improved seed, day-old chicks, feeds, insecticides, chemicals, and rental tractors and other farm equipment. These inputs would make it possible for farmers to adopt recommended technologies and achieve desired levels of production. Since Nigeria does not have a well-developed private agribusiness sector, the extension services of the state ministries of agriculture should procure and distribute these inputs until the private sector is capable of taking over this function.

When farmers are organized in groups, such as cooperative societies, their problems become more manageable because government officials can more easily provide them with useful information and advice. Rural women should be encouraged to join existing cooperatives or to form new producer-oriented agricultural cooperatives that could qualify to receive assistance from the government and commercial banks. Members should also be able to combine their

fragmented parcels of land and other resources to enhance agricultural productivity through collective work and ownership.

To move Nigeria from a subsistence rural economy to a modern exchange economy, the government must play a major role in providing the infrastructure. The government can demonstrate its concern for rural people by providing facilities such as access roads, water for drinking and irrigation, market stalls, schools, recreation and health centers, clinics and hospitals, electricity, communication systems, and agriculture-based industries. These will create employment opportunities and thereby retain youth in the rural areas.

These recommendations are broad. They suggest action that can be taken throughout rural Africa to enhance the productivity and contribution of rural women in agricultural development. Agricultural development planners in Nigeria must see women as a dominant and important force in agriculture. Unless women are so recognized and appropriate institutional and administrative changes are made, little progress can be achieved in the nation's aim to become self-reliant and self-sufficient in food and fiber production.

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Table 1. Characteristics of women farmers, eastern Nigeria, 1988.

Characteristic	Percentage of respondents reporting characteristic				
	Anambra (N=240)	Imo (N=200)	Cross River (N=260)	River (N=180)	Total (N=880)
Received no schooling	48	42	29	32	38
Attended primary school	40	43	50	57	47
Attended secondary school	7	9	18	7	10
Farms full-time	29	21	29	21	88
Has nonfarm occupation	53	77	63	88	71
Married	68	66	64	80	69
Widowed	27	26	23	13	23
Husband is farmer	42	43	30	69	44
Husband is not farmer	56	52	65	29	52
No children help with farm work	33	16	21	11	21
1 to 4 children help with farm work	58	71	54	64	61
Over half of income comes from farm	67	53	70	85	66
Spends less than ₦ 50 per wk on food	33	55	73	24	48
Spends ₦ 50 to ₦ 100 per wk on food	57	41	26	67	46
Spends more than ₦ 100 per wk on food	10	5	1	9	6
Hires labor for farm work	92	88	87	93	90
Obtains farm capital from family	85	80	86	82	83
Borrows farm capital	15	21	14	18	17

Table 2. Attitudes of women farmers, eastern Nigeria, 1988.

Attitude	Percentage of respondents reporting attitude				
	Anambra (₦240)	Imo (₦200)	Cross River (₦260)	River (₦180)	Total (₦880)
I like farming	83	89	86	89	86
I don't like farming	18	12	14	11	14
I do little farm work	4	5	2	7	4
I do much farm work	33	25	34	26	30
I feel overworked	23	29	42	28	31
I receive little or no help from husband	64	62	65	46	60
I receive much help from husband	36	38	35	54	40
Farm labor is scarce	55	64	36	49	50
Farm labor is available	45	36	64	51	50
Farm labor is relatively cheap	43	25	28	54	37
Farm labor is expensive	57	76	72	46	63
I would prefer a farming occupation	18	18	26	7	18
I would prefer a nonfarm occupation	82	82	74	93	82
I know the agricultural station	25	38	44	19	32
I don't know the agricultural station	75	63	56	81	68
I know the extension worker	8	31	53	9	27
I don't know the extension worker	72	70	47	81	73
I have visited the extension office	2	16	22	3	11
I have never visited the extension office	98	64	78	97	87
MOA is helpful to farmers	43	49	50	19	42
MOA is not so helpful	57	51	50	81	58

Table 3. Tree-crop production operations performed by women farmers in eastern Nigeria.

Operation	Percentage of respondents reporting operation									
	Anambra		Imo		Cross Rivers		Rivers		Total	
	Before 1970	1987	Before 1970	1987	Before 1970	1987	Before 1970	1987	Before 1970	1987
Clearing land	13	24	31	42	34	54	5	13	22	35
Burning	8	30	45	45	30	43	12	20	24	35
Stumping and removing burned sticks	8	22	9	46	21	37	13	23	13	32
Making ridges or mounds	22	24	31	34	34	46	12	13	26	30
Planting	23	25	28	34	45	48	12	13	29	31
Applying fertilizer	0	10	23	26	26	34	1	7	13	20
Maintaining farm	34	37	38	44	44	48	23	25	35	39
Harvesting	17	18	22	36	29	46	11	12	21	29
Transporting/carrying	32	41	65	68	60	62	27	27	47	50
Processing produce	10	20	81	84	69	71	28	29	49	51
Marketing produce	19	20	75	84	66	66	29	29	48	50
All activities	17	25	41	49	42	50	16	19		
t-test value	3.57*		2.73*		4.04**		3.04*			

*$p < 0.05$ **$p < 0.01$

Table 4. Food-crop production operations performed by women farmers in eastern Nigeria.

Operation	Percentage of respondents reporting operation									
	Anambra		Imo		Cross Rivers		Rivers		Total	
	Before 1970	1987	Before 1970	1987	Before 1970	1987	Before 1970	1987	Before 1970	1987
Clearing	40	70	49	52	14	79	6	16	20	57
Burning	65	65	50	52	53	46	4	35	45	60
Stumping and removing sticks	55	61	26	56	1	24	5	33	22	43
Making ridges or mounds	30	53	30	46	3	61	7	34	17	50
Planting	66	72	45	48	77	80	24	32	56	61
Staking yams	43	48	42	45	36	64	21	26	36	48
Weeding	69	73	69	72	73	76	9	42	58	64
Applying fertilizer	37	53	29	39	7	34	0	7	19	35
Harvesting	60	71	39	43	67	79	24	32	48	53
Preparing barn	38	45	23	32	32	52	19	22	29	39
Tying yams	40	48	19	30	39	48	18	21	30	38
Storing	54	57	38	40	55	59	24	26	45	47
Processing	39	42	40	43	54	62	19	19	39	43
Transporting/carrying	30	38	55	59	10	29	1	7	24	33
Marketing	67	72	56	60	73	74	29	38	58	63
All activities	49	58	40	47	39	59	14	26		
t-test values	4.52**		3.59**		4.01*		3.03**			

*$p < 0.05$ **$p < 0.01$

Table 5. Animal husbandry operations performed by women farmers in eastern Nigeria.

Operation	Percentage of respondents reporting operation									
	Anambra		Imo		Cross Rivers		Rivers		Total	
	Before 1970	1987	Before 1970	1987	Before 1970	1987	Before 1970	1987	Before 1970	1987
Preparing site	16	29	16	26	12	27	11	7	13	24
Building pens	15	35	16	35	14	32	7	21	14	31
Collecting feed	30	43	40	52	26	30	21	27	29	38
Fetching water	31	40	46	53	15	17	26	26	29	33
Feeding animals	33	44	43	53	10	36	8	26	23	40
Cleaning pens	35	44	41	54	24	33	19	27	30	39
Collecting eggs	40	49	40	66	30	42	26	37	34	48
Slaughtering/dressing	1	16	4	8	2	13	1	4	2	11
Marketing products	19	42	22	48	19	33	21	28	20	38
Composting wastes	12	33	18	52	4	15	2	26	9	30
All activities	21	34	26	40	11	25	13	20		
t-test values	6.20**		4.64**		5.39**		3.41**			

**$p < 0.01$

Table 6. Constraints to women's productivity as perceived by women farmers, eastern Nigeria, 1988.

Constraint	Percentage of respondents reporting constraint				
	Anambra (₦240)	Imo (₦200)	Cross River (₦260)	River (₦180)	Total (₦880)
Lack of capital and family resources	84	86	83	87	85
Male extension workers' do not work with women	86	70	57	86	74
Processing, transporting, and marketing problems	50	66	78	58	64
Lack of incentives from government	51	56	85	53	63
Shortage of farm labor	57	53	72	49	59
Strenuousness of farm work	53	46	81	39	57
Unavailability of programs	44	57	72	49	56
Shortage of land	34	72	49	71	55
Lack of basic education and training	39	40	67	28	45
Lack of infrastructure	25	16	32	23	25

ECONOMIC ASSESSMENT OF TRACTOR USE IN SUBSISTENCE AGRICULTURE: MOROGORO REGION, TANZANIA

Sylvery L. B. Ishuza

SUMMARY

Tractors have been introduced in parts of many Asian, African, and Latin American countries in recent decades, in an attempt to increase agricultural productivity in areas typically farmed with draft animals or hand hoes. In general, the results have been disappointing. Past studies have typically found that tractor use has reduced labor demand per hectare, increased production costs, and had no noticeable effect on yields. Differences in productivity which have occurred have usually been attributed to other yield-enhancing factors such as the use of fertilizers, insecticides, improved seeds, and water control.

Poor tractor management has been cited as a principal reason for the high costs and lower than expected yields associated with tractor use. Studies have found that tractor use experiments have been plagued with (1) poor record keeping, (2) lack of adherence to efficient land preparation schedules, (3) lack of spare parts and fuel, (4) inappropriate pricing policies, (5) high costs of tractor use relative to the value of crops cultivated, (6) favoritism and a lack of commitment on the part of some tractor owners and hired drivers, and (7) a poor record of tractor loan repayment. In many areas, tractor cultivation has also been hampered because tractors must travel long distances between farm plots that are small, awkwardly shaped, and badly cleared.

Tanzania has made several attempts at improving agricultural productivity by the provision of tractors to areas traditionally cultivated by hand hoe. Experience from past failures and the urgent need for increased agricultural output led the government, in 1985, to organize a tractor pilot project in Morogoro region. Under this project, private individuals, villages, and cooperatives have been allowed to own tractors on a credit basis by making a downpayment equal to at least half the value of the tractor. Tractor owners are then required to send their tractors to assigned sites in designated crop production zones where farmers come to hire tractor services for land preparation prior to planting.

Survey data was obtained for the 1986-87 growing season from a sample of farmers in two zones of Morogoro region's Morogoro District. A total of 47 farmers who used tractors for land preparation and 32 farmers who relied on hand hoes were interviewed for the study.

It was found that, on average, farmers who hired tractors were older, had more farmland, and had slightly larger households than farmers who did not hire tractors. Both categories of farmers farmed small, scattered plots and the majority of farmers in both categories hired farm labor to supplement family labor sometime during the season. Most farmers did not use fertilizers or insecticides.

No statistically significant difference in maize yields per hectare was found between households that did and did not use tractors for the 1986-87 season. However, 57% of the surveyed farmers who used tractors reported that they did not receive tractor services in time to meet optimal planting schedules, and other indications of poor tractor management were detected.

Most farmers surveyed practiced monocropping, regardless of their method of cultivation. However, a comparison of the 1985-86 season with the 1986-87 season reveals a substantial increase in the practice of monocropping by farmers who used tractors, and a substantial decrease in the practice of monocropping by farmers who relied on hoes. This suggests tractor use may be linked to the shift from mixed cropping to monocropping, which is consistent with government policy, but contrary to traditional methods of minimizing farming risks.

Survey results indicate that the use of tractors for land preparation reduced labor requirements by nearly 46.2 man-days per hectare. Therefore, in areas where labor is abundant and wage rates are low, using tractors to clear land is not justified. However, in situations where labor for clearing land is scarce and timely planting is critical, the use of tractors may be essential to enable farm expansions and ensure timely planting.

Tractor cultivation can only improve the timing and efficiency of farm operations in Tanzania to the extent that the tractors are well managed and efficiently organized. The following recommendations are made toward this end:

- Records should be kept that enable cost-effective use of the tractors, and individual tractor ownership should be encouraged to ensure that individuals have a personal stake in managing the tractors efficiently.

- Land clearing schedules should be devised and followed that ensure timely planting with a minimum of unproductive travel time.

- Tractors should be regularly serviced, and spare parts and fuel should be made available at reasonable costs.

- Farmers' fields should be free of stumps, and farmers' landholdings and tenure arrangements should be reorganized, where feasible, to consolidate small plots into larger fields for more efficient tractor cultivation.

- Tractor use should not be restricted to clearing land if there are other tasks for which tractors can be profitably used that do not compete with land clearing operations.

- Tractor hire charges should be responsive to local economic conditions and should not be restricted to a particular hire rate.

Proper tractor management alone will not suffice to increase agricultural productivity. Many factors interweave to influence farm decisions and determine crop output and yields. Essential inputs such as fertilizers and insecticides need to be made available on a timely and affordable basis. Extension agents must assist farmers to maintain proper crop husbandry practices. Necessary infrastructure, such as roads, market centers, and lending institutions must be available to farmers to facilitate market production and sales. Finally, to avoid extensive use of parallel markets and the resultant distortion of crop output data, the government should offer attractive producer prices.

Accordingly, it is recommended that the decision to promote tractor use be made cautiously, as part of an evaluation of a locality's need for a whole range of farm inputs and infrastructure, and that any such decision take into account the locality's demand and supply of land and labor, and its incentive and ability to manage the tractors efficiently.

Worldwide food demand has increased at an alarming rate in recent years. It is estimated that by the year 2000 a world population of more than 6 billion will require an agricultural output that is 50% to 60% greater than in 1980 (Higgins, Kassam, and Naiken, 1982, p.13). Similarly, the United Nations Food and Agricultural Organization (1981) predicts that the demand for food and agricultural products in developing countries will double between the years 1980 and 2000. Given these predictions, it is not surprising that researchers and policy makers are questioning whether developing countries are taking the right measures to reconcile their population growth and food demand with the resources at their disposal.

Tanzania's struggle to provide food for its growing population is a case in point. Efforts to feed its citizens have been crippled by a rapid population growth rate of about 3.7% and periodic droughts. Chronic food shortages and massive food import programs have resulted. In response, the government has experimented

with various agricultural programs in an attempt to increase agricultural productivity. One such program has been the trial introduction of tractors in areas traditionally farmed by hand hoes. Many countries have introduced mechanized agriculture to traditionally farmed areas, with varying degrees of success. Tanzania has made several such efforts.

This study reviews the evidence from past experiments with improving productivity through use of mechanized agriculture, and specifically evaluates the production and resource augmentation and displacement effects of the provision of tractors to Tanzania's Morogoro District during the 1986-87 crop year.

THE HISTORICAL RECORD: INTRODUCING MECHANIZED AGRICULTURE TO TRADITIONALLY FARMED AREAS

Tractor cultivation has been introduced to several parts of the world in recent decades, including many Asian and African countries, in an attempt to increase agricultural productivity in areas typically farmed with draft animals or hand hoes. In general, the results have been disappointing.

Experience of Other Countries

According to Farrington, Abeyratne, and Gill (1983), a major evaluation of the effects of tractor use in Sri Lanka was conducted in 1979. This study concurred with an earlier study by Carr (1975) and a later study by Burch (1980) which reported that the introduction of tractors did not bring about a significant difference in crop yields when tractor cultivated farms were compared with farms cultivated by other means.

In another study in Sri Lanka, Farrington and Abeyratne (1982, p.113) found that tractor ownership was strongly associated with the operation of multiple economic enterprises, among which farming was not the primary generator of net income. Tractors owned by business people, as opposed to those owned by farmers, were used mostly for nonagricultural activities. The researchers also found that the farms of potential tractor hirers were commonly 1.0 ha to 1.25 ha in size and that small farms such as these presented substantial obstacles to the intensive use of tractors. The use of tractors in tillage operations was not found to contribute to an improvement in the timing or synchronization of paddy cultivation. Similarly, the quality of tilth, control of weeds, and crop yields achieved with tractor cultivation were not superior to what was achieved using traditional farming methods. Observed yield differences were attributed to other yield-enhancing inputs such as fertilizers.

Farrington and Abeyratne (1982) observed that tractor use displaced mostly family labor, and that overall labor use per hectare on tractor owners' farms was substantially lower than on the farms of those who relied on water buffalo to pull the plow. Labor displacement on tractor owners' farms was also found to be greater than on the farms of those who hired tractor services.

Latin American researchers have argued that a precise assessment of the effects of agricultural mechanization on yields and employment is not possible because the necessary farm-level information is scarce and difficult to isolate. Diaz (1962, pp. 42-43) points out that the farmer who mechanizes farm operations is often the progressive one who goes in for many other improvements as well, making it almost impossible to sort out the influence of each on productivity. Abercrombie (1973, p.55) has concluded that, "what is important in operational terms is to determine the overall technological package that will enable production targets to be met and at the same time provide as much employment as is feasible."

Abercrombie also observed that the direct effect of tractor use on yields per hectare has been much less than the effects of other yield-enhancing practices such as the use of improved seeds, fertilizers, pesticides, herbicides, and water control. Regarding labor effects of mechanization, he asserts that labor productivity could increase for those few workers employed on mechanized farms, but that this increase would be at least partially offset by a decline in the productivity of the workers directly displaced by mechanization.

In Pakistan, McInerney and Donaldson (1975) have reported that no significant differences were found in desi rice yields, cotton yields, or sugar cane yields, before and after the use of tractors on farms. However, Ahmed (1972) argues that one of the reasons for the lack of evidence of yield effects in Pakistan is that the tractor owners were performing tillage operations with a simple cultivator, and thereby merely mechanizing the primitive desi plow.

Statistical studies of tractor use in Brazil also did not find a strong yield effect. Cline (1970, p.188) regressed yield per hectare against the number of tractors per hectare and the amount of fertilizer used per hectare for 117 rice farmers in the south of Brazil. Although the results showed a statistically significant, positive correlation between tractor use and yields, the magnitude of the correlation was negligible. Estimation of the function using the highest observed tractor/area ratio showed a yield only 0.02% higher than the estimated yield for production without tractors.

According to Buchele (as cited in Shaw, 1970), yields in Japan reported in 1960 for highly mechanized farming were not higher than those reported for land farmed by hoe.

Similarly, in the Punjab province of India, for the 1971-72 and 1972-73 seasons, Kahlon (1976) found no statistically significant yield difference between tractor farms and bullock farms. Studies conducted in the Delhi territory and Nepal revealed that statistically significant yield differences between 10% and 30% existed between tractor farms and bullock farms in the Delhi territory (Singh and Singh, 1972). However, it is suggested that the observed yield differences are attributable to differences in fertilizer application rather than tractor use. Shaw (1970) and Binswanger (1977) found tractor use had no significant effect on crop yields in studies conducted in India.

Greenland and Lal (1977) observe that the introduction of mechanized schemes in the humid tropics has led to wide-spread barren and unproductive lands. Similarly, studies comparing mechanized clearing and the traditional slash-and-burn system practiced in the tropics have revealed that inferior crop yields have been obtained using mechanized clearing, with and without the use of fertilizers (Sanchez, 1976, p.618). Further studies conducted in the tropics show that there has been a decline in soil fertility and a deterioration in soil conditions as a result of continuous tractor cultivation (Okigbo and Lal, 1978).

Ley (1983) found that the principle cause of low and variable yields in some parts of the tropics is the frequent occurrence of unsatisfactory soil moisture regimes. Tractor cultivation can adversely affect soil moisture regimes in the tropics by increasing the water evaporation rate, and by increasing the water-nutrient infiltration rate during heavy rains, causing essential nutrients to leach below crop root depth. This is particularly evident where tractor cultivation results in deeply tilled soils. Curf (1976, p.179) and Khatibu (1981), in Nigeria and Tanzania, respectively, further observed that soil moisture content was lower in tilled soils compared with untilled soils, particularly during dry spells in the rainy season. Tractor cultivation, particularly on damp soils, can also result in soil compaction, which adversely affects soil aeration, water infiltration, and crop root penetration.

Arguments in favor of mechanized agriculture have been reported in Java, where agricultural agents and government officials have claimed that overdependence on draft animals and hand methods causes delays and reduces cropping intensity (Saefudin et al., 1983). They have suggested that power tillers and tractors can lead to increased yields because these implements can prepare soils more deeply and thoroughly. As a result, farmers in the densely populated islands of Java and Bali, and the sparsely inhabited outer islands of Sulawesi and Sumatra have been encouraged to purchase power tillers and mini-tractors, respectively. However, the preliminary results of a study conducted in West Java by Saefudin et al. (1983) for the years 1970 and 1980, covering two dry seasons and one wet

season, indicate that mechanization (1) had no effect on yields, (2) had little, if any, effect on cropping intensity, and (3) sharply reduced labor use.

In Uganda, the introduction of tractor cultivation did not bring about a significant increase in agricultural or labor productivity. The use of tractors on an organized basis began as early as 1947 when Worthington (1949, pp. 29-30, 87-90) identified the need to introduce tractors into the country to make proper use of land for productive purposes. To facilitate mechanized cultivation, he suggested the establishment of central government farms surrounded by small tenant holdings. One such set-up was the Busoga scheme which started production in 1950. Found to be unsuccessful, this scheme was officially discontinued in 1954. A study of the Busoga scheme was conducted by Jones (1960), who concluded that although there was no evidence to prove that mechanized cultivation was generally uneconomic in Uganda, general market conditions and price structures for annual crops in Uganda made it extremely unlikely that the type of crops that could be grown in a place such as Busoga could produce returns sufficient to cover the higher costs of mechanized cultivation. The value of crops grown was identified, therefore, as a key factor in the determination of the level of returns necessary to economically justify tractor use.

The Bunyoro Agricultural Company, Ltd., was another large-scale mechanized farming scheme which was launched in 1954, with a set-up similar to the Busoga scheme. It also did not perform well, and was brought to an abrupt end in 1956 (Clayton, 1973, p.25). The main reasons for the failure of the scheme were reported to be sociological factors and low crop revenues relative to the cost of mechanization.

In addition to the introduction of mechanized agriculture on large government schemes, Uganda promoted the use of tractors through the establishment of the Uganda Government Tractor Hire Service, which was initiated in 1948. After the failure of this service, the government encouraged the individual ownership of tractors. Hall (1969), who evaluated the performance of the tractor hire service between 1947 and 1967, observed that the annual deficits associated with mechanization during the review period reached alarming proportions. On the basis of his findings, he suggested that the yield-increasing potential of tractor cultivation was lost due to inadequate extension follow-up to ensure that crop husbandry standards were maintained.

Hall also found that the new tractor owners encountered financial difficulties largely because they allowed the tractors to travel long distances between plots that were often small, awkwardly shaped, and badly cleared. In his assessment of mechanization and employment in Uganda, Clayton (1973) remarked "many of

the new owners were quite wealthy and able to absorb the losses involved; but others found that as the tractor aged they could not afford the necessary repairs and loan repayments." Nevertheless, Hall concludes that private tractor ownership has several advantages over other mechanization schemes. In particular, he points out that (1) private owners have a clear self-interest in keeping costs down, (2) private tractor owners are likely to have local knowledge of their potential customers and customers' land, and (3) private contracting might encourage the growth of rural entrepreneurship.

The effect of tractor mechanization on rural labor use was also studied in Uganda in the early 1970s. Based on a working day of eight hours, it was estimated that about 183.8 man-days per hectare were required for cotton cultivation, including land preparation, weeding, and harvesting operations, when hand hoes were used. This labor requirement was reduced by more than 50% (to 78.4 man-days per hectare) when mechanical cultivation was substituted for hand hoes (MacFarquhar and Hall, 1970).

The use of oxen, as opposed to tractors, was experimented with in some parts of Uganda as a capital-saving farm technology. While the use of oxen may have required less capital than the use of tractors, studies conducted in Uganda's Lango District revealed that the effect on employment was no less discouraging than when tractors were used (Okai, 1966).

In Kenya, the government's attempt to improve agricultural productivity by facilitating the purchase of tractors by smallholder contractors was also deemed unsuccessful. The Kenya government obtained financing from the International Development Association which enabled it to purchase 210 tractors with auxiliary equipment between 1967 and 1968. The exercise was found to be a costly failure with no evidence of increased production or employment generation (Clayton, 1973). According to the study conducted by White and Downing (1968), most farmers purchased tractors to enhance their prestige and made little effort to increase the cultivated area on their farms. In other cases, poor tractor management and misuse of equipment restricted output. The study also found that the record of loan repayment was dismal, and that the tractors had deteriorated to the point where their market value was less than the amount of the outstanding loan.

Tractor Use in Tanzania

Most farmers in Tanzania rely on hand hoes to cultivate small plots on which they attempt to produce enough to meet their families' basic food and cash requirements.

The use of tractors in Tanzania dates back to 1942, when plows were introduced in the lake shore area of Rungwe District to mechanize rice farming. By 1944, about 400 plows were being used in the area (Sterkenburg, 1970). However, there is no evidence that this tractor use produced any significant economic advantages.

In the 1950s, the government of mainland Tanzania (then Tanganyika) attempted to expand tractor cultivation by allowing smallholder farmers to own tractors and by setting up tractor hire stations. It is reported that the tractor hire service was a financial failure and that only half of the costs incurred were ever recovered from the farmers (Clayton, 1973). The results are reflected in a World Bank mission report published in 1961 which, in its assessment of mechanization in Tanganyika, stated that, "...there are rather few farmers who can at present benefit from loans to buy tractors" (International Bank for Reconstruction and Development, 1961, p. 117).

Despite these findings, after independence, the newly formed Tanzanian government encouraged an increase in agricultural productivity through mechanized cultivation. This move was reflected in the nation's first 5-year development plan (1964 to 1969), which resulted in the establishment of 74 cooperative farming villages. The village settlement schemes allowed for mechanized land clearing and cultivation, and the development of infrastructure Between 1963 and 1965 the government purchased 673 tractors, worth a total of T Sh 18 million (Tanzanian shillings). Most of these tractors were then loaned to the marketing cooperatives, local and central governments, and individual farmers through the National Development Credit Agency (Sterkenburg, 1970; Clayton, 1973).

Various studies have evaluated the success of tractor use in Tanzania during the period 1963 to 1966. Ruthenberg (1964) observed that the main reason for the failure of the groundnut scheme established in the 1960s was that mechanized clearing was conducted on marginal soils which could not provide adequate returns. Similarly, regarding cooperative farming in Tanzania, Ellman (1969, p.3) remarked that, "in almost all cases mechanization was introduced automatically without due regard to whether it was economically justifiable or technically feasible."

According to Sterkenburg (1970), an economic evaluation of tractor use at the Unyakyusa Cooperative Union was not encouraging. Although poor record keeping hampered a thorough evaluation of tractor performance, an analysis based on available information for the 1966-67 season indicated that the tractor account lost money. Out of 480 farmers whose plots were cultivated by the society, only 23 paid the full amount in one installment, and most of the farmers who hired the tractors on a credit basis could not repay the loan. Poor tractor

management was cited as a principle reason for the excessive costs of tractor cultivation. For example, frequent tractor breakdowns resulted from the inadequate training of tractor drivers, and the maintenance and repair of tractors was problematic. Also, tractor operations were not performed according to a timely and efficient schedule.

Between 1964 and 1969, the Tanzanian government also encouraged tractor use in block cultivation schemes. The main goal was the more-efficient use of the 158 tractors and associated implements operated by the Victoria Federation of Cooperative Unions. This was to be accomplished by consolidating cotton fields into optimum-sized 300 acre (121.5 ha) plots on which 75 families were to cultivate 4 acres (1.62 ha) each (Heijnen, 1969). In practice, about 50 blocks were established, averaging 153 acres (62 ha) per block. Poor tractor management at cultivation time was blamed for the failure of this scheme. Heijnen observed that the blocks probably would not be able to afford new tractors once their existing stocks were beyond repair, and concluded that "the obvious solution would be the use of ox-drawn implements."

By 1966 the government recognized the shortcomings of policies that overcapitalized the cooperative farming schemes and oversubsidized farm mechanization in the villages. It announced that future emphasis would be on "modernizing existing traditional villages by injecting capital and technical services to enable the farmers to work together and obtain the benefits of modern farming techniques" (Ellman, 1969). The second 5-year development plan (1969 to 1974) reflected a more cautious attempt at promoting tractor cultivation. It concentrated on state farms from which tractor hire services could be obtained, and encouraged the Ujamaa villages to own tractors. Also, an emphasis was placed on the use of ox-drawn cultivation and the design of animal-drawn implements. To date, however, the success of ox-drawn cultivation remains unproven in Tanzania.

In Morogoro region's Morogoro District, tractor cultivation was seized upon as a means of implementing the Tanzanian government's Resources Deployment Act, which was established in May 1983. Tractors in the district were organized into a hire service supervised by the Morogoro Town Council. About 20 tractors, along with tractor drivers, supervisors, and fuel, were stationed in selected camps near the farmers' fields surrounding Morogoro town. The mobilization of the tractors was so spectacular during the 1984-85 cropping season that most observers felt certain that implementation of the act, commonly referred to as "NGUVU KAZI" (able-bodied persons should work) would succeed. Unfortunately this was not to be the case. Indeed, in subsequent seasons the tractor-hire service was virtually inoperative. Little documented information is available on the use of these tractors, and no comprehensive evaluation of the tractor-hire service's

performance has been conducted. However, mechanization officials in the District Agricultural Development Office attribute the tractor-hire service's failure to frequent tractor breakdowns with no available spare parts and to high operating costs with insufficient income generated from tractor leasing. Farmers complained that their fields were left unplowed or haphazardly plowed, at best.

The need to increase agricultural productivity and the failure of past mechanization strategies led the government, in 1985, to organize yet another farm mechanization experiment. This time, 100 Fiat tractors were obtained with the help of Italy and the Food and Agricultural Organization. These tractors were allocated to the Morogoro region as part of a pilot project aimed at increasing food crop and cash crop productivity. If successful, similar projects were to be introduced in other regions of Tanzania.

A significant difference between this project and previous organized attempts at mechanization is that private individuals, as well as villages and cooperatives, were allowed to own tractors on a credit basis. To limit potential losses on the tractors and in an attempt to ensure owners had the capital resources necessary to operate and maintain them, the government required a down payment on each tractor sold, equal to at least half the value of the tractor. This limited the individual ownership of tractors to the relatively wealthy minority of the district's population, mostly business people. Payments were made to a credit institution, the Cooperative and Rural Development Bank.

Morogoro District received 80 of the 100 tractors allocated to the Morogoro region. Of these, 43 (54%) were sold to individuals, 32 (40%) were sold to villages and cooperatives, and the remaining 5 (6%) were sold to the District Council. While individuals and private groups may own the tractors, the government has retained considerable regulatory control over their use. Each tractor has been assigned to one of 11 crop production zones that were identified by district and regional authorities. At cultivation time, tractor owners are required to send their tractors to assigned sites in the production zones where farmers come to hire the tractors. Tractors have been confiscated and repurchased from owners who have not abided by this regulation. This has frustrated the tractor owners, who, having paid for the tractors, believe they should be allowed to retain decision-making control over their use.

MOROGORO DISTRICT CASE STUDY

A study of the tractor pilot project in the Morogoro region was conducted to assess the project's effects on agricultural productivity and resource use. Particular

attention was focused on determining the possible influence of tractor use on maize yields, cropping patterns, and labor use in maize production.

Data Collection

Data was obtained for the 1986-87 growing season from a sample of farmers in two zones of Morogoro District. The southern zone (including the villages of Bonye and Mbwade) and the northern zone (including the villages of Mkundi, Wami Dakawa, and Mvomero) were selected due to their accessibility and importance in maize production. A total of 83 farm households were randomly selected from the two zones, including those which cultivated with tractors and those which relied on hand hoes. In those cases where farmers were unavailable at scheduled interview times (because they were busy harvesting crops), alternate farm households were randomly selected for the survey. Four of the households were eventually dropped from the study because they were unable to provide the necessary survey information. Ultimately, 47 farmers who cultivated with tractors and 32 farmers who cultivated with hand hoes were interviewed for the study.

Information on (1) maize hectarage, yield, and output, (2) fertilizer and pesticide usage, (3) use of family and hired labor, (4) other crops grown in the study area, and (5) household and farm characteristics was obtained from heads of households by trained enumerators using pretested, structured questionnaires. Households did not keep written farm records, so the survey relies upon the accuracy of figures reported from memory. Additional information was gained from authorities in the district's maize production zones, including village chairpersons, village secretaries, and extension agents.

Socioeconomic Characteristics

Various socioeconomic characteristics of the farm households were surveyed to determine whether significant differences existed between households that cultivated with tractors and households that cultivated with hoes (see table 1).

In Tanzania, it is common to find that males head most farm households and are responsible for most of the farm production decisions, whereas much of the production activity is physically conducted by females. In this study, about 96% of the households surveyed were headed by males and, on average, household members included slightly more males than females. These characteristics did not vary significantly by the household's method of cultivation.

Household size was found to be slightly larger on tractor-cultivated farms. These households had an average of 10 persons per household compared with an

average of 8 persons per household on hoe-cultivated farms. On average, half of the members of each category of household were described as working persons, providing tractor-cultivated farms with a slightly larger family labor force. Both categories averaged four children per household, although households using tractors had a higher percentage of children attending school.

Households cultivating by tractor also tended to have significantly larger farms, which can be indicative of relative wealth or financial security. On average, farms cultivated by tractor were 1.46 ha in size, which is 60% larger than the average size (0.91 ha) of farms cultivated by hoe. In general, larger farms are associated with greater income-earning potential and greater total labor requirements, both of which make tractor use more feasible.

Differences in farm size, household size, effective family labor force, and in the percentages of children attending school may be partially a reflection of differences in the age structure of households surveyed. Members of households cultivating by hoe tended to be younger, with head of households averaging 41.5 years old (standard deviation of 32), compared with an average age of 48.3 years (standard deviation of 12) for head of households using tractors. The former category included the majority of young men, who could be expected to have younger children and less farmland than older farmers. They could also be expected to have less financial ability to hire tractors and more energy and stamina necessary for cultivation by hoe.

Farm Configuration and Management

The feasibility of tractor use is dependent, in part, on the number, size, and location of a household's farm plots. Smaller and more widely scattered plots require more tractor turns per hectare and more unproductive driving time between plots per hectare, both of which reduce the economic efficiency of tractor cultivation.

Small, scattered farm plots are characteristic of subsistence farming in Tanzania. Most farmers acquire land through inheritance (customary law), which means farms may be passed on in whole, or in part, to offspring and extended family members. Farmers may acquire additional land from their village governments, which are legally authorized to allocate unoccupied village land to whoever has the ability to develop it. The village governments retain ownership rights to the village lands they allocate to farmers. These lands stay unused for a long period (say more than 5 consecutive seasons). Hence, such village land could be reallocated to somebody else in search of it. These practices, coupled with Tanzania's growing population, have led to the existence of many small, fragmented farms.

Eighty-eight percent of the surveyed farmers who cultivated by hoe had fragmented farms, compared with 83% of the farmers who used tractors. Households that cultivated by hoe had an average of 1.8 farm plots, averaging 0.506 ha in size, for a total mean farm size of 0.91 ha. In comparison, households that used tractors farmed an average of 2.2 farm plots, averaging 0.664 ha in size, for a total mean farm size of 1.46 ha. Therefore, on average, households that used tractors had 60% more land, slightly more plots, and a mean plot size about 31% larger than the mean plot size of households who relied on hoes (see table 2).

The average distance from homesteads to a household's scattered farm plots was 3.5 times greater for the households that hired tractors than for those that did not (see table 2). The average distance between plots and homesteads was 4.6 km for households that hired tractors. Therefore, a significant proportion of total tractor hours was spent traveling between plots.

The time required to cultivate a given area of farmland by tractor is an indication of the conditions of the farmers' fields. In 1987, discussions with officials of the Ministry of Agriculture and Livestock Development in Dar es Salaam revealed that the commonly suggested time required for plowing was 30 to 45 minutes per acre (37 to 56 minutes per 0.5 ha). Survey results show that plowing actually required an average of 60.1 minutes per acre (74.2 minutes per 0.5 ha). This suggests that most of the farmers' plots were rough and awkwardly shaped, necessitating frequent tractor turns and slow driving speeds in the fields and thereby further reducing the potential economic efficiency of tractor use.

Survey results also show that most farmers hired labor to supplement family labor during the 1986-87 growing season, and most farmers did not use fertilizers. About 70.2% of households that cultivated with tractors hired labor compared with 53.1% of the households that cultivated by hoe. The average amount of labor hired was 42.5 man-days per hectare and 32.2 man-days per hectare, respectively, for the two categories of households. In contrast, the percentage of households that applied fertilizer was slightly higher for the households that relied on hoes than for those that used tractors (see table 2).

Maize Productivity

Farm output can be enhanced by increasing the total area cultivated and by increasing yields per hectare. Theoretically, with its time- and labor-saving advantages, tractor use can increase total output by making it possible to farm areas that would otherwise remain uncultivated due to seasonal labor shortages or excessive travel time to fields. Survey results show that households using tractors farmed more land than households relying on hoes; however, the cross-

sectional data does not indicate whether tractors were employed because households had more farmland or whether households farmed more land because they had access to tractors.

The yield of any agricultural crop is influenced by several factors, including timely planting, weeding, and harvesting; the use of improved seed; optimum plant spacing; timely and sufficient rainfall or irrigation; and appropriate use of fertilizers and pesticides. The use of tractors for land preparation can be advantageous if it ensures that land preparation will be completed by optimal planting dates, particularly where rain-fed agricultural production is practiced. In most areas of Morogoro District, optimal land preparation time is limited by the timing and duration of the area's rainy and dry seasons. Timely land preparation can be a critical yield determinant because the amount of land a household can farm depends on how much it can till by the optimum planting dates.

Average maize yields were compared between households that used tractors and those that did not use tractors to determine whether there was a significant difference in yields per hectare. No statistically significant difference was found between the yields at the 5% level of significance. A comparison of maize yields between farmers who did and did not use tractors in the previous season was also made, and these results also showed no statistically significant differences in maize yields per hectare. One can conclude from this that the use of tractors in the survey area did not bring about a significant increase in maize yields when compared with yields obtained without the use of tractors. However, further analysis indicates that other factors, such as poor tractor management, may have restricted yields by preventing the optimal use of the tractors.

Information on the manner in which tractors were organized at the time of land preparation was gathered from village leaders and village extension agents to gauge the role of tractor use in ensuring optimal planting schedules. However, no proper records were kept on the tractors which belonged to the villages. At best, a list was maintained of drivers who were fired due to tractor misuse. It was also reported that the individuals who owned tractors were reluctant to release tractors to places they did not prefer, so that farmers in some places could not obtain tractor services. Individual tractor owners were unwilling to provide information on the use of their tractors, particularly regarding the hectarage cleared and the revenues realized. At best, they complained of a lack of spare parts and diesel fuel. Also, villagers were critical of village leaders whom they felt regarded the village tractor as their own private property.

About 57% of the surveyed farmers who used tractors reported that they did not obtain the tractors in time to allow for optimum planting schedules. When asked

why they did not receive the tractors in time, the farmers responded that (1) there were not enough tractors, (2) there was a poor system of tractor allocation to farmers (for example, farmers with strong financial backing were given first priority), (3) their finances were insufficient at cultivation time, and (4) farmland could not be easily obtained in time from village government officials (see table 3). Therefore, poor tractor management may have contributed to lower than expected yields on tractor-cultivated farms.

Yields for both tractor-cultivated and hoe-cultivated farms were lower than expected, however, indicating the importance of other factors in yield determination. The average maize yields for both categories of farmers were about 74% lower than the recommended level of 3,375 kg/ha.

One possible reason for the relatively low yields on both categories of farms is the lack of fertilizer and pesticide use on most farm fields. Another important determinant of crop yields are the thoroughness and timeliness of weeding operations. Herbicides are prohibitively expensive for most farmers, who instead must rely on family and hired labor for weeding operations. However, hired labor has its limitations. As observed by Kline, Green, Donahue and Stout (1969), "In areas where antipathy exists between different groups of villagers, commercial enterprises cannot assume that local hand labor can be hired easily since different village groups may not be willing to work together." The same situation may arise at the household level where certain farming operations such as weeding require substantial amounts of labor. A knowledge of the potential labor force to be hired is, therefore, essential, as is the ability to pay for hired labor when it is required.

Travel to and from farm plots requires both time and energy. Therefore, farmland which is distant from farm homesteads is apt to receive less tending than farmland close to a farmer's home. This observation is supported by survey results, which show a negative relationship between maize yields and the distance between homesteads and farm plots for households that did not use tractors. It was found that maize yields tended to decrease at an increasing rate with distance.

Low official prices for farm crops have encouraged the establishment of parallel markets in Tanzania. Sales to parallel markets might also account for lower than expected reports of total maize output.

These findings indicate that the introduction of tractors alone will not necessarily lead to increased crop yields or output. Many other factors, such as tractor management, farmland and labor availability, use of other yield-enhancing

inputs, and the timeliness of farming operations influence the extent to which tractor use can increase crop production.

Cropping Patterns

Subsistence farmers commonly use intercropping techniques to reduce the risks and uncertainties associated with farming. Intercropping, as opposed to planting crops in sole stands, reduces the risk of crop failure due to drought, diseases, and pests, can protect and enhance the soil, and provides some insurance of meeting basic food and cash requirements regardless of changes in crop prices. When asked to comment on cropping patterns in the study area, however, three prominent agricultural extension agents said it was the policy of the Ministry of Agriculture and Livestock Development to encourage farmers to practice monocropping instead of mixed cropping.

Cropping patterns were investigated in the study area to determine whether tractor use was associated with particular cropping practices (see tables 4 and 5). It was found that most farmers surveyed practiced monocropping, regardless of their method of cultivation. A comparison of the 1985-86 season with the 1986-87 season, however, reveals a substantial increase in the practice of monocropping by farmers who used tractors, and a substantial decrease in the practice of monocropping by farmers who relied on hoes. These results suggest tractor use may be linked to the shift from mixed cropping to monocropping, which is consistent with government policy, but contrary to traditional methods of minimizing farming risks.

Labor Use

Tractor use will increase the demand for labor providing it results in much more intensive cultivation, or in the cultivation of lands that would otherwise not be farmed. Although tractor cultivation reduces the per-hectare labor requirements for land preparation, it can increase the total labor requirements for other field operations such as planting, weeding, fertilizing, pesticide application, and harvesting, by stimulating more intensive or extensive cultivation.

An increased demand for labor will translate into increased employment only if labor is available at mutually acceptable wage rates. For example, the current official wage rates of T Sh 48.45 and T Sh 40.45 per man-day for urban and rural unskilled labor, respectively, are considered unattractive -- particularly when the cost of living is continuously rising. In practice, labor is hired on a piece-work basis rather than per man-day in rural areas. Survey results indicate that on an average per-hectare basis, T Sh 5,100.00 and T Sh 3,400.00 was spent for labor on maize fields by tractor-cultivated and hoe-cultivated farms, respectively. When

these figures are converted into a per man-day basis, the average wage rates paid were T Sh 120.00 per man-day on tractor-cultivated farms and T Sh 105.59 per man-day on hoe-cultivated farms. These rates are more than 2.6 times the official rate in rural areas.

The demand for farm labor is higher during peak maize weeding periods, pushing up farm wage rates. Increases in maize hectarage would further escalate wage rates during these periods, particularly because many hired farm laborers have their own plots to tend, as well.

Surveyed farmers were asked how many man-days of labor were required per month to complete various field operations for one acre of maize. These estimates were converted to a per-hectare, eight-hour working day basis (see table 6). It was found that an average of 151.4 man-days of labor were required per year to farm one hectare of maize without the use of tractors. This is consistent with the findings of Ishuza (1984) and Boesen and Mohele (1979), who obtained comparable figures for maize labor requirements of 159.7 man-days per hectare for the Tabora region of Tanzania, and 142 man-days per hectare for Tanzania, respectively.

Survey results suggest that the use of tractors for land preparation reduced labor requirements by nearly 46.2 man-days per hectare. Therefore, unless labor displaced by the use of tractors is absorbed in other productive activities, such as the farming of additional land or the cultivation of other crops, tractor use will adversely affect the demand for labor and result in little or no net economic benefit. As indicated above, whether the introduction of tractors leads to the cultivation of land that would otherwise not be farmed, thereby increasing crop output and the demand for labor, depends, in part, on the availability of such land and on the availability of the necessary labor force to farm the land at acceptable wage rates.

CONCLUSIONS AND POLICY RECOMMENDATIONS

According to standard production theory, land, labor, and capital resources must be combined in an optimal manner if optimal production goals are to be achieved. Therefore, policies which require the use of certain combinations of resources, or which would result in the substitution of one resource for another should be considered in light of the relative availability and optimum use of each resource.

The use of tractors for land clearing operations did not result in a noticeable difference in maize yields per hectare in the survey area. This is consistent with most of the previous studies cited which evaluated the effect of tractor use on

yields. Tractor use was found to increase the cost of land clearing per hectare and to significantly reduce per hectare labor requirements. Therefore, in areas where labor is abundant and wage rates are low, the use of tractors for clearing land is not justified. However, in situations where labor for land clearing is scarce and timely planting is critical, the use of tractors may be essential to enable farm expansions and ensure timely planting.

Tractor cultivation can only improve the timing and efficiency of farm operations in Tanzania to the extent that the tractors are well managed and efficiently organized. The following recommendations are made toward this end:

- A system of record keeping should be used that enables cost-effective use of the tractors. Daily records should be kept on tractor use, revenues, and expenses.

- Land clearing schedules should be devised and followed that ensure timely planting with a minimum of unproductive travel time. Drivers should be provided with incentives to avoid fraud, and a roster of the farmers desiring tractor services should be maintained.

- Tractors should be regularly serviced, and spare parts and fuel should be made available at reasonable cost, to minimize service disruptions during critical periods.

- Farmers' fields should be free of stumps and other impediments to tractor cultivation.

- Farmers' landholdings and tenure arrangements should be reorganized, where feasible, to consolidate small, irregularly shaped plots into larger fields for more efficient tractor cultivation.

- Individual tractor ownership should be encouraged to ensure that individuals have a high personal stake in managing tractors efficiently.

- Tractor use should not be restricted to clearing land if there are other tasks for which tractors can be productively used without interfering with land clearing operations (such as hauling produce, building materials, and firewood).

- Tractor-hire charges should be responsive to local economic conditions, and should not be restricted to a particular hire rate.

The results of this study suggest that proper tractor management alone will not suffice to increase agricultural productivity. Many factors interweave to influence farm decisions and determine crop output and yields. A package of inputs responsive to farmers' needs must be advanced to farmers if agricultural productivity is to be increased. For example, essential inputs such as fertilizers and insecticides need to be made available on a timely and affordable basis. Extension agents must assist farmers to maintain proper crop husbandry practices. Necessary infrastructure, such as roads, market centers, and lending institutions must be available to farmers to facilitate market production and sales. Finally, to avoid extensive use of parallel markets and the resultant distortion of crop output data, the government should offer attractive producer prices.

The beneficial effects of tractor use on agricultural productivity have yet to be proven for subsistence farming communities in Tanzania. Accordingly, it is recommended that the decision to promote tractor use be made cautiously, as part of an evaluation of a locality's need for a whole range of farm inputs and infrastructure, and that any such decision take into account the locality's demand and supply of land and labor, and its incentive and ability to manage the tractors efficiently.

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Table 1. Socioeconomic characteristics of surveyed households.

Characteristic	Households that used tractors (n=47)	Households that did not use tractors (n=32)
Male-headed households	95.7%	96.7%
Female-headed households	4.3%	3.3%
Male members	51.7%	51.4%
Female members	48.3%	48.6%
Average age of head of household	48.3	41.5
Average number of persons per household	10.0	8.0
Average number of working persons per household	5.0	4.0
Children	40.0%	46.3%
Children in school	74.7%	61.7%
Average area farmed per household	1.46 ha	0.91 ha

Source: Survey data, 1987.

Table 2. Farm and farm management characteristics for households that did and did not use tractors for land preparation.

Farm/farm managment characteristics	Households that used tractors (n=47)	Households that did not use tractors (n=32)
Households with scattered farm plots	39.0 (83%)	28.0 (88%)
Average number of farm plots per household	2.2	1.8
Average plot size	0.664 ha	0.506 ha
Average area farmed per household	1.46 ha	0.91 ha
Average distance between homestead and scattered plots	4.6 km	1.3 km
Households that hired labor	70.2%	53.1%
Households using fertilizer	11.0%	13.0%

Source: Survey data, 1987.

Table 3. Reasons farmers gave for not receiving tractors in time to prepare land by optimal planting dates.

Reasons	Farmers concurring (n=47)	
	Number	%
Bad system of tractor allocation to farmers	28	59.6
Insufficient supply of tractors	26	55.0
Lack of finance at time of cultivation[a]	6	9.7
Land not available to farmers in time	2	4.3

Source: Survey data, 1987.
[a]The average tractor hire charge for cultivation and harrowing was T Sh 3,626.60 (Tanzanian shillings).

Table 4. Cropping patterns of surveyed farmers who used tractors.

Crop Mixture	1985-86 Number	1985-86 %	1986-87 Number	1986-87 %
Maize alone	29	52.7	34	72.3
Maize + other Crops[a]	26	47.3	13	27.7
Total	55	100.0	47	100.0

Source: Survey data, 1987
[a]Mainly greengram and paddy.

Table 5. Cropping patterns of surveyed farmers who did not use tractors.

Crop Mixture	1985-86 Number	1985-86 %	1986-87 Number	1986-87 %
Maize alone	27	96.4	26	72.2
Maize + other Crops[a]	1	3.6	10	27.8
Total	28	100.0	36	100.0

Source: Survey data, 1987
[a]Mainly greengram and paddy.

Table 6. Average monthly labor requirements for various maize operations on sampled farms in man-days per hectare.

Month	Operations					Total
	Prepare land (by hand)	Plant	Weed	Fertilize	Harvest	
January	14.5	-	5.8	1.8	10.5	32.6
February	-	2.5	4.5	2.0	9.5	18.5
March	-	-	10.0	3.0	-	13.0
April	-	-	-	-	2.0	2.0
May	-	-	-	-	10.5	10.5
June	-	-	-	-	10.8	10.8
July	-	-	-	-	4.8	4.8
August	-	-	-	-	-	-
September	6.5	-	-	-	-	6.5
October	5.3	3.0	-	2.0	-	10.3
November	9.5	2.4	8.6	2.5	-	23.0
December	10.4	-	6.5	2.5	-	19.4
Total	46.2	7.9	35.4	13.8	48.1	151.4

Source: Survey data, 1987

AN ECONOMIC EVALUATION OF THE MOBILE SAWMILLING INDUSTRY IN TANZANIA

Godwin S. Kowero

SUMMARY

The forestry sector in Tanzania has been underutilized in promoting national development. The government owns large timber plantations that have not been fully harvested due, in part, to a lack of processing capacity. In the early 1980s, the Tanzanian government introduced five mobile sawmills to utilize the surplus of small-dimension timber from its overstocked plantations. These mobile sawmills have proven themselves to be both financially and economically profitable in Tanzania's unstable economy.

A financial and economic evaluation of the mobile sawmilling industry in Tanzania was undertaken to evaluate the factors that influence the profitability of the industry. Data was collected on the costs and revenues of the sawmills since their operation was initiated.

When using small-dimension timber, the mobile sawmills have a higher recovery rate than large sawmills. When using prime timber, the recovery rates for the mobile sawmills are between 40% and 50%, which is comparable to the range obtained by large sawmills. However, very few of the mobile sawmills utilize even 50% of their capacity, which suggests that more efforts should be directed towards full capacity utilization by these mills. As the workers have become more skilled with the machinery, the productivities of the mills have increased.

Because of better cost control and increased productivity, unit production costs, at constant prices, have declined over time. Costs could be further decreased through better management and by negotiating for lower royalty rates for plantation wood. Even at low levels of capacity utilization, these sawmills have been profitable. Projections based on current inflation rates indicate that the mills will continue to be profitable, even though the sale price for the sawn wood is increasing at a lower rate than the price of inputs.

The mobile sawmills have economic benefits in addition to the financial ones. They provide employment in areas where the unemployment rate is high. In addition, they distribute wealth

to rural areas of the country. However, their economic benefits are constrained by the high level of foreign exchange that is used by the mills for capital equipment, fuel, and spare parts.

Both the financial and the economic results indicate that the mobile sawmills should be continued. The mobile sawmills were profitable during the first years of operation even when there were few skilled workers. This profitability, together with the mills' relatively small capital investment requirements and their flexible operational skills, supports the conclusion that mobile sawmills should be widely adopted by both the public and private sectors.

Although approximately 40% of Tanzania's land is under forest cover, the forestry sector's contribution to national development has been limited. The sector represents only 3% to 5% of the gross domestic product. Forestry labor comprises only 2.8% of the paid employment in Tanzania (Dykstra, 1983). These figures suggest that both the tangible and intangible current benefits of the forest industry are small when compared to the forest resource base. The lack of manufacturing capacity in the forest products industry is the primary reason these resources are underutilized.

Tanzania has a surplus of industrial roundwood in the government forest plantations. There are 80,000 ha of plantation forests, of which 70,000 ha are planted with softwoods. However, there is a serious imbalance between softwood raw material supplies and their utilization. The surplus is expected to reach about one million cubic meters per year in the mid-1990s (Ministry of Natural Resources and Tourism, 1985).

Forest industries can be a valuable tool to alleviate economic underdevelopment:

- Forest products include a wide range of both consumer and intermediate goods. The intermediate goods may lead to the establishment of industries based on these products.

- Forest industries have a strong backward linkage to a renewable natural resource that can be grown relatively cheaply in tropical countries.

- Forest industries can be established in rural areas that are close to the resource base, thus assisting balanced economic growth.

- Forest industries are relatively labor intensive, requiring low capital investment.

THE SAWMILLING INDUSTRY IN TANZANIA

The sawmilling industry is usually the first of the forest industries to be established. The required initial investment in sawmilling can be kept moderate and the industry's labor requirements are very flexible.

Most of the wood processing capacity in Tanzania is based in the sawmilling industry and utilizes hardwoods. The industry ranges from pit sawing to processing in large, technically advanced sawmills. Tanzania has approximately 100 sawmills, which satisfy about 60% of the domestic demand for sawn wood. The remaining 40% is supplied by pit sawyers. In addition, Tanzania has two plywood mills, a particle-board factory, a hard-board factory, and three pulp-and-paper factories.

The sawmilling industry is currently faced with a number of problems, ranging from an inability to rationally match forest resources with utilization facilities to factory operational problems. The following examples highlight the extent of these problems in the industry:

- In spite of the surplus of wood, the capacity utilization in most sawmills is very low, averaging less than 50%.

- Tanzania's exports of sawn hardwoods have declined drastically from a peak of 24,000 cu m in 1969 to 4,300 cu m in 1987.

- The recovery rates for many hardwood sawmills, especially those participating in export trade, are very low, averaging 23% for fine flooring timber and 38% for fine hardwoods, both of which have established export markets. For general utility hardwoods (which, currently, are not exportable) the recovery rates average 43% (Moyo, 1985).

- Logging distances in natural forests have increased to economically questionable proportions, given the poor condition of the roads and the inadequacy of available logging gear. For example, Mkata, Tanga, and Mingoyo sawmills are at present obtaining logs from as far as 105 km to 150 km away.

The scarcity of wood products in many areas of the country has precipitated high prices on the domestic market. The industry is unable to fully meet domestic demand. In addition, the government is trying to eliminate illegal pit sawyers, which will mean more pressure on the sawmills to contain the shortfall. Because the plantations are not being fully utilized, pressure is being exerted, especially by pit sawyers, on the dwindling natural forests in order to supply the local market. This has promoted encroachment on catchment forests to the detriment of water supplies and soil conservation.

The government has a substantial amount of money tied up in the form of softwood stumpage. If harvested and sold, the present surplus could earn the government enough revenues from royalties to meet 34.1% of the 1988-89 expenditure budget for the Forest and Beekeeping Division, which is responsible for forestry matters in Tanzania. This is equivalent to meeting 13.6% of the 1988-89 expenditure budget for the Ministry of Lands, Natural Resources, and Tourism. If the government does not harvest and process the surplus, the relatively expensively raised timber may be wasted or simply used as firewood.

By not having sufficient wood processing facilities at present, many employment opportunities are lost and the government is losing considerable revenues from the forestry sector that could be used for economic development. If it is turned around, the forestry sector has the potential to make a large contribution to Tanzania's economic development.

A number of the industry's operational problems are associated with the lack of both local and foreign funding. Funds have not been available to train enough workers. Past funding constraints impaired proper tending of many of the plantations. The consequence has been inadequately thinned plantations, which has resulted in small-dimension logs. When processed in stationary sawmills, the recovery rate for small-dimension logs is low and uneconomical. In addition, the lack of foreign funding has made it difficult to obtain spare parts and logging gear.

Funding constraints have motivated planners to look for alternative and cheaper ways of handling this timber surplus. In the early 1980s, the government introduced mobile sawmills into the softwood plantations. According to the Ministry of Natural Resources and Tourism (1983), mobile sawmills have the following advantages:

- The machinery can be made available and installed without the type of delays accompanying other types of sawmills.

- Sawing can be done at the logging site thereby reducing transport costs.
- Mobile sawmills can handle small-dimension logs, like those from thinnings, which constitute a big portion of the surplus.
- Mobile sawmills require less technical skills than large stationery sawmills.
- Costs are relatively low.
- Mobile sawmills are more labor intensive than larger stationary sawmills.

The Tanzania Wood Industry Corporation (TWICO) owns all the mobile sawmills in Tanzania, except for one mill that is managed by Sokoine University of Agriculture (SUA) Training Forest.

FINANCIAL ANALYSIS

Data was collected from the five mobile sawmills which were in operation during 1987. These sawmills are SUA Training Forest Mobile Sawmill in Arusha, West Kilimanjaro Mobile Sawmills in Kilimanjaro, Mbeya Mobile Sawmills in Mbeya, Mtibwa Teak Forest Mobile Sawmill in Morogoro, and Rubya Mobile Sawmill in Mwanza. The sawmills began operation in the early 1980s. The available data was collected for each year of their operation. In some cases, information was unavailable for a given year. In other cases, the data available from TWICO was at variance with the data collected in the sawmill office. These problems notwithstanding, the various authorities concerned with providing the data for this study were very cooperative. The data collected is sufficient to support meaningful financial and economic analyses of this industry.

Recovery Rates

The recovery rate indicates the percentage of a log that is converted into usable timber. It is an important indicator of sawing efficiency. Sawing skills usually increase over time and tend to increase recovery rates. This is consistent with the learning curve theory, which states that when a person or crew of people perform the same activity repeatedly over a period of time the skills and productivity gradually increase. However, a number of other factors enter into the recovery rate for mobile sawmills. The end product demanded affects the rate; prime sawn timber has a lower recovery rate than rough sawn timber.

Recovery rate is also a function of the shape of the logs; crooked logs have lower recovery rates than straight ones. The condition of the logs also can affect the rate; for example, logs with heart rot have a low recovery rate. A high proportion of sapwood is associated with low recovery rates. The thickness of the saw blade will also affect recovery rates; a thick saw blade will be associated with a lower rate than a thinner one. Therefore, a strict comparison of the recovery rates of the various sawmills is not possible because of differences in log characteristics, skills of operators, and the type of machinery used in the sawmills. However, it is useful to examine the recovery rates at individual sawmills.

The recovery rates for the mobile sawmills fluctuated between 39% and 51%. Recovery rates do not explicitly indicate an increase in productivity, except at the Mbeya sawmill, where the recovery rate has steadily increased from 47% to 51%. The fluctuations in recovery rates are primarily due to the sawmills' mixing mature, large-dimension timber with smaller-dimension timber from thinnings. This is easily seen at the SUA Training Forest Sawmill, which has been sawing thinnings in recent years. The recovery rate has dropped gradually from 43% to 39%.

Overall, the recovery rates at the mobile sawmills compare favorably with those from larger sawmills that handle mature softwood timber almost exclusively. When sawing small-dimension timber, the mobile sawmills obtain higher recovery rates than the large mills.

Productivity

Productivity analyses for all sawmills were based on the relationship between yearly output and the corresponding worker days. The mobile sawmills have very low productivities, especially in the initial years of operation. The sawmills of SUA, Mtibwa, and Rubya each have one sawmill unit capable of producing between 10 cu m and 15 cu m of sawn timber per day. The sawmills of Mbeya and West Kilimanjaro have four and five sawmill units respectively. The productivities of all the sawmills have gradually increased over time.

The mobile sawmills started with few trained workers. Most of the workers have been trained on the job. Over the years the workers have become more skilled and consequently have increased productivity. The increased production has not resulted in explicitly higher recovery rates, but it has resulted in increased daily turnover of sawn timber as the workers have increased the speed and accuracy with which they handle the logs.

Productivity could be increased by utilizing more of the mills' capacity. Most of the mills operate below 50% capacity.

Production Cost Analysis

An analysis of the production costs for each sawmill was made by category of expenses to show the relevance of each category in sawn wood production costs (see tables 1, 2, 3, 4, and 5).

Wood Raw-Material Costs. The cost of wood raw material at each mill site was evaluated to determine its effect on total sawn wood production costs. These figures include the cost of delivering the wood to the mill. There are fixed royalty rates for all timber raised in government plantations.

The variation in the proportion of wood raw-material costs as a percentage of total sawn-wood production costs is fairly wide; it ranges from 12% to 40% for the sawmills stationed in the forest. SUA Training Forest Mobile Sawmill is not located in the forest and therefore has a higher proportion (23% to 58%). This reflects the freight cost of transporting logs from the forest to the sawmill. The wood raw-material costs form a fairly sizeable proportion of sawn-wood production costs.

At real prices, the wood raw-material costs have generally declined over time. This could be a reflection of efficiency in harvesting operations or of the better use of transport facilities. High inflation rates experienced during the 1980s, averaging 30% annually, mask this trend.

It was also possible to isolate royalty payments from the wood raw-material costs. The proportion of royalty payments in wood raw-material costs is very high, ranging from 32% to 72%, and usually above 50%. This implies that, to lower wood raw-material costs, sawmills should concentrate on bargaining for lower royalty charges from the sellers of stumpage. This is further emphasized by the relatively high proportion of royalty payments in total sawn-wood production costs, ranging from 7% to 29% and usually above 10%. This proportion is usually less than 10% for bigger and stationary sawmills. The small-dimension timber does not have an alternative industrial use. Its only alternative use, as firewood, would give stumpage sellers insignificant revenues since the government rates on firewood sales are much lower than the rates for industrial round wood. Under these circumstances, the sawmills have an edge in bargaining for lower royalty charges.

Capital Costs. The proportion of capital costs in sawn-wood production costs has usually been less than 10%. These sawmills are not capital-intensive, and

therefore they are attractive to developing countries with capital constraints wishing to utilize small-dimension timber.

For each sawmill, the capital costs for each unit of output taper off with time as the machinery, buildings, vehicles, and equipment age, and as the sawmill's output increases over time.

Labor Costs. There has been a general decline in labor costs for each unit of sawmill output, despite rising salaries and wages during the same period. The implication is that the increasing efficiency in the use of sawmilling labor more than offsets the cost effects of wage and salary increments. The productivity of the sawmills has increased over time.

The proportion of labor costs in sawn-wood production costs fluctuates between 10% and 24%, implying that sawmilling is moderately labor intensive. The sawmills employ an average of 10 permanent workers for sawmilling activities per sawmill unit. In addition, the sawmills employ people on both a casual and permanent basis for other operations including logging and administration. This increases the overall labor intensiveness of the sawmills.

Operating Expenses. There has been a general decline of real operating costs per unit in the mobile sawmills despite the steady rise in prices of fuel and spare parts. The declining trend is an indication of better control of items, together with the noted increase in productivity. Such increases in efficiency have more than offset increases in the prices of inputs constituting operating expenses.

With the exception of Mtibwa Teak Forest Project Sawmill, which saws a greater proportion of hardwoods, the proportion of operating costs in sawn-wood production costs rarely reaches 30% and is usually less than 20%. Improved management and monitoring could further cut down operating expenses.

Overhead Expenses. There has been a declining trend over the years in the proportion of real overhead expenses in sawn-wood production costs, with the exception of Mbeya and, to a lesser extent, West Kilimanjaro Mobile Sawmills. The overhead costs can largely be controlled by the management of each of the sawmills. Efforts have been made throughout the production and services sectors in Tanzania to contain overhead cost escalation. Productivity over time has increased significantly, making it possible to distribute these expenses over many more units of output. On the whole, these two factors, cost control and increased productivity, are largely responsible for the observed trend.

Again, with the exception of Mbeya and West Kilimanjaro mobile sawmills, there is a declining trend in the proportion of overhead costs in sawn-wood

production costs. With the exception of the Mtibwa Teak Forest Project Sawmill, the proportion ranges from 20% to 67% and is usually in the range of 20% to 30%. Such costs are fairly significant and therefore the management of each sawmill should be advised to exercise tight control of the items constituting overhead expenses.

Mtibwa Teak Forest Project Sawmill is owned by TWICO and a private sawmilling company, Grewal Sawmills. The management of the sawmill leans heavily on Grewal Sawmills. A characteristic of the private sector is minimal overheads as exemplified by the overhead expenses of this sawmill being only 0.2% to 0.5% of total sawn-wood production costs. This sawmill has few administrative personnel, in contrast to the others. Public sawmills have a top-heavy organizational structure which does not take the size and location of the sawmill into consideration. The government may wish to study the structure of private sector investments if it is to significantly increase efficiency and cut down on production costs.

A problem in comparing the proportions of production costs is that proportions are influenced by the relative prices of inputs. For example, if fuel costs rise much faster than costs of other inputs, operating expenses will assume a higher proportion of total production costs, and the other expense categories will have lower proportions. This could be wrongly construed to imply an increase in efficiency. Since there have been very marked price changes for inputs like labor and fuel, their relative effects have to be taken into consideration so as not to impair an accurate assessment of gains in efficiency by the sawmills. Even taking this into consideration, the sawmills have generally shown an increase in the efficiency with which they are using various resources.

Profitability Analysis

Although the real prices of many inputs have increased, the real sales prices for sawn timber have declined. Inflation tends to mask this observation, since both current costs and prices have increased. It would be expected that under these unfavorable conditions, the profitability of the mobile sawmills would be jeopardized. Yet, the mills continue to be profitable.

At the SUA Training Forest Mobile Sawmill, the unit production costs have declined over the years as a consequence of increases in efficiency. The profit margin has increased considerably over time, starting at 12.4% in 1982, jumping dramatically to 98.9% in 1985, and dropping slightly to 86.5% in 1986. Thus, this sawmill has been very profitable. This observation is reinforced by its benefit/cost ratio of 1.53 and a net present value of T Sh 590 (590 Tanzanian

shillings) per cubic meter (see table 6). It is noteworthy that the sawmill has never operated at a loss.

Similarly, at the Mtibwa Teak Forest Project Mobile Sawmill, there was a large decline in unit production costs due to increased sawmill efficiency (see table 7). Over the same period, the unit profits have more than doubled and the profit margin has increased exponentially, from 29.4% in 1985 to 121% in 1986. Despite the modest decline in real sawn wood prices, this sawmill is very profitable. This observation conforms with the observed benefit/cost ratio of 1.64 and a net present value of T Sh 743/cu m.

With the exception of 1987, unit production costs at the Mbeya Mobile Sawmills, at real values, have declined over time (see table 8). The pattern of unit sales prices is a fluctuating one, with real unit sales prices being highest in 1987. This sawmill is located in an area where there is a deficit of sawn wood and therefore has a wide latitude for varying the sales price of sawn wood. The unit profits at real values have been increasing over the years, with the exception of 1987 when there was a decline. A similar observation is made for the profit margins, which rose from 8.6% in 1984 to 93.9% in 1986, then declined to 18.4% in 1987. Overall, this sawmill has been profitable as indicated by its relatively high profit margins, a benefit/cost ratio of 1.35, and a net present value of T Sh 448/cu m.

At the Rubya Mobile Sawmill, the unit production costs have declined over two years while the unit sales prices have increased (see table 9). The consequence has been an increase in both unit net profits and profit margins. The sawmill is very profitable, as indicated by its high profit margins of 17.1% in 1986 and 64% in 1987, a benefit/cost ratio of 1.38, and net present value of T Sh 368/cu m.

With the exception of 1987, both unit production costs and sales prices of rough sawn timber at the West Kilimanjaro Mobile Sawmills have declined (see table 10). As in the other sawmills, the decline in unit production costs at real values is a function of increased sawmill productivity. However, on the average, unit net revenues and profit margins for the West Kilimanjaro sawmill have increased. The relatively high profit margins of 29.1% in 1983, 17.9% in 1984, and 64.8% in 1986 indicate that this sawmill has been very profitable. It did experience a slight loss from January to June 1987. The sawmill's profitability is further confirmed by a benefit/cost ratio of 1.23 and a net present value of T Sh 253/cu m.

The mobile sawmills have been very profitable even during the start-up phase when capacity utilization was very low and operating skills inadequate

Future Profitability

The net profits and profit margins for all five mobile sawmills were projected based on the assumption that the costs for labor, operating expenses and overhead would continue to increase, as would the sales price for sawn wood. Over the past three years, wages and salaries have increased between 10% and 30% each year, while operating expenses, such as fuel, have increased by about 30% per year. The prices for sawn timber have, in most of these sawmills, increased by 25% per year. It is likely that the economy will continue to support these increases by similar magnitudes in the near future. Therefore, the profitability projections for all sawmills have been based on the assumption that sale prices of sawn timber will increase by 25%, operating expenses will increase by 30%, and overhead and labor costs will each increase by 20%.

With the exception of Mtibwa Teak Forest Project Sawmill, the prescribed increases in input costs and sawn wood prices result in increased profitability at each sawmill. At SUA, the profit margin will increase from 86.5% to 114.3%; at Mbeya, from 18.9% to 29.1%; at Rubya, from 64.0% to 75.6%; and at West Kilimanjaro, from a loss to 6.8%. Only at Mtibwa will the profit margin decline, from 121% to 51.0%.

If the cost increases materialize in the absence of corresponding increases in sawn-wood prices, the sawmills will experience modest declines in profit margins, with the exception of Mtibwa, whose profit margin will almost be halved, and West Kilimanjaro, which will continue to incur a loss.

The implication of these observations is that the economy of softwood mobile sawmilling industry is relatively stable in Tanzania's economic environment.

ECONOMIC ANALYSIS

Financial profitability of a project is an important index of its performance. However, financial profit or loss is not always the most suitable criterion for assessing whether or not to commit resources to a particular investment (Busby, 1985). Financial profitability analysis assumes that market prices adequately reflect social opportunity costs of resources and therefore the ultimate consumption benefits. However, market systems seldom operate perfectly and consequently are often characterized by distortions on prices of some resources. Because of these market imperfections it is important to carry out economic evaluations using shadow prices. These shadow prices reflect the real value or opportunity cost of inputs and outputs (Dasgupta, Sen, and Marglin, 1972). Mobile sawmilling affects society as a whole in ways that are not taken into

consideration in a financial analysis and therefore deserves to be evaluated economically.

Net Aggregate Consumption Benefits

There are three stages to evaluating the net aggregate-consumption benefits of investments (Dasgupta et al., 1972). The first stage involves assessment of benefits and costs under the assumption that market prices reflect social opportunity costs, and therefore the ultimate consumption benefits. This stage is merely an extension of the financial profitability, calculated to determine the profit or loss of the operation as a whole, rather than the per-unit profit. The conclusion based on this method is that all five of the mobile sawmills deserve to draw on scarce national resources for continued operation.

The second stage involves incorporation of opportunity cost premiums on the costs of resources, in order to get shadow prices. Adjustments were made to the market prices of specific resources for which market prices did not reflect their real contribution to the aggregate-consumption objective. The remaining resources were tacitly assumed to be correctly priced by the competitive market mechanism.

Dasgupta et al. (1972), Grut (1972), and Little and Mirlees (1974) note that the social cost of labor in developing countries often differs from its market price as expressed by wages. In Tanzania, there is a surplus of unskilled and semiskilled labor, both of which are used by the mobile sawmilling industry. Therefore, the premium on this category of labor is negative. In this evaluation, unskilled and semiskilled labor has a shadow price of 0.75. Thus, a premium of -0.25 is associated with these categories of labor because the government-owned sawmills pay wages higher than the opportunity cost of labor. The premium multiplied by the wage bill corresponds to the margin by which the total wage bill exceeds the amount necessary to attract that category of labor. This margin corresponds to the net extra income received by the unskilled and semiskilled labor due to the mobile sawmills. The gains to labor are substantial and would not be realized in the absence of the mobile sawmills. These gains also measure the sawmills' contribution to employment in the localities concerned.

On the other hand, Tanzanian currency is overvalued with respect to foreign exchange. Therefore, foreign exchange is scarce and is rationed by the government. The real value of the foreign exchange is substantially higher than the official exchange rate. The shadow price of foreign exchange has been estimated at 2.0 (Msemo, Tanzania Investment Bank, personal communication, 1987). Therefore, the premium on foreign exchange is 1.0.

The economic profitability levels of the mobile sawmills tend to be lower than the financial profitability levels (see tables 6, 7, 8, 9, and 10). Only in cases where the foreign exchange costs were low and the labor costs unusually high was this tendency reversed. The use of large amounts of costly foreign exchange is the primary reason for the low economic profitability levels. Whereas all the output from these sawmills is sold in domestic currency, the sawmills spend large sums of foreign currency on imported fuel, lubricants, spare parts, and initial capital equipment. Stricter management practices could reduce, but not eliminate, these costs.

Economic costs at the mobile sawmills tend to be higher in the initial years of operation. All of the sawmills, except Rubya sawmill, realized negative net aggregate-consumption benefits in the first year of operation. This may be a result of low capacity utilization and of low skills and inexperience on the part of the labor force.

The third and final approximation of the net aggregate-consumption benefits to the national economy as a whole in any given year can be derived as the social value of net benefits flowing to each distinct group between government and labor. However, the value of the net aggregate-consumption benefits depends on the propensity to invest, and on the shadow price of investment, which also depends on the social rate of interest. Since the shadow price of investment is 1.0 (Msemo, Tanzanian Investment Bank, personal communication, 1987; Operations Manager, Tanzania Industrial Studies and Consulting Organization, personal communication, 1987), the net aggregate-consumption benefits do not differ from the social value. However, there are costs and benefits which accrue directly to the government and to labor from the operation of the mills.

The government funds these mobile sawmills through annual budget allocations. Because the Tanzanian currency is overvalued, the government also bears costs associated with foreign exchange. The government gains from the sawn timber produced from these sawmills. The timber augments existing supplies of sawn timber in the country, and the revenues obtained from its sale go directly to the government. At the termination of these projects, the government will also gain from the scrap value of the mobile sawmills' assets, if they can be sold.

Due to economic hardships prevailing in Tanzania, it may be safely assumed that mobile sawmill employees make negligible savings. However, it may also be assumed that, due to the low investment levels in the country, the government is ready to devote all available funds for investment in order to raise the level of future consumption benefits.

Generally, all the mobile sawmills are of positive economic value, because the benefits realized are substantial enough to offset the high costs associated with the operation of these sawmills.

Redistribution Benefits

The five mobile sawmills play a significant role in redistributing economic benefits to the regions in which they are situated. The redistributed benefits to each region for each year do not require correction for social opportunity costs of foreign exchange, labor, investment, or consumption. However, Dasgupta et al. (1972) note that it is still important to assess the total net consumption benefits distributed to the region by each investment.

Whether the direct benefits are consumed or invested, some of them are spent within the regions where the mobile sawmills are situated. This has the effect of causing a net transfer of wage and profit earnings from elsewhere in Tanzania to the regions where the mobile sawmills are located. This activates otherwise idle resources in these regions. A new round of regional multiplier effects are set into motion. It is assumed that at least 50% of the total wage bill of each mobile sawmill that is accrued as direct benefits is spent within the region in which the mobile sawmill is located. This assumption conforms with the one made earlier that most employees make negligible savings due to economic hardships.

In spite of the relatively low level of net benefits to the nation, these mobile sawmills contribute significantly to the socioeconomic development of the regions where they are located. The direct benefits flowing to these regions are all positive and substantial, as are the total values of net regional consumption benefits. This income redistribution is an important contribution in Tanzania, where income disparity between regions is very significant.

CONCLUSIONS AND RECOMMENDATIONS

The mobile sawmills were developed to utilize the small-dimension timber that Tanzania has in surplus. They have demonstrated their ability to utilize this timber effectively. The recovery rates for all sawmills are satisfactory given that the sawmills are sawing small-dimension timber. Medium and large sawmills record lower recovery rates when sawing such timber and in most cases such business is not profitable. The mobile sawmills are better situated to retrieve sawn wood out of small-dimension timber.

The daily productivities for the sawmills are unsatisfactory because the mills are operating at less than 50% capacity. However, there is an increasing trend in

productivity for each sawmill. Sawmill managers should put more emphasis on fully utilizing the sawmills' capacities by either extending working times for those operating on a single shift or by increasing the number of shifts per day. The introduction of a bonus system for exceeding daily output targets would also stimulate better capacity utilization.

At 1977 prices, wood raw-material costs, capital costs, sawmilling labor expenses, and operation and overhead costs have all exhibited a declining trend over time. Unit production costs have also declined over time for the sawmills. This decline can be attributed to better cost control and the observed increase in productivity. However, control of costs could still be improved, especially in operating and overhead expenses, which are largely under the control of the mill management. In addition, it will be important for the mills to lower wood raw-material costs by negotiating for lower royalty rates in plantations.

Despite the declining trend in real sales prices for sawn wood, each sawmill has been profitable. The profit margins are as high as 121% and the net present values at 1977 prices range from T Sh 360/cu m to T Sh 740/cu m. The benefit/cost ratios range from 1.35 to 1.64. All these financial criteria confirm that these sawmills are very profitable despite the fact that they have been operating below 50% capacity.

The fact that the mobile sawmills became profitable in their initial years of operation, when the workers' skills were inadequate, indicates that these sawmills could be owned and managed by the private sector or on a cooperative basis by villagers. One skilled sawmill operator or technician is needed to provide on-the-job training for other workers. The Forest Industries Training Institute at Moshi could train the initial operators for such sawmills.

The promotion of mobile sawmills at the village level could provide net revenues to fund development programs or social services. In addition, the sawmills could provide opportunities for employment of the rural labor force in harvesting operations, sawmilling, administration, and marketing activities. Since the provision of sawn timber is also a stimulus for carpentry and construction activities, employment could be created indirectly in both the construction and furniture sectors. Such employment will alleviate chronic unemployment in some villages and help to curb the flight of unemployed youths to urban areas.

Even in the relatively unfavorable economic climate prevailing in Tanzania, it is projected that the mobile sawmills will continue to be profitable, even if inflation continues at current rates.

Currently, the domestic market absorbs all of the mills' production. Sawn timber is usually sold green since there is no time to dry it; but, the market is not sensitive to quality. However, in order to export sawn timber, quality must be controlled. Logs must be sorted, since many stands have not been pruned and the timber is full of knots. Sawing accuracy should be increased. Drying and careful grading of the timber will be essential. These measures, together with efficient production, may enable sawn timber to be exported. The sawmills will then be able to benefit from a government export value-retention scheme.

The government owns all of the industrial forest plantations and the sawmills considered in this study except for Mtibwa Sawmill, which has a mixture of private and government ownership. The pricing of roundwood has always been a government monopoly, with prices set to meet various revenue requirements. A pricing system that takes into account the needs of both the seller and buyer of stumpage is necessary. Such a system could also take into account roundwood quality, accessibility to forest areas, and financial gains on roundwood processing.

The results of the financial and economic analyses strengthen the recommendation to propagate wider adoption of mobile sawmills by both public and private sectors and their introduction into villages bordering suitable forest resources. In addition to containing the softwood surplus problem, these sawmills could provide funds for investments, thereby contributing to the broader goal of national development.

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Table 1. SUA Mobile Sawmill: Summary of production cost analysis.

Item	1982	1983	1984	1985	1986
Wood raw material (%)	23.5	43.7	46.3	56.6	58.9
Capital (%)	6.5	6.5	3.1	2.4	1.9
Labor (%)	23.6	14.7	15.0	12.5	12.1
Running expenses (%)	12.0	8.8	11.4	8.1	7.1
Overheads (%)	30.4	26.3	24.2	20.4	20.0
Total production (m^3)	255	731	812	1,027	1,042
Unit production cost (T Sh/m^3)	1,388	1,035	1,134	1,041	1,149

Source: Field data.

Table 2. Mtibwa Teak Project Mobile Sawmill: Summary of production cost analysis.

Item	1982	1983
Wood raw material (%)	16.3	16.3
Capital (%)	2.7	2.5
Labor (%)	22.2	20.8
Running expenses (%)	37.2	47.0
Overheads (%)	21.6	13.4
Total production (m^3)	250	416
Unit production cost (T Sh/m^3)	4.005	4.094

Source: Field data.

Table 3. Mbeya Mobile Sawmill: Summary of production cost analysis.

Item	1984	1985	1986	1987
Wood raw material (%)	22.0	19.0	18.9	16.9
Capital (%)	8.3	7.5	5.1	1.9
Labor (%)	13.2	14.8	12.9	9.9
Running expenses (%)	17.9	14.3	4.6	4.8
Overheads (%)	38.6	44.4	58.5	66.5
Total production (m^3)	1,765	3,289	5,896	4,541
Unit production cost (T Sh/m^3)	1,937	1,597	1,787	2,772

Source: Field data.

Table 4. Rubya Mobile Sawmill: Summary of production cost analysis.

Item	1986[a]	1987[b]
Wood raw material (%)	11.9	19.8
Capital (%)	3.9	7.3
Labor (%)	17.6	21.0
Running expenses (%)	31.7	24.6
Overheads (%)	34.9	27.3
Total production (m^3)	845	505
Unit production cost (T Sh/m^3)	4,610	3,314

[a] Data for July-December.
[b] Data for January-June.

Table 5. West Kilimanjaro Mobile Sawmill: Summary of production cost analysis.

Item	1982	1983	1984	1985[a]	1986	1987[b]
Wood raw material (%)	30.5	29.3	39.1	--	30.8	21.6
Capital (%)	24.3	21.9	6.7	--	9.8	3.9
Labor (%)	13.8	13.9	19.2	--	23.4	21.6
Running expenses (%)	8.1	5.7	11.5	--	8.1	21.2
Overheads (%)	23.3	29.2	23.5	--	27.8	31.2
Total production (m^3)	925	2,422	4,458	--	4,786	2,434
Unit production cost (T Sh/m^3)	1,353	1,125	1,443	--	1,698	3,806

[a] Data not available.
[b] Data for January-June only.

Table 6. SUA Mobile Sawmill: Economic profitability based on 1977 prices.

	1982	1983	1984	1985	1986
Total production cost	(139,485)	(234,651)	(210,308)	(182,806)	(154,216)
Total revenues	156,825	393,278	327,236	363,558	287,592
Total profit (MC)	17,340	158,627	116,928	108,450	113,376
Foreign exchange receipts	(41,589)	(65,773)	(60,652)	(53,187)	(48,139)
Premium on foreign exchange cost (aF)	(41,589)	(65,773)	(60,652)	(53,187)	(48,139)
Labor cost	(83,250)	(111,000)	(138,415)	(133,800)	(145,440)
Gains to labor (bL)	20,812	27,750	34,603	33,450	36,360
Net aggregate-consumption benefits (SC)	(3,436)	120,603	90,879	89,014	121,596
Direct benefits to the Arusha region (DR)s	83,250	111,000	138,415	133,800	145,440
Total value of net regional consumption benefits (R)s	166,500	222,000	276,830	267,600	290,880

Source: Field data.
Note: SC=MC+aF+bL
a=1.0
b=0.25
(R)s=(DR)s x (1/1-0.05)

Table 7. Mtibwa Mobile Sawmill: Financial profitability.

	1985	1986
Total production cost	(213,250)	(196,352)
Total revenues	276,000	433,472
Total profit (MC)	62,750	237,120
Foreign exchange receipts	(122,396)	(105,970)
Premium on foreign exchange cost (aF)	(122,395)	(105,970)
Labor cost	(210,055)	(331,539)
Gains to labor (bL)	52,513	82,884
Net aggregate-consumption benefits (SC)	(7,132)	214,034
Direct benefits to the Arusha region (DR)s	210,055	331,539
Total value of net regional consumption benefits (R)s	420,110	663,078

Source: Field data.
Note: SC=MC+aF+bL
a=1.0, b=0.25
(R)s=(DR)s x (1/1-0.5)

Table 8. Mbeya Mobile Sawmill: Economic profitability.

	1984	1985	1986	1987
Total production cost	(780,130)	(897,897)	(1,361,976)	(2,143,352)
Total revenues	847,200	1,387,958	2,641,408	2,547,501
Total profit (MC)	67,070	49,061	1,279,432	404,149
Foreign exchange receipts	(234,785)	(274,520)	(328,278)	(763,001)
Premium on foreign exchange cost (aF)	(234,785)	(274,520)	(328,278)	(763,001)
Labor cost	(452,000)	(776,456)	(1,360,361)	(1,248,626)
Gains to labor (bL)	113,000	194,114	340,090	312,156
Net aggregate-consumption benefits (SC)	(54,715)	(31,345)	1,291,243	(46,696)
Direct benefits to the Arusha region (DR)s	452,000	776,456	1,360,361	1,248,626
Total value of net regional consumption benefits (R)s	904,000	1,552,912	2,720,722	2,497,252

Source: Field data.
Note: SC=MC+aF+bL
a=1.0, b=0.25
(R)s=(DR)s x (1/1-0.05)

Table 9. Rubya Mobile Sawmill: Financial profitability.

	1986	1987
Total production cost	(502,775)	(216,140)
Total revenues	588,965	354,510
Total profit (MC)	86,190	138,370
Foreign exchange receipts	(213,243)	(92,435)
Premium on foreign exchange cost (aF)	(213,243)	(92,435)
Labor cost	(686,524)	(411,704)
Gains to labor (bL)	171,631	102,926
Net aggregate-consumption benefits (SC)	44,577	148,860
Direct benefits to the Arusha region (DR)s	686,524	411,704
Total value of net regional consumption benefits (R)s	1,373,048	823,408

Source: Field data.
Note: SC=MC+aF+bL
a=1.0
b=0.25
(R)s=(DR)s x (1/1+0.5)

Table 10. West Kilimanjaro Mobile Sawmill: Economic profitability.

	1982	1983	1984	1985[a]	1986	1987
Total production cost	(493,025)	(864,297)	(1,466,682)	--	(1,048,134)	(1,195,094)
Total revenues	491,175	1,116,081	1,729,704	--	1,727,746	1,192,660
Total profit (MC)	(1,850)	251,784	263,022	--	679,612	(2,434)
Foreign exchange receipts	(172,990)	(265,424)	(301,650)	--	(331,031)	(420,015)
Premium on foreign exchange cost (aF)	(172,990)	(265,424)	(301,650)	--	(331,031)	(420,015)
Labor cost	(172,811)	(378,100)	(1,233,300)	--	(1,902,000)	(2,001,400)
Gains to labor (bL)	43,202	94,525	308,250	--	475,500	500,350
Net aggregate-consumption benefits (SC)	(131,637)	80,884	269,621	--	824,080	77,900
Direct benefits to the Arusha region (DR)s	172,811	378,100	1,233,000	--	1,902,000	2,001,400
Total value of net regional consumption benefits (R)s	345,622	756,200	2,466,000	--	3,804,000	4,002,800

Source: Field data.
Note: SC=MC+aF+bL
a=1.0
b=0.25
(R)s=(DR)s x (1/1-0.05)
[a] Data not available.

VILLAGE FORESTRY IN TANZANIAN AGROPASTORAL VILLAGES

Aaron S. M. Mgeni

SUMMARY

Tanzania has been experiencing rapid deforestation. The consumption of fuelwood is greater than the sustainable yield. Although Tanzania has a long history of forestry projects, none have been able to mobilize the village populations to plant enough trees to meet their needs.

In 1967-68, the central government of Tanzania initiated the Village Afforestation Program to distribute seedlings to villages for planting around homes and schools and in communal woodlots. However, the program has been only marginally successful. Studies have examined the reasons that villagers have not implemented the program; however, they have concentrated only on the characteristics of the villagers and the system, not on the characteristics of the innovations themselves.

This study of six agropastoral villages in Karatu Division of Tanzania describes and characterizes villagers' uses of and approaches toward forest products. During 1988, 213 villagers were interviewed. In addition, the village leaders were interviewed.

Villagers were aware of the importance of the forests. The products they obtained from the forests included fuel, poles for building houses, wild fruits and vegetables, meat, honey, and fodder. Wood remained the most important source of energy for cooking and heating water.

However, the opinions of village households and leaders differed on several forestry issues. The villagers were concerned about the presence of snakes and wild animals in woody areas around the villages. The leadership did not share this concern. The leaders said the constraints to planting trees were drought, termites, and lack of seedlings. The villagers listed these constraints plus inadequate land, and poor organization, maintenance, and timing of forestry projects.

Many forestry projects have introduced new species of trees into the area; however, the villagers preferred 40 indigenous species because of those species' advantages: As building poles, they last

two to six times longer than the introduced species, and they are used in tribal ceremonies and medicines. Because of the villagers preferences, forestry projects that simply introduce new species will be ineffective.

Forestry-related development problems were rated as less important by villagers than the scarcity of land for grazing and farming, the high prices of agricultural inputs, and the scarcity of water. Therefore, forestry projects should be components of development programs that address all of the concerns of the villagers.

Tanzania is facing serious deforestation. Consumption of fuelwood in Tanzania is greater than the sustainable yield. Thus, the forests are being overexploited, and 300,000 ha to 400,000 ha a year are being deforested.

The forest sector consists of natural forests, woodlands, and plantations. Tanzania's forest area is 38 million ha to 44.4 million ha -- 43% of its total land area (Mgeni and Malimbwi, 1990) (see table 1).

The forests are both productive and protective. Forest products include fuelwood, poles, industrial roundwood, and nonwood products, including animal fodder, fruit, medicine, and food. The forests protect the environment and fertilize the soil. Some of the ecosystems contain important genetic resources for medicinal plants, timber, wild coffee, and African violets. The forests are also important catchment areas.

Fuelwood is the most important forest product. Firewood and charcoal constitute 97% of all wood-product consumption. Some 91% of the national macroenergy consumption is from wood. The national biomass energy consumption is estimated at 22 million m^3 of solid wood (Forestry and Beekeeping Division, 1989). Households consume 93% of the biomass energy; the remainder is consumed in agriculture (for curing tobacco and tea), industry (for making bricks, smoking fish, and pottery), and the commercial and institutional sectors (restaurants, schools, hospitals, and so on).

Most land in Tanzania is available for public use. About 70% of the forestland is publicly owned (Mgeni, 1985). This public land is the main source of fuelwood. Wood industries, especially privately owned sawmills, obtain roundwood from these forests. The lands are also increasingly being used for grazing and for agriculture. All of these factors contribute to rapid deforestation.

Tanzania's forest resources are not systematically managed (Mgeni, 1983). The industrial plantations are underutilized because industrial wood processing is inefficient. Wood industries in Tanzania operate at about 30% capacity (Ahlback, 1988) because of aging machinery, frequent electric-power breakdowns, transportation problems, inadequate supplies of raw materials, cash-flow problems, and lack of foreign exchange to import spare parts, fuel, and chemicals. The forest industries, which include pit sawing, sawmilling, furniture making, pulp and paper production, and tannin extraction, constitute only a small portion of Tanzania's small-industry sector.

Tanzania is trying to tackle the problems of the forestry sector. One of the strategies it has adopted to combat deforestation is village or social forestry.

HISTORY OF FORESTRY IN TANZANIA

The written precolonial history of forestry in Tanzania is limited (Mgeni, 1983). Deforestation occurred in association with shifting cultivation and grazing. Organized forestry activity was inaugurated in Tanganyika in 1897 when some of the natural forests in the mountains were demarcated and reserved to protect the water-catchment area, prevent soil erosion, and commercially exploit timber (Lundgren and Lundgren, 1982). The large-scale planting of pines, cypress, and eucalypts began in the early 1950s in the highland forest reserves to produce industrial wood.

Professional forestry in Tanzania has traditionally been concerned with protecting and commercially exploiting the natural forest reserves and with developing industrial plantations to produce forest products for export. Woody crops, such as coffee, tea, coconut, cashew nuts, fruit trees, and shrubs, were considered within the realm of agriculture, not forestry. Because forest management has often involved policing the forests, many villagers have developed negative associations with forestry. Thus, the concept of managed forestry has remained alien to the rural people.

A few attempts have been made to involve the rural people in forestry management. During the colonial era, the local government in some areas of Tanzania encouraged local people to protect forests and public lands and to reforest denuded areas (Chachage and Mvungi, 1988). The first communal approach to forest-based problems was launched between 1920 and 1925 by introducing a small-scale afforestation program for rural communities in Sukumaland (Mnzava, 1980). Afforestation programs were extended in the 1930s to Mbulu District (Thornton, 1980) and in 1949 to the Bena Wattle

Scheme of Njombe District (Mgeni, 1981). Some villagers have benefitted through employment in forestry.

The Study Area: Karatu Division Mbulu District

Traditionally, the Iraqw people practiced shifting cultivation and herded livestock communally. By the late 1940s, southern and central Iraqw areas had severe erosion problems. The government encouraged people to move from these areas to "expansion" areas (Winter and Molyneaux, 1963). Karatu Division was one of the expansion areas.

When the Iraqw settled in Karatu Division of Mbulu District in the 1930s, the land was being used by the pastoral Masai for grazing livestock. The Iraqw expanded their territory by occupying this uninhabited wilderness. Once the land was under cultivation, it was useless to pastoralists.

The predominant vegetation at that time was the acacia woodland. The land was deforested as people cleared woody vegetation to eradicate the tsetse fly, opened land for growing crops and grazing animals, and gathered fuelwood and poles. As a result, the woody vegetation cover has been reduced to less than 1% of the Karatu area within the last 20 years (Helmfrid and Persson, 1986).

The planting of woody species in Mbulu District was started by decree in the mid-1930s. However, the people were reluctant to follow the decrees and they uprooted seedlings. Using forced labor, the Forest Department planted several plantations of black wattle (*Acacia mearnsii*). Due to the decrees, several households planted black wattle around their homes for fuel and building materials (Thornton, 1980).

Tree planting in Karatu District started around large estates. The first Iraqw to plant woody species in the Karatu area was a subchief who ruled between 1953 and 1963. He provided only limited encouragement to his subordinates to plant woody seedlings.

The Village Afforestation Program

The central government of Tanzania was not involved in forestry programs until 1967-68, when the Village Afforestation Program (VAP) was initiated under the national policy of "socialism and self-reliance" (TANU, 1967).

The program has been the main strategy for increasing the supply of fuelwood in rural Tanzania and reducing environmental degradation. Field implementation strategies have included individual tree planting, school and institutional

woodlots, communal woodlots, and forest service demonstration plots. Since VAP started, some trees have been planted in all regions of Tanzania (Kaale, 1984).

VAP is, in effect, an extension service program. The Forest and Beekeeping Division of the Ministry of Tourism, Natural Resources and Environment, in collaboration with the Ministry of Local Government and Regional Administration, provides free seeds, seedlings, and technical advice to interested villages, institutions, and individuals. There has been little coordination with the Ministry of Agriculture and Livestock Development. VAP also promotes the use of improved stoves that use existing fuelwood efficiently.

VAP has been a top-down approach whereby extension officers determined which woody species should be grown in the villages. VAP is evaluated quantitatively -- the indicator of success is the number of seedlings distributed for planting in the villages. Field planting, performance, and management have been insufficiently assessed. Based on the number of seedlings distributed, the area planted under VAP should have been 115,000 ha, but it is estimated to be only about 50,000 ha (Ahlback, 1988).

The overall impact of VAP on fuelwood supply and environmental rehabilitation remains marginal (Forestry and Beekeeping Division, 1989). VAP in Tanzania has developed to a stage where it is necessary to review the scope, methods, and resource needs to design a pragmatic strategy of village forestry (Mascarenhas, Kikula, and Nilsson, 1983; Werner, 1986; Mgeni, 1988).

A number of studies have been done to determine the reasons that the adoption of VAP has been minimal. Some of the factors that have deterred adoption are associated with the forest extension service, including inadequate transportation facilities, inadequate manpower and funds, and the lack of a coherent VAP policy. Other factors are associated with the villagers, including their perception that extra wood is not needed, their dislike for woody species, their lack of experience in growing trees, the incompatibility of trees with their farming systems, the unpopularity of communal activities, and the inadequacy of planning.

On the other hand, adoption of VAP by individuals and in institutions such as primary schools, the armed forces, and religious organizations has been remarkable (Kaale, 1983). Individuals have planted trees around their homesteads and farm boundaries. More than 10,000 schools have planted trees in the form of school woodlots and tree avenues. The success of tree planting in schools and institutions may be due to greater awareness of deforestation, better

organization skills, and access to necessary facilities such as transportation (Kowero and Temu, 1985).

However, all of these studies examined villagers' characteristics and the support system, but none examined the characteristics of the innovations themselves.

THEORETICAL FRAMEWORK

Village forestry is "forestry geared towards meeting rural people's basic tree and wood related needs" (Forest Division, 1984). These needs include fuelwood, poles, timber, fruits, fodder, medicine, honey, mushrooms, cash crops, and environmental stabilization.

Participation is a key concept in the development of village forestry. Depending upon the understanding of participation, different policies will be developed. Participation can be defined as either a means or an end (Oakley, 1987). As a means, participation makes it easier to achieve an established goal by using the economic and social resources of the people affected. The achievement of predetermined targets is more important than the act of participation. VAP seems to have been implemented under this interpretation of participation.

When participation is viewed as an end, the emphasis is on a process in which confidence and solidarity between rural people is cemented. Such participation is dynamic and actively responds to local needs and changing circumstances. The goal is to facilitate or enable rural people to be the main actors in rural development. Organization building is a critical element in this form of participation.

Ethnoforestry

The revolutionary approach to village forestry used in Tanzania has several shortcomings. For instance, the choice of woody species introduced to the villagers has been based on criteria set by professional foresters (Forest Division, 1984), which include trials, successful plantings around schools and missions, and inferences from literature. The villagers' needs and wishes were not taken into account, nor was their indigenous knowledge considered. An evolutionary approach would investigate indigenous knowledge and use it to develop forestry programs.

Rural people have developed their own knowledge of soils, plants, fertility, weather patterns, wildlife, pests, technology, and management systems. This knowledge is generated and developed dynamically by experimenting and

exchanging knowledge. Rural people are also rich in indigenous technical knowledge about forestry resources. Ethnoforestry taps these resources; social forestry does not, so far.

The need for integrating indigenous knowledge and formal scientific knowledge in developing technology, particularly in third world agriculture, has been discussed extensively in the literature (Brokensha, Warren, and Warner, 1980; Chambers, 1983; Richards, 1985; Rhoades, 1987 among others). Participatory technology development brings together, practically and interactively, the knowledge and research capabilities of local farming communities with that of commercial and scientific institutions.

Agroforestry

Agroforestry is "all practices that involve a close association of trees or shrubs with crops, animals and/or pasture" (Rocheleau, Weber, and Field-Juma, 1988) with the focus of the association being both ecological and economic. Agroforestry may involve using a combination of practices simultaneously or rotating practices on a piece of land.

Agroforestry practices may integrate woody species in pastures and rangelands, in livestock systems, or in landscaping. Based on the classification of Rocheleau, Weber, and Field-Juma (1988) the following agroforestry practices are relevant to Karatu Division:

- agroforestry in cropland -- dispersed trees in cropland and alley cropping

- agroforestry with structural conservation measures -- trees, shrubs, and grasses on small earthwork structures; protection and stabilization of waterways and gullies; and microcatchments and water management

- agroforestry for in-between places -- living fences; trees and shrubs on borderlines and boundaries; windbreaks; trees and shrubs along waterways, roads, and paths; trees and shrubs around houses and in public places

- agroforestry in pastures and rangelands

STUDY GOALS AND METHODOLOGY

This study surveyed six agropastoral villages of Karatu Division to describe and characterize the villagers' uses of and approaches toward forest products. This information was used to assess the value of different approaches to public-sector forest management.

Three of the villages -- Bashay, Gongali, and Gyekrum Arusha -- were rated high performers in afforestation by forest extension officers. Two -- Tloma and Kilimatembo -- were rated medium. Oldeani was rated a low performer. The ratings were based on the number of seedlings distributed to these villages for planting, not the number of seedlings planted or surviving.

Four cells containing up to 10 households each were randomly selected in each village. All of the households in each cell were interviewed, for a total of 213 households.

Because village leaders, who are elected every 5 years, are instrumental in propelling village development strategies, the opinions of the formal leaders also were solicited.

DESCRIPTION OF STUDY AREA

Karatu Division is in the high-altitude ecological zone and has an average annual rainfall of 900 mm to 1,150 mm. It is south of the Ngorongoro conservation area and west of the great Rift Valley. The area has a rolling landscape with some steep hills that are easily affected by erosion. The fertile soils of volcanic origin are vulnerable to erosion when mismanaged.

According to the 1978 census, the population of Karatu is more than 65,000, with an annual growth rate of 3.5%. Karatu area is now overpopulated and overutilized. Almost all of the arable land is cultivated, and steep slopes, swamps, and stony areas are grazed. This has led to the disintegration of the traditional farming and grazing systems.

Forestry-related problems in Karatu Division include soil erosion and shortages of fuelwood and building poles. The 1974-76 villagization program concentrated people and their livestock within delimited village boundaries. This concentration increased the rate of soil erosion. One study suggested that, in some villages, gullies widened at the rate of about 50 m annually (Lobulu, 1989). Soil surveys done at Kambi ya Simba, Kilimatembo, and Chemchem showed the presence of hardpan caused by a continuous use of disc plows. Such hardpan

restricts water infiltration, thus increasing runoff and erosion. Because wood is in short supply, people must walk long distances to gather wood. In Gyekrm Arusha, 28% of the people walked more than 7 km to gather wood. In two of the villages, Bashay and Tloma, no one reported collecting wood within 1 km of home.

Authorities have tried to reverse environmental degradation in Karatu Division by encouraging people to move with their livestock to "expansion" areas (Helmfrid and Persson, 1986). However, only limited expansion areas are available. Strategies for sustainable development for Karatu Division are urgently needed.

Since 1982, Karatu Division has been receiving aid from Sweden for the Village Afforestation Program. The objective of this aid is to supply woody seedlings to villages, individuals, schools, and governmental and nongovernmental institutions for planting. The total capacity of the program's nurseries has risen from 100,000 seedlings in 1982-83 to 347,400 seedlings in 1988-89 (S. Mruma and K. Samali, personal communication, 1989). Other nurseries belong to villages, individuals, schools, and nongovernmental organizations. The main constraint facing nurseries is the scarcity of water. Although Karatu Division has a number of seasonal rivers, only two rivers flow all year. Due to deforestation, the quality and quantity of river water is decreasing.

DESCRIPTION OF SURVEYED VILLAGES

The main organ of village administration is the village assembly -- every resident at least 18 years old is a member. The executive functions of the village assembly are performed by the village council, which consists of 25 members democratically elected every 5 years by the assembly. The council is legally empowered to raise funds and make by-laws for the village.

The administrative structure in Tanzania has four strata: central government, regional administration, local government, and village government. Since 1972, under the decentralized system, the administration in each region has functional units of most ministries. The structure found at the regional level is replicated at the district level as local government. At all levels of administration there are equivalent levels of the ruling party.

The official land distribution per household varied among villages: 1.2 ha of arable land per family in Bashay, 6.1 ha in Gongali, 2 ha in Gyekrum Arusha, 1.2 ha in Tloma, 0.1 ha in Oldeani, and 2.4 ha in Kilimatembo. The villages also had communal fields, including land available for planting trees.

Land was scarce in all of the sample villages. Oldeani, which was surrounded by coffee, wheat, and barley estates, faced the greatest scarcity. Karatu township was expanding and taking land from Gyekrum Arusha, Gongali, and Tloma without compensation.

Most of the sampled households were headed by men. Only 7% to 36% of the village households had members who were village leaders. Men did the plowing; women and children normally did the weeding and gathered the firewood. All decision-making power regarding land use rested with the husband, except in female-headed households; that is the husband approved the crop-production mix, harvesting time, selling time, and use of the proceeds. Although the relationship between the husband and wife varied among families, no woman could plant or harvest anything, including trees and shrubs, without the approval of her husband.

The main economic activities of the six villages surveyed were crop production and animal husbandry. These activities were carried out under three modes of production: households, villages, and private large-scale estates.

Villagers grew maize, wheat, beans, pigeon peas, finger millet, bulrush millet, potatoes, sunflowers, and onions. Long-term-lease estates grew wheat on a large scale. Coffee was grown on large estates along the mountain of Ngorongoro conservation area.

On the average, each household had five livestock units -- one livestock unit equals one head of cattle, one donkey, or five sheep or goats. Cattle were kept to provide milk, meat, manure, skins, and animal traction for plowing and to meet a variety of cultural needs. Livestock was more reliable than cash as a source of wealth and accumulation: Bride prices were still paid in cattle; status in the village was associated with the size of a household's cattle herd. Thus, villagers were eager to increase their herd size. Sheep and goats were kept to provide meat.

To prevent soil erosion in the villages, by-laws on destocking have been promulgated to encourage zero grazing (stall feeding) and promote rearing cross-bred dairy cattle. To conform to the by-laws on grazing, large herds have been transferred to the Mangola area in the west, the expansion area for Mbulu District. The majority of villagers preferred the traditional cattle breeds because the cross-bred cattle, which are vulnerable to tick-born diseases, must be dipped two or three times a week with expensive, scarce chemicals.

Although most of the surveyed households said they were not familiar with any agroforestry practices, many such practices were used in Karatu Division.

Traditionally, dispersed groups of trees and shrubs have been left growing on cultivated land. Such species include *Acacia mearnsii* , *Erythrina abyssinica, Rauvolfia caffra, Euphorbia tirucalli, Ficus natalensis,* and *Dovyalis caffra*. All these trees or shrubs have some uses to the villagers. Living fences were also used in Karatu Division, particularly with *Euphorbia tirucalli*, to form livestock driveways and enclosures.

STUDY RESULTS

The survey asked villagers and leaders about their use of forest products, their tree planting activities, and the forestry problems that they have encountered.

Uses of Forest Products

The villagers' lack of awareness of the role of forestry has been cited as one of bottlenecks facing village forestry in Tanzania (Kaale, 1983). However, in the sampled villages the importance of forests was recognized. Villagers obtained a number of products from the forests, including fuel, timber, wild fruits and vegetables, meat, honey, and fodder (see table 2).

Because firewood and poles were important wood products, villagers were asked how they acquired and used these items. Firewood was the main source of energy for cooking and heating water, while paraffin was used to provide light. Firewood and crop residues, particularly maize cobs and pigeon pea, maize, and bulrush millet stalks, were important sources of energy for heating. They were also used as fuel in brewing and firing bricks (see table 3).

Collecting fuelwood was the responsibility of women and children. Most villagers gathered most of their fuelwood, although they may have supplemented it with purchased wood (see table 4). In Oldeani, which had a much higher proportion of wage workers and business people than the other villages in the study, 28% of the sampled households purchased all of their wood and only 31% gathered all of their wood. Most of the sampled households collected dead wood. In Tloma and Oldeani, over half of the sampled households collected both dead and green wood. Harvesting green wood contributes to deforestation.

Most of the village leaders said it was more difficult to collect fuelwood at the time of the survey than it was five years previously; most of the the villagers said the opposite was true. However, in Oldeani, the leadership believed the fuelwood situation was improving while sampled households believed it was becoming more difficult. This difference in perceptions may explain why Oldeani planted the fewest number of trees: If village leaders perceived the situation as

improving, they may have been less eager to engage in forestry projects. In the other villages, the leadership said the situation had become more difficult or that it had remained the same. Under these conditions, the village leaders may have been more likely to encourage villagers to plant trees.

Over 90% of the houses in the villages were made of upright poles stuck into the ground, tied together, and covered with mud. Poles were also used for building the roofs. Thus, timber for building poles was important to villagers. In three of the six villages, most households continued to obtain poles by collecting them. However, many households had begun purchasing some poles and, in Gongali, 84% of the households reporting purchasing all of their poles, as did 95% of the households in Oldeani.

The village leaders did not see any disadvantages in planting woody species around the villages. However, the villagers expressed concern about the presence of snakes and wild animals in the vegetation.

Gyekrum Arusha and Kilimatembo had old stands of eucalypts. Concern had developed about the "eucalypt syndrome" -- the claim that eucalypts causes a variety of short-to long-term ills, including impoverished soils, decrease availability of water, and unsuitability for wildlife habitation (FAO, 1985). These concerns may discourage villagers from participating in future forestry projects.

Tree Planting Activities

Trees were planted by individuals, villages, and institutions. Woody species were planted in woodlots or agroforestry plots. The villages had a history of participating in forestry projects; parents of several respondents said they participated in planting trees when they were young.

Villagers planted woody species to obtain both wood and nonwood commodities. Households considered a number of factors in deciding whether to plant trees: the area of land available, the source of seedlings, the labor requirements, the species to be planted, and the distribution of benefits. None of the leaders were concerned about the distribution of the benefits from planting trees because revenues from communal projects, including forestry projects, are sources of funds for village government.

One of the issues in village-level forestry is whether trees should be planted privately or in communal woodlots. Almost everyone interviewed agreed that both modes of production are important. Almost all of the sampled households had participated in planting trees. The preferred place to plant trees was

around homes. The high level of participation in village forestry projects may have been due to coercion applied by the village governments. Planting the seedlings, clearing the plot, and weeding were the community forestry activities most frequently engaged in by villagers (see table 5).

The survey indicated that men and women were equally interested in village forestry. The decision of whether or not to plant trees at the household level was usually made by men, while women and children tended the trees. Men, especially those from poorer households, invested in trees as a means of obtaining poles rather than firewood.

The village leaders and households identified a number of constraints to successful village forestry projects (see table 6), including lack of seedlings, drought, and termites. In addition, people complained that the wrong species had often been planted. Households also listed inadequate land, poor organization, poor maintenance, and poor timing as constraints to the effectiveness of forestry projects.

When households spoke of poor organization, they included problems with the forest extension service. Tloma had the highest level of contact with the extension service because one forest extension officer resided in the village. Oldeani had the lowest amount of contact, with only 23% of the households receiving any advice from government agents on planting trees in 1988-89. Extension services were provided ad hoc and were sectorally operationalized. Among the many problems that the extension agents faced was a lack of transportation to visit the villages.

Although lack of labor was not consistently listed as a constraint, the labor needs of agriculture competed with those of tree planting. Agricultural activities had first priority, except when the village government coerced people to participate in communal forestry projects. Because planting trees had a lower priority and was often performed at less-than-optimal times, the survival rate for trees in many households was less than 50%. Since few trees were planted to begin with, the low survival rate indicated that few trees reached maturity.

Villagers will continue to plant and manage woody species that provide needed goods and services. Village afforestation in Tanzania has been attempted through a revolutionary, as opposed to evolutionary, approach. This approach has been ineffective in several localities. Even the instruments of arousing consciousness, especially the media, extension service, and forestry publications programs, are weak (Chachage and Mvungi, 1988). These would have to be much stronger for a revolutionary approach to work.

The villagers expressed preference for 40 woody species that are indigenous to the area. All 40 of the species have vernacular names. These species were used for fuelwood, medicine, building poles, tribal ceremonies, hedges, sawn timber, and mortars. Three of these species can be propagated easily from stumps and four can be raised easily in nurseries. These seven species have fast growth rates. In addition, several of these species are both drought and termite resistant.

Although most of the introduced species produce a variety of products, they do not meet the villagers' needs for medicine, building poles, and fruit. No introduced species has become a substitute for the indigenous species used in tribal ceremonies. Although several introduced species have medicinal value, the local herbalists do not have access to information about these medicines. Most of the species that have been introduced in Karatu do not produce edible fruits. Although several introduced species produce building poles, such poles are more vulnerable to biological degradation, such as termite attacks, than are those from indigenous species. Poles produced from indigenous species are expected to last from 7 yr to 20 yr, while those produced from introduced species last only from 3 yr to 4 yr, unless they are specially treated. These observations indicate that a forestry program that concentrates only on introducing new species of trees will not meet the needs of the villagers.

Many of the introduced species are sensitive to weed competition and drought; thus, both weeding and intensive land preparation are necessary to improve the survival rate of planted woody seedlings. By plowing completely before planting eucalyptus, the villagers in Gyekrum Arusha significantly improved the survival rate. The competition from other vegetation was eliminated, and the area then became unattractive for grazing livestock.

Problems

When asked to identify problems facing their villages, village leaders listed the scarcity of land, inadequate storage facilities for agricultural crops, high prices of agricultural inputs, and shortages of water. The leaders of every village mentioned the scarcity of farm and grazing land, while the leaders of only three villages mentioned the need for additional land for forestry projects. Leaders of all of the villages mentioned that the prices of agricultural inputs, especially improved maize seed, were too high: The high cost of maize seed caused several farmers to revert to using unimproved maize seed. Leaders of three of the villages mentioned the scarcity of water. The villages with adequate supplies of water were those bordering the Northern Highlands Forest Reserve, from which several permanent rivers flow.

Forestry-related issues, such as deforestation, soil erosion, and the scarcity of fuelwood and timber, were not explicitly identified as problems by the village leaders. These issues were not even mentioned in discussions of future projects desired in the villages. Instead, leaders wanted projects that dealt with improving agriculture, milling grain, and providing piped water.

Potential solutions to the problems of land scarcity include emigration, family planning, and adoption of improved agricultural technologies. Emigration is the most popular solution; however, frontier areas are dwindling, thereby limiting this possibility. Rural extension workers advocate family planning as a solution; however, leaders in only two of the villages agreed. Iraqw culture opposes the use of contraceptives, as does the Roman Catholic church. Thus, family planning through the use of contraceptives faces many barriers to becoming a widely accepted development strategy.

The leadership in four of the villages said that adopting improved agricultural technologies -- the use of improved seed, chemical fertilizer, manure as fertilizer, insecticides, and proper agronomic practices -- and, thus, increasing agricultural production is an acceptable strategy. Over 80% of the sampled households used some agricultural inputs, particularly manure fertilizer and improved seed. It appears that all of the available land is currently being exploited and the productivity of the land is deteriorating due to soil erosion. The availability and cost of labor and other inputs affect the villages' ability to intensify agricultural production.

Because the villagers are agropastoralists, the availability of land for grazing is also important. All of the villages agreed that the amount of land for grazing was inadequate. The leaders in four of the villages discussed the negative impact of overgrazing on the environment.

Villages have taken a few steps to prevent cultivated land from eroding. Some farmers practice contour plowing. To control gully erosion, some farmers plant sisal (*Agave sisalana, Euphorbia turucalli*) and cactus (*Rhipsalis baccifera*) in, along, and above the gullies. In some localities, banana plants and castor-oil plants (*Ricinus communis*) are also planted. These species are easy to plant, grow rapidly, and bind the soil. Other farmers dig contour ditches on slopes at the foot of hills.

CONCLUSIONS AND RECOMMENDATIONS

Professional forestry in Tanzania has traditionally been concerned with managing state-owned forest resources. Although 70% of the forestland is publicly owned, the public has not been scientifically assisted in managing and utilizing this resource. Since the Village Afforestation Program started in 1967-68, only marginal results have been achieved.

The reasons for the marginal achievement have been explained by the characteristics of the villagers and the forest extension service, but not in terms of the characteristics of the innovations themselves. Technical packages for village afforestation were acquired from industrial plantations and introduced to the villagers from the top down. This approach has not been successful.

Although deforestation occurred rapidly in Tanzania, forestry-related development problems -- deforestation, scarcity of wood, and soil erosion -- were rated as less important by villagers than the scarcity of land for farming and grazing, the high prices of agricultural inputs, and the scarcity of water. This suggests that forestry programs in Karatu Division cannot be effective until these other concerns are addressed. One solution will be to nest village forestry programs within projects addressing these other issues.

The sampled households and village leaders had differing perceptions on several issues. For example, the villagers were concerned about the presence of snakes and wild animals in woody vegetation near villages, but the leaders were not. These differences may have influenced the effectiveness of the design and implementation of village forestry programs.

Households perceived more benefits from planting trees and shrubs than the leadership did. In addition, households were more concerned about minor forest products.

Households perceived more constraints to planting trees than the village leadership did. This may have been, in part, because all physically able adults were required to participate in village development programs.

People in Karatu Division knew which of the indigenous species were suitable for different purposes, even though they had no tradition of planting them. A few individuals had raised seedlings of introduced and indigenous species. These farmer-led trials should be researched and the results incorporated into future forestry programs. The woody species that have been introduced in Karatu Division do not meet all of the needs traditionally satisfied by indigenous species.

Situation analysis of village forestry is an important step toward improving the current Village Afforestation Program in Tanzania. The microdata gathered provides feedback to the programs. Learning from villagers is a fragmented and repetitious process requiring repeated interaction between researchers or extension workers and the farmers over an extended period. The rapid rural appraisal done for this study provided insights into village forestry in Karatu Division. Agropastoralists have multiple objectives that are multidimensional and interlinked.

It will be important to pursue further the application of participatory technology development in Karatu Division. A multidisciplinary team should carry out pilot studies for one or two of the villages. The results of the studies should be used to produce multifaceted development plans that incorporate village forestry as one aspect of broader programs.

It is evident from the study results that village or social forestry cannot be implemented effectively under the top-down technology-transfer paradigm. People's participation in designing and implementing social forestry programs is essential. Therefore, social forestry programs must be designed and implemented from the bottom up. The rural extension service should be integrated. Currently, each village works with a number of extension agents, each of whom is responsible for a topic, such as agronomy, livestock, forestry, health, or adult education. The policies related to these different aspects of village life will also have to be synchronized. Real political support is needed if rural development strategies are to become more efficient and effective

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Table 1. Forest areas of mainland Tanzania.

Forest	Gross area (000 ha)	Net productive area (000 ha)
By type:		
Closed forests	936	337
Savanna woodlands	32,641	25,803
Intermediate woodlands[a]	10,714	8,406
Mangrove forests	80	80
Total	44,371	34,626
By legal status		
Forest reserves	13,024	11,410
Forests within national parks	2,000	0
Public forestland	29,347	23,216
Total	44,371	34,626

Source: Mgeni and Malimbwi, 1990, modified from Ahlback, 1988.
[a]Includes 150,000 ha of plantation forests: 80,000 ha industrial plantations owned by the central government, 10,000 ha owned by local government, 10,000 ha privately owned, and 50,000 ha under village forestry.

Table 2. Percentages of sample households acquiring goods from woody species and forests, by village, Karatu Division, Tanzania, 1988.

Good	Bashay	Gongali	Gyekrum Arusha	Tloma	Oldeani	Kilimatembo
Firewood	97	97	97	100	90	96
Charcoal	76	8	31	25	44	44
Construction timber (poles)	58	33	97	100	87	96
Sawntimber	63	30	47	50	56	63
Game meat	16	5	25	28	36	44
Wild fruits and vegetables	32	32	53	47	38	48
Fodder	21	5	3	22	5	33
Honey	24	3	0	31	23	30
Grazing	63	41	42	81	23	63

Table 3. Percentages of households using various sources of energy for domestic activities, by village, Karatu Division, Tanzania, 1988.

Energy source	Bashay	Gongali	Gyekrum Arusha	Tloma	Oldeani	Kilimatembo
Heating water:						
Firewood	100	95	100	100	100	100
Charcoal	5	0	0	0	0	0
Crop residues	0	8	0	0	0	0
Paraffin	0	3	0	0	0	0
Lighting:						
Firewood	0	3	0	0	0	0
Crop residues	8	22	3	28	23	0
Paraffin	89	84	97	69	77	100
Heating:						
Firewood	34	54	33	28	51	33
Charcoal	0	5	0	0	0	0
Crop residues	13	11	47	47	5	11
Brewing:						
Firewood	21	27	42	47	5	11
Crop residues	45	27	25	31	38	33
Firing bricks:						
Firewood	26	38	25	22	5	7
Crop residues	29	5	3	17	13	19

Note: More than one answer possible.

Table 4. Percentages of households using various methods to acquire fuelwood by village, Karatu Division, Tanzania, 1988.

Method of acquiring fuelwood	Bashay	Gongali	Gyekrum Arusha	Tloma	Oldeani	Kilimatembo
Gathering	61	86	72	94	31	100
Gathering and buying	23	3	28	6	41	0
Buying	16	11	0	0	28	0

Table 5. Percentages of households participating in various village-level forestry activities, by village, Karatu Division, Tanzania, 1988.

Activity	Bashay	Gongali	Gyekrum	Tloma	Oldeani	Kilimatembo
Taking part in initial discussion	68	22	86	72	74	63
Giving land for tree plot	68	36	78	75	67	85
Planting seedlings/ seeds	71	92	97	81	87	44
Choosing site	59	59	94	86	79	81
Clearing plot	89	62	97	86	100	31
Weeding	92	58	86	69	92	74
Watering (nursery)	0	0	22	44	0	7

Table 6. Percentages of households identifying various constraints to planting trees, by village, Karatu Division, Tanzania, 1988.

Constraint	Bashay	Gongali	Gyekrum Arusha	Tloma	Oldeani	Kilimatembo
Lack of seedlings/ seeds	89	59	97	100	100	100
Inadequate land	89	54	53	53	95	70
Shortage of labor	63	5	45	28	36	63
Lack of forestry knowledge	66	30	34	39	64	54
Drought	84	43	100	69	49	92
Livestock eating seedlings	71	65	53	42	79	63
Illegal cutting of seedlings	66	22	53	31	49	59
Pests (termites)	87	81	75	61	100	81
Wrong species planted	89	5	64	67	79	81
Poor organization	76	38	88	56	100	74
Planted at wrong time	76	32	100	69	82	44
Poor maintenance	63	35	69	64	69	81

FACTORS AFFECTING AGRICULTURAL MARKETABLE SURPLUS IN TANZANIA: THE CASE FOR MAIZE

Isaac J. Minde

SUMMARY

Tanzania's agricultural sector provides over 40% of the gross domestic product, 75% of total export earnings, and 85% of the nation's employment, but has not always been able to produce enough food to keep up with the nation's increasing demands. The sector grew at a dismal rate of 1.8% between 1975 and 1986, compared to an estimated annual population growth rate of 3.4%. The general consensus is that the achievement of food security in Tanzania will require substantial increases in the marketed surplus of agricultural commodities.

Using historical analysis and survey methods, this study identifies and analyzes factors that affect the quantity of subsistence food crops marketed in Tanzania. In particular, the study focuses on socioeconomic and institutional factors that influence the amount of maize marketed by small farmers. Maize is examined because it is the staple food for the majority of Tanzanians and because it is grown widely by small farmers in many parts of the country.

State intervention in the agricultural sector preceded independence. A government grain purchasing monopoly was established in 1946, which set high producer prices to encourage grain production. Excessive grain surpluses and financial losses led to the establishment of a free market in grain in 1957. In 1962, drought-induced supply shortages led Tanzania's newly independent government to enact the Agricultural Products Control and Marketing Act to control and regulate the pricing and marketing of agricultural products. Government intervention in the production and marketing of agricultural products has continued, to varying degrees, from 1962 to the present.

Government control of food production tightened after the Arusha Declaration of 1967, which led to the nationalization of major grain milling companies and the relocation of many farmers into communal farming villages. Low real producer prices for staple grain crops such as maize, marketing restrictions and inefficiencies, and dislocations resulting from the villagization experiment resulted in lowered marketed output of maize. Much of the maize that was marketed was sold through the parallel market where the prevailing free-market prices were substantially higher than official prices.

In 1984, following a reevaluation of past agricultural policies, the government liberalized its policies on agricultural production and marketing by reintroducing market incentives. In particular, policy measures were adopted which sought to

- raise real producer prices by 5% per year to correct for historical price declines
- eliminate consumer food subsidies
- reduce regulations on the transport of produce by private traders
- remove agricultural input subsidies and revert to producer price incentives to encourage farmer adoption of improved crop husbandry techniques

The implementation of these measures, combined with good weather conditions from 1985 to 1987, dramatically increased supplies of maize marketed through official channels. By 1987 government stocks of maize reached record levels. Given the current situation -- grain stocks are not moving, world commodity markets are weak, storage costs are high, and bank credit ceilings are stringent -- the government's new challenge is to continue to honor its commitment to maintain guaranteed prices to farmers.

To test the role of various household, market, and institutional factors in the determination of the amount of maize marketed, a survey of maize producers was undertaken in Tanzania's Moshi and Morogoro districts in 1987. Thirty-one and 33 smallholder farmers were interviewed from major maize-growing villages in each district, respectively. Survey results support the findings of other recorded studies which indicate that a complex web of economic, social, institutional, and environmental factors interweave to determine the amount of maize marketed.

At the household level, key factors apart from weather include area planted to maize, total maize output, family consumption requirements, household storage capacity, cash requirements, effective use of advanced technologies, and higher education. The role of family size was found to be somewhat ambiguous. It is suggested that instead of family size, studies should focus on household consumption requirements and effective household labor supply. Survey results also indicate that the farming of cash crops such as coffee can compliment and augment the production of subsistence crops such as maize. Cash cropping need not interfere with maize land and labor requirements and can provide income for the purchasing of maize production inputs.

Across the farm gate, economic and institutional factors shown to influence the amount of maize marketed include pricing and marketing policies, local availability of consumer goods, timely local availability of credit and production inputs, and adequate marketing infrastructure such as transportation and storage.

Although producer price incentives have been shown to be a key determinant of the amount of maize produced and marketed, they can only be effective when combined with sufficient investment in supportive infrastructure. The production of surplus maize is a necessary, but not

a sufficient, condition for the realization of market sales. An effective integration of the market from primary producers to final consumers is necessary to achieve market efficiency and increased product sales. In particular, there is a need for improved rural roads and transportation facilities, and rural grain storage facilities to ensure timely provision of production inputs and to facilitate the sale of surplus produce.

Food security has become a household phrase in Tanzania. The agricultural sector provides over 40% of the gross domestic product, 75% of total export earnings, and 85% of the nation's employment, but has not always been able to produce enough food to keep up with the nation's increasing demands (United Republic of Tanzania, 1986). The sector grew at a dismal rate of 1.8% between 1975 and 1986, compared to an estimated annual population growth rate of 3.4%. Food shortages resulting from declining per-capita food production in this country have attracted the attention of donor agencies, policy-makers, and social and agricultural research scientists.

The general consensus is that in a predominately agricultural economy such as Tanzania's, the achievement of food security will require a substantial increase in the marketed surplus of agricultural commodities. An increase in marketed surplus is needed to provide food and raw materials for the growing urban sector of the economy and for the landless, rural population. Surplus must also be set aside for bad crop years, and is an important source of foreign exchange. However, as Coulson (1982) and Lele (1984) have noted, despite its importance there is little understanding of what is required to achieve an adequate marketed surplus of maize because it is the staple food for the majority of Tanzanians, and is grown widely by small farmers in many parts of the country.

HOUSEHOLD FACTORS AFFECTING MARKETED SURPLUS

Household factors suspected to affect the quantity of food crops marketed include family size, education, consumption habits, and cropland holdings.

Several researchers, including Kahlan and Reed (1961) and Krishna (1962), have shown that the amount of marketed surplus is dependent on consumer preferences and the nature of the product. Behrman (1966), Chinin (1976), and Mwamufiya and Fitch (1976) assert that household preference of a crop for consumption is negatively associated with marketed surplus, especially in the

case of subsistence crops. Renkow (1983) found that changes in maize flour consumption habits in Tanzania increased household demand for maize relative to previous consumption habits.

The proportion of subsistence crops retained for household consumption has been found to decrease with an increase in the size of farmland holdings. Hoarding of produce also depends on other factors such as family size (consumption requirements), storage capabilities, cash requirements, and marketing opportunities.

Large families can generally out-produce small families, all else being equal, because they form a larger labor base. However, studies by Strauss (1984) and Nkonya (1986) show that farmers with small families contributed more to marketed surplus than those with larger families. The apparent lack of concensus is not surprising, however, because many factors are at play. The age of family members must be considered, as must the level of technology being employed. In fact, production technology may be more important in determining the area planted and yields realized than the number of productive family members. If a large family uses the hand hoe, it may just produce enough for household consumption. Whereas a small family using a tractor and herbicides may produce a significant surplus for sale.

Khaldi (1985) found that education enhances the allocative efficiency of farmers, by enabling them to more quickly adjust to changing prices and the availability of new information regarding crop production. This can have an indirect effect on marketed surplus.

ECONOMIC FACTORS AFFECTING MARKETED SURPLUS

Economic factors that influence the amount of food crops marketed include crop prices, income levels, and the price and availability of credit, consumer goods, and production inputs.

Producer prices are among the most important and effective tools for influencing agricultural output. However, opinion is divided over the nature and direction of the relationship between producer price and marketed surplus. Malthur and Ezekiel (1961) contend that an inverse relationship exists between prices and marketed surplus in some situations where farmers are marginally subsistent producers. It is argued that these farmers will sell only what is necessary to meet their household cash requirements. Therefore, if there is an increase in the producer price of their crop, they will sell less of it and either increase

household storage and consumption of the crop, or devote less resources to crop production. This inverse relationship is expected to disappear as economic development proceeds and more consumer goods become locally available at affordable prices.

In contrast, Toquero (1975), Haessel (1975), and Strauss (1984) found that an increase in producer price did have a positive effect on the amount of marketed surplus of a subsistence crop, as did an increase in output. This lends support to an inference made earlier by Krishna (1962) and Behrman (1966) that prices below market equilibrium have an adverse effect on the marketed surplus of basic staples. Keele, Scobie, and Renkow (1982) found that efforts to increase food production in Tanzania have been frustrated by declining producer prices relative to world market prices. They note that while world prices doubled in 1979-80, real domestic producer prices offered by the official government purchasing agent remained constant. Strauss also found that cross price elasticities are significant and usually negative in sign, indicating the importance of considering the effect of relative changes in crop prices on marketable surplus.

Studies by Malthur and Ezekiel (1961), Bharghava and Rustogi (1972), Haessel (1975), Harris (1984), and Toquero (1975) have demonstrated the existence of a positive relationship between the level of crop production and marketed surplus. Toquero found that the elasticity of supply with respect to output is greater than unity. Farmers will retain a smaller percentage for household consumption as output increases. This implies that increases in output have a strong positive affect on marketed surpluses of subsistence crops.

Strauss (1984) found a positive correlation between the use of advanced production technology and output. A discriminate analysis by Mwamufiya and Fitch (1976) demonstrated a positive correlation between the level of marketed surplus and the ownership of consumer goods such as bicycles and radios. This supports the claim that, in addition to attractive prices, desirable consumer goods must be available to induce farmers to increase marketed surplus.

Adequate marketing infrastructure is also essential to increase marketed output. Nkonya (1986) and Due (1982) have shown in their Tanzania-based studies that marketing efficiency is a function of the existing infrastructure, including transportation, storage, measurement, packing, and skilled labor for operation, supervision, and auditing. Inadequate transportation facilities, for example, can discourage farmers from producing above household consumption levels. Harris (1984) has shown that distance to market and level of marketed surplus are negatively associated.

Insufficient consideration of these economic factors affecting the marketed surplus of staple food items has been one of the main reasons national agricultural programs and institutions have for many years failed to significantly increase per-capita food production.

THE ROLE OF INSTITUTIONS IN THE MARKETING OF MAIZE

State intervention in the agricultural sector, and particularly in grain marketing, preceeded independence. From 1946 to 1957 the grain storage department had a purchasing monopoly for all commercial quantities of grain marketed. It set high prices to encourage producers, but this led to surpluses which were exported at a financial loss to the colonial government (Amani, Kapunda, Lipumba, and Ndulu, 1987).

This system of guaranteed prices and government control of grain marketing was abandoned in 1957, when a free market in grain was established. Grain prices were determined by supply and demand until independence in 1961. In 1960-61 maize prices increased sharply, particularly in Dar-es-salaam, because of drought-induced supply shortages. Grain traders were wrongly blamed for the high price increases. As a result, the government introduced the Agricultural Products Control and Marketing Act of 1962 to control and regulate the pricing and marketing of agricultural products (Kriesel 1970).

A three-tier single marketing system was established. At the apex was the National Agricultural Products Board (NAPB), which was made the sole commercial buyer of grain. Direct sales from producers to consumers were allowed, but large quantities of grain could only be transported with the permission of NAPB. NAPB appointed cooperative unions as marketing agents and charged them with the responsibility of purchasing maize and other food products, either directly or through their cooperative societies, and selling them to NAPB. The board was then responsible for selling the grains to millers.

Although the main justification for the creation of NAPB was the elimination of intermediary agents, the new system strengthened the role of intermediaries by establishing them as legal institutions. Kriesel (1970) quotes a NAPB report which states that the one-channel marketing system is designed to ensure that the price, movement, storage, and final export or internal sale of products are centrally organized and controlled by the government. Intervention in the marketing of agricultural products has, therefore, been a persistent characteristic of the political economy of agriculture in Tanzania.

NAPB controlled the marketing of staple food grains such as maize, rice, and wheat until 1972. The government set the NAPB commercial price and cooperative unions set producer prices after deducting marketing costs. State control of grain marketing increased with the nationalization of major grain milling companies and the formation of the National Milling Corporation (NMC) in 1967, after the Arusha Declaration. In 1973 the activities of NAPB were taken over by NMC, which continued to use cooperative unions as its agents.

Before 1976, cooperatives monopolized agricultural marketing. Many were inefficient, incurred financial losses, and delayed, or never fully made, payments to farmers (Minde, 1986). According to Msambichaka, Amani, and Ndulu (1982), cooperative weaknesses included lack of marketing experience, lack of skilled labor, dishonesty within cooperative management, a proliferation of cooperative activities, and undemocratic governing procedures. Wealthier farmers tended to control cooperatives, and this control gave them an independent political power base. To improve marketing efficiency and eliminate the independent authority of cooperative leaders, the government abolished all cooperatives in 1976 and introduced government-owned crop authorities (parastatals) which became responsible for purchasing, processing, and exporting or selling products locally. The parastatals were also responsible for extension services. There were no specific parastatals for grains. Instead, NMC assumed responsibility for their direct purchase, transport, milling, and wholesaling.

While this reorganization did end the independent authority of cooperative leaders, the public bureaucratic nature of the new crop authorities limited their effectiveness in reducing marketing inefficiencies. Public marketing has tended to be a high cost operation due to overstaffing, poor financial controls and accountability, and inexperienced management (Minde, 1979). Referring to the use of parastatals in Africa, Eicher (1982) states that, "the record is clear that parastatals are ineffective in stimulating the production of private farmers and they are not more efficient than the private traders in food grain marketing." He also notes that the abolition of cooperatives is one of the mistakes former President Nyerere has admitted to have made during his presidency.

In 1984 the government reintroduced the use of cooperative unions and the three-tier, single-channel marketing system. Just as the policy of their abolishment was not selective, neither was the policy of their reintroduction. Cooperative structures were established in each region regardless of local tradition and grassroots support of the institutions. Since their reestablishment in 1984, cooperatives have been the sole designated buyers of all surplus agricultural crops.

Villagization and Agricultural Production

The 1967 Arusha Declaration had among its objectives the arrest of capitalist development through the establishment of Ujamaa villages which were intended to be economic and social communities where people lived and worked together for the good of all. This meant that large acreages could no longer be cultivated by hired labor, which limited total and marketed surplus of all estate crops, including export crops such as tea, tobacco, coffee, sisal, and sugar cane.

At first, movement to communal villages was voluntary. However, in 1973 the ruling party's biennial conference resolved that the entire rural population should move to permanent villages by 1976. Over the period 1974 to 1976 many families moved or were moved by force into 8,000 villages. Although many scholars have avoided the issue of the use of coercion in the moving of people into villages in Tanzania, Eicher (1982) has used it as an example of the unsuccessful experimentation of socialism in Tanzania. Today, communal farms remain little more than political rhetoric. Not more than 0.5% of cultivated land in Tanzania is under communal production.

The movement of the rural population into new villages disrupted agricultural production because of the necessity of abandoning existing farm fields and establishing new ones. Traditional villages were carefully chosen and established over the years, taking into account the most suitable places for the cultivation of particular crops. But the new villages were delineated in a hurry and without farmer participation. Most were located in barren places, close to roads, or on ridges. During this period of villagization, total agricultural production and marketed quantities of grain declined. This decline was exacerbated by the drought of 1973-74 which adversely affected the production of most cereal crops.

Producer Prices and Pricing Policies

The government response to the food shortages from 1973 to 1975 was to increase the official prices of food crops, particularly the less preferred crops such as cassava, sorghum, and millet. The production response was so substantial that NMC had to export a large proportion of these crops at a loss due to the lack of sufficient domestic demand.

Despite nominal increases in the official producer prices of the preferred staples, maize and rice, prices remained below the free market price except in very remote areas (Marketing Development Bureau 1984; 1985; 1986). In fact, between 1975 and 1981, the real official producer prices of maize declined. The causes of the decline include the high marketing margin claimed by official

marketing agencies and an increasing overvaluation of the currency as domestic inflation greatly exceeded international inflation over this period. The low pan-territorial prices instituted in 1974-75 and the pricing policy emphasizing less-preferred grains and root crops led to a 21% reduction in the amount of preferred grains sold to the NMC (Ellis 1980).

Over this same period, Renkow (1983) found that unofficial market prices were constant or increasing in real terms. The dual market system for food crops, and maize in particular, explains why procurements by NMC declined while the unofficial urban share of the marketed surplus was constant or rising. Official marketed output of maize continued to decline as a result of these pricing policies, after 2 years of increased marketed output during the bumper crop years of 1977-78 and 1978-79. NMC maize purchases fell from 219,000 tons in 1978-79 to 71,000 tons in 1983-84, despite modest production increases over these years (Ministry of Agriculture and Livestock Development 1984).

The years 1978 to 1980 were an economically difficult period for Tanzania, partly due to the Uganda war bill and the second oil price shock of 1979. In a desperate attempt to protect consumers from rising prices, the government imposed price controls on most goods. To increase the flow of food, including maize, to official marketing channels, the authorities imposed restrictions on the transporting of food grains across district boundaries. Road blocks were set to prevent unauthorized transport of grain, which added risk premiums and bribery transaction fees to the consumer price of illegally transported foods. The amount of food grains which could have been transported by private traders to markets across districts was substantially reduced.

In 1983 a task force was appointed by the government to examine past agricultural policies. The task force recommended the adoption of market-oriented agricultural development policies with a strong incentive structure. Partly due to task force recommendations, in 1984 the government adopted policy measures that departed from previous policy. Those measures relevant to agricultural production and marketing include

- the reintroduction of cooperatives and removal of crop authorities
- the devaluation of the currency
- a substantial increase in the producer prices of major export and food crops
- the removal of consumer subsidies

- a modest liberalization of food production and marketing

In particular, policy measures aimed at revitalizing the agricultural sector sought to

- bring the official ex-store cost and consumer prices closer together by removing consumer subsidies on food crops, including maize

- raise real producer prices by 5% per year, to correct for historical price declines

- reduce bottlenecks for private traders in scheduled food crops by removing road blocks and permitting private traders to buy and transport up to 500 kg of produce at a time

- remove agricultural input subsidies and revert to the use of producer price incentives to encourage farmer adoption of improved crop husbandry techniques and innovations

The implementation of these measures, combined with good weather during 1985-86 and 1986-87, significantly increased supplies of food, especially maize. The 1984-85 crop year resulted in above average production of maize, estimated at 2.09 million tons. This was an increase of 8% from 1983-84 production levels. Maize production increased an additional 5.6% in 1985-86 and 6.7% in 1986-87 (Marketing Development Bureau, 1987). These increases dampened consumer prices of maize, particularly on the open market. In 1984-85 average open-market consumer prices for maize declined significantly from their 1983-84 peak, and this downward trend continued until 1987.

Official purchases of maize increased an average of 40% per year over the period 1984-85 to 1986-87. This was due partly to the increase in production and partly to an increase in official producer prices relative to open-market prices. In fact, in the chief maize-producing areas official prices served as support prices, exceeding open-market prices.

In March 1987, all restrictions on the movement of food grains were removed. By this time NMC maize stocks had reached record levels, estimated at over 200,000 tons. Local sales have continued to be slow because open-market producer prices have averaged lower than official prices. Because the exporting of maize can result in significant losses at existing prices a liquidity crunch has developed. NMC is faced with non-moving stocks, high storage costs, and stringent bank credit ceilings. Under these circumstances, NMC and the

government at large now face the big challenge of honoring the promise to maintain guaranteed prices to farmers.

SURVEY METHODS AND RESULTS

To test the role of various household, market, and institutional factors in the determination of the marketed surplus of maize in Tanzania, a survey of maize producers was undertaken in two of Tanzania's maize-producing districts in 1987. A 17-page, 90-question survey was administered to smallholder farmers in Moshi and Morogoro districts. These two districts were selected to capture differences in the behavior of farmers selling a staple food in an area where there is a permanent cash crop and in an area where there is none. Moshi District in northeastern Tanzania is one of the leading coffee producing districts in the country. A permanent cash crop is assured in this district and every farmer participates in cash-crop production. In addition to coffee, farmers in this Moshi District grow crops such as maize. In contrast, Morogoro District in east-central Tanzania produces chiefly maize, rice, and sorghum.

A sample of 31 smallholder farmers was picked from Morogoro District and a sample of 33 smallholder farmers was picked from Moshi District. Lists of the 10 top maize-producing villages were obtained from the district agricultural officer in each of the two districts. Two villages were picked at random from each of these lists. Using village registers, 15 farmers were randomly selected from one village in Morogoro District and 16 farmers were randomly selected from the other village. In the same fashion, 16 and 17 farmers respectively were selected from the two villages in Moshi District.

Household Characteristics

Family size, particularly the number of family members over the age of 17, determines a household's available farm labor force. Thirty-six percent of the families in Morogoro District had family sizes ranging from 8 to 11 members. This group of families produced, consumed, and sold the highest average number of bags of maize per family: 32.5 bags, 11 bags, and 18.2 bags, respectively. In Moshi District, 51% of the households interviewed had family sizes in the 8 to 11 member category. This group produced, consumed, and sold a per-family average of 35.7, 6.7, and 27 bags of maize, respectively. Nevertheless, it was out-produced, out-consumed, and out-sold, on an average per-family basis, by the 24% of families in the four to seven member category (see table 1). Good weather contributed to higher than average production of maize in the crop years 1984-85 and 1985-86 for which these survey data was obtained.

Most of the heads of households surveyed in Morogoro District were between 40 and 69 years of age. Production and sales of maize were highest among households with heads of families between the ages of 40 and 49, followed by households with heads between the ages of 60 and 69. The same results were found in the Moshi District sample, except that households with heads between the ages of 60 and 69 produced and sold roughly equivalent amounts of maize, on average, as those with heads between the ages of 40 and 49. Average head-of-household ages are an indication of family size, experience, and perhaps willingness to assume the risks associated with the adoption of new farming technologies.

There was a remarkable difference in the level of formal education attained by the farmers in the two districts. Historical factors, such as the date of infiltration of Christianity, and the availability of local schooling opportunities are likely to be the reasons behind these differences. In Morogoro District, 58% of the surveyed farmers had no formal education, compared to only 21% with no formal education in Moshi District. In fact, in Morogoro District no farmer surveyed had more than eight years of standard education. In Moshi District, farmers with secondary and college educations were found. About 17% of the farmers surveyed in each district had some adult education (see table 2).

It is interesting to note that in the Morogoro sample, years of formal education were inversely related to maize production. Farmers with no formal education out-produced and out-sold all other farmers in that sample. This suggests that other factors, such as years of practical on-farm experience, may play a larger role in the determination of crop output. In the Moshi sample, farmers who had obtained five or more years of formal education produced and sold more, on average, than those farmers with less formal education. Farmers who had obtained some college education substantially out-produced and out-sold all other categories. While advanced education enables farmers to keep up with available new technologies and make better production and marketing decisions, it may also be linked with other factors such as relatively high family incomes or greater landholdings, which also can affect output.

Land Resource Availability and Use

Since maize is a staple food in both districts, it is expected to be grown on a significant portion of each farm. In Morogoro District, where there is more arable land per capita, most farmers have two to six hectares of arable land. Over the sample period, these farmers produced and marketed an average of 20 and 10 bags of maize, respectively. With the exception of the 16% of farms in the 6.0 to 7.9 hectare category, increased land area corresponded with increased output and sales (see table 3).

In Moshi District, land is a more limiting production factor. Over 80% of the households surveyed had farm sizes of less than four hectares. Average output was higher in this sample, however, reflecting better rainfall conditions and greater use of modern technology such as improved fertilizers, hybrid maize seed, and pesticides. Farm size was again positively correlated with maize output and sales.

Coffee is an important cash crop in Moshi. It was found that maize output was positively correlated with coffee output in the Moshi sample (see table 4). This can be explained by the fact that coffee and maize are complementary crops in this area, and do not compete for land or labor. Maize is normally planted in the lowlands between January and June, whereas the peak labor demand for coffee occurs between July and September when picking activities are at their highest level. The cash received from coffee sales assists farmers in buying the required maize inputs, which in turn increase maize yields, leading to increased marketed surplus. Land devoted to coffee averaged about half the amount of land devoted to maize. This reflects the importance of maize as the area's chief staple.

Growing maize for sales purposes was an objective expressed by 58% of the farmers in the Morogoro sample and the Moshi sample. As one would expect, these farmers out-produced and out-sold farmers whose primary objective was to produce for home consumption. Farmers whose primary stated objective was to produce for home consumption tended to limit maize sales to five or six percent of their total maize production. The finding of such a large group of smallholder farmers who produce substantial shares for the market appears to contradict with findings of farming systems research that smallholder farmers grow primarily to meet household food requirements. The reason for this discrepancy is probably that the villages chosen for this study were purposely biased towards heavy maize producers.

Maize Production Technology

About 71% of the farmers surveyed in Morogoro District used improved seed purchased from the Tanzania Seed Company. About 45% used fertilizers and the same percentage used insecticides. Contrary to expectations, those who claimed to have used such inputs produced and sold less maize, on average, than did their counterparts. This suggests the importance of other factors, such as the appropriate use of new inputs and technologies, and the possibility that farms adopting such technologies may be faced with other resource constraints that limit production. Farmers who used improved seeds and fertilizers in the Moshi sample did average higher output and sales than their counterparts. This was not the case with insecticide use (see table 5).

Tractors were used mainly for land preparation. The two-thirds of the farmers in the Morogoro District sample who used tractors produced and sold about 85% and 90%, respectively, of the total maize produced and sold. In Moshi District, all farmers but one used tractors for land preparation, and these farmers produced and sold more than that farmer.

The availability of pesticides and fertilizers were the primary production input concerns of Morogoro farmers surveyed. In Moshi District, 60% of farmers surveyed listed improved seed availability as their primary input concern and 36% listed insecticide availability. The problem lies chiefly in these inputs being available at the time and place required by farmers.

Maize Marketing

All farmers surveyed sold maize sometime during the year. In Morogoro District, 68% of farmers surveyed sold maize to meet cash requirements. A lesser number of farmers sold maize due to having an excess amount or inadequate storage facilities. While most farmers surveyed in Moshi District also sold maize principally to meet cash requirements, a higher percentage also sold maize because they had produced an excess amount (see table 6). This suggests that the average marketable surplus is higher in Moshi District. Those farmers who sell primarily to meet cash requirements or to solve storage problems may find it necessary to buy maize back when household stocks are depleted.

Three marketing channels were available to smallholder farmers at the time of the survey: the local market, intermediaries, and cooperative societies. For the last two years, NMC has received maize from unions and cooperative societies, which was initially bought from farmers. Individual smallholder farmers cannot currently sell to NMC directly. Intermediaries purchase maize at the farm gate. Maize sold to cooperative societies or at the local market must be transported to the market.

About 68% of the farmers surveyed in Morogoro District sold some maize to intermediaries, 45% sold to cooperative societies, and only 10% sold to local markets. As the numbers indicate, some farmers sold through more than one channel. In contrast, 61% of the farmers surveyed in Moshi District sold some maize at the local market, 30% sold to intermediaries, and 12% sold to cooperatives.

Farmers in both district samples were asked to identify the principal constraints limiting their marketed surplus of maize. More than 80% of Morogoro farmers surveyed listed high input prices as a key production and marketing constraint.

Most farmers also cited the need for improved credit facilities and more timely tractor operations. Other constraints listed by at least 25% of the farmers are producer prices and the availability of consumer goods. All Moshi farmers surveyed listed consumer goods availability as a key constraint to producing maize for the market. Most of these farmers also cited the need for a more timely supply of inputs. About half complained of high input prices and inadequate credit facilities. Low producer prices were listed as a constraint by 42% of the farmers (see table 7). Input prices (for example of seeds and fertilizers) were listed as constraints partially because it was only in 1984 that government subsidies of agricultural inputs were removed.

Asked whether current maize prices were good, satisfactory or fair, or poor, most farmers in each district sample found them to be satisfactory or fair. Thirty-six percent of Morogoro farmers characterized them as good, compared to 6% of Moshi farmers. None of the Morogoro farmers described maize prices as poor, compared with 12% of the Moshi farmers. Thus, although most farmers were basically satisfied with current prices, a higher incidence of dissatisfaction was found in the Moshi sample.

Satisfaction with current producer prices probably stems from the fact that nominal producer prices for maize have increased substantially over the last three years, giving rise to money illusion on the part of some farmers. In real terms, producer price increases have not been impressive. The reason for the greater dissatisfaction with producer prices in Moshi District may be because farmers here are less taken with money illusion, and(or) because there are alternative cash crops and income-earning opportunities that compete with the cash cropping of maize in Moshi District. Only eight farmers in the Morogoro sample earned nonfarm income, and most of these earned less than shs 2,000 per year for nonfarm work. In contrast, 13 of the Moshi farmers surveyed earned nonfarm income, and all but one of these earned more than shs 2,000 for nonfarm work. The highest nonfarm income reported was shs 7,000 earned by a Moshi farmer.

CONCLUSIONS AND POLICY IMPLICATIONS

The foregoing survey and analysis indicate that a complex web of economic, social, institutional, structural, and environmental factors interweave to determine the amount of maize marketed.

At the household level, key factors apart from weather include area planted to maize, total maize output, family consumption requirements, household storage capacity, cash requirements, effective use of advanced technologies, and higher

education. The role of family size was found to be somewhat ambiguous. It is suggested that instead of family size, studies should focus on household consumption requirements and effective household labor supply. Survey results also indicate that the farming of cash crops such as coffee can compliment and augment the production of subsistence crops such as maize. Cash cropping need not interfere with maize land and labor requirements and can provide income for the purchasing of maize production inputs.

Across the farm gate, economic and institutional factors shown to influence the amount of maize marketed include pricing and marketing policies, local availability of consumer goods, timely local availability of credit and production inputs, and adequate marketing infrastructure such as transportation and storage. Past experience shows that negative pricing policies have dampened incentives to produce enough food for sale. In addition to prices, institutional production and marketing arrangements, and the delivery and disposition of inputs and output have been instrumental in determining marketed surplus. Insufficient attention has been paid to these factors in Tanzania, and the potential for improvement is tremendous.

Although producer price incentives have been shown to be a key determinant of the amount of maize produced and marketed, they can only be effective when combined with sufficient investment in supportive infrastructure. The production of surplus maize is a necessary, but not a sufficient, condition for the realization of market sales. An effective integration of the market from primary producers to final consumers is necessary to achieve market efficiency and increased product sales. In particular, there is a need for improved rural roads and transportation facilities, and rural grain storage facilities to ensure timely provision of production inputs and to facilitate the sale of surplus produce.

The ongoing domestic policy debate over ways to increase agricultural production and sales has started to have some effect. The more pragmatic approach adopted by the Economic Recovery Program, now in its third and last year, has contributed much to increased agricultural production and marketed surplus in Tanzania in the last few years.

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Table 1. Morogoro and Moshi Districts: Family size in relation to maize output, consumption, and sales, 1984-85 to 1985-86.

District	Family size	Households		Output		Consumption			Sales		
		No.	%	Total (bags)	Avg. (bags)	Total (bags	Avg. (bags)	%[a]	Total (bags)	Avg. (bags)	%[b]
Morogoro	0-3	2	6.5	10.0	5.0	4.8	2.4	48.0	2.0	1.0	20.0
	4-7	7	22.5	99.5	14.2	23.8	3.4	23.9	50.5	7.2	50.7
	8-11	11	35.5	338.0	30.7	122.5	11.1	36.2	200.5	18.2	59.3
	12-15	8	25.8	126.5	15.8	68.0	8.5	53.8	47.5	5.9	37.3
	16 and above	3	9.7	94.5	31.5	32.0	10.6	33.9	58.0	19.3	61.3
Total, average, or percentage		31	100.0	668.5	22.1	251.1	8.1	36.7	358.5	11.6	53.6
Moshi	0-3	1	3.0	22.5	22.5	1.0	1.0	4.4	16.0	16.0	71.1
	4-7	8	24.2	339.0	42.4	57.0	7.1	16.8	270.0	33.8	79.6
	8-11	17	51.5	606.8	35.7	114.5	6.7	18.9	462.0	27.7	76.1
	12-15	4	12.2	69.5	17.4	30.5	7.6	43.9	27.5	6 9	39.5
	16 and above	3	9.1	61.0	20.3	26.0	8.7	42.6	21.0	7.0	34.4
Total, average,or percentage		33	100.0	1098.8	33.3	229.0	6.9	20.8	796.5	24.1	72.5

[a]Percentage of total consumption with respect to total output.
[b]Percentage of total sales with respect to total output.

Table 2. Morogoro and Moshi Districts: Age of the household head in relation to maize output and sales, 1984-85 to 1985-86.

District	Age of household head	Households (No.)	Output Total (bags)	Output Avg. (bags)	Sales Total (bags)	Sales Avg. (bags)	Sales %[a] (bags)
Morogoro							
	20-29	2	7.0	3.5	0.0	0.0	0.0
	30-39	4	28.0	7.0	9.5	2.4	33.9
	40-49	7	234.5	33.5	156.5	22.4	66.7
	50-59	5	91.0	18.2	34.5	6.9	37.9
	60-69	10	283.5	28.3	149.5	15.0	52.7
	70 and above	3	40.5	13.5	13.5	4.5	33.3
Total, average, or percentage		31	684.5	22.1	363.5	11.7	53.1
Moshi							
	20-29	1	46.0	46.0	43.0	43.0	93.5
	30-39	4	125.0	31.0	76.0	19.0	60.8
	40-49	10	381.0	38.0	296.5	29.6	77.8
	50-59	11	292.3	26.6	206.0	18.7	70.5
	60-69	6	232.0	38.7	175.0	29.2	75.4
	70 and above	1	22.5	22.5	0	0	0
Total, average, or percentage		33	1098.8	33.3	796.5	24.1	72.5

[a]Percentage of total sales with respect to total output.

Table 3. Morogoro and Moshi Districts: Arable land owned in relation to maize output and sales, 1984-85 to 1985-86.

District	Amount of arable land owned (ha)	Households (No.)	Households %	Output Total	Output Avg.	Sales Total	Sales Avg.	Sales %[a]
Morogoro	0.0-1.9	2	6.4	23.0	11.5	8.0	4.0	34.8
	2.0-3.9	10	32.4	186.5	18.5	81.5	8.2	43.7
	4.0-5.9	12	38.7	263.7	21.9	138.5	11.5	52.7
	6.0-7.9	5	16.1	66.6	13.2	20.2	4.1	31.0
	8.0 and above	2	6.4	146.0	73.0	110.0	55.0	75.3
Total, average, or percentage		31	100.0	685.8	22.1	358.2	11.6	52.2
Moshi	0.0-1.9	16	48.5	233.3	14.6	103.5	6.5	44.4
	2.0-3.9	11	33.3	453.5	41.2	323.0	29.4	71.2
	4.0-5.9	4	12.1	170.0	42.5	142.0	35.5	83.5
	6.0-7.9	0	0.0	0.0	0.0	0.0	0.0	0.0
	8.0 and above	2	6.1	242.0	121.0	228.0	114.0	94.2
Total, average, or percentage		33	100.0	1098.8	33.3	796.5	24.0	72.5

[a]Percentage of total sales with respect to total output.

Table 4. Moshi District: Coffee hectarage and output in relation to the amount of maize sold, 1984-85 to 1985-86.

Coffee planting (ha)	Households (No.)	Households (%)	Coffee output per household (bags)	Maize Sales (bags) Total	Maize Sales (bags) Average per household
0.0-0.5	8	28.6	1.8	163.6	20.4
0.6-1.1	11	39.3	7.5	149.5	13.6
1.2-1.7	6	21.4	7.5	156.0	26.0
1.8-2.3	1	3.6	11.0	55.0	55.0
2.4 and above	2	7.1	38.8	170.5	85.2
Total or average	28	100.0	--	694.6	24.8

Note: One bag of coffee weighs approximately 60 kg.

Table 5. Morogoro and Moshi Districts: Input use in relation to maize output and sales, 1984-85 to 1985-86.

District	Input use	Households		Output (bags)		Sales (bags)		
		No.	%	Total	Avg.	Total	Avg	%
Morogoro	With							
	Improved seed	22	71.0	429.0	19.5	230.5	10.5	53.7
	Fertilizers	14	45.2	246.5	17.6	117.5	8.4	47.7
	Insecticides	14	45.2	246.5	17.6	117.5	8.4	47.7
	Without							
	Improved seed	9	29.0	255.6	28.4	128.0	14.2	50.1
	Fertilizers	17	54.8	438.0	25.8	241.0	14.2	55.0
	Insecticides	17	54.8	438.0	25.8	241.0	14.2	55.0
Moshi	With							
	Improved seed	27	81.8	960.0	35.6	707.5	26.2	73.7
	Fertilizers	26	78.8	907.5	34.9	667.0	25.7	73.5
	Insecticides	5	15.2	144.5	28.9	103.0	20.6	71.3
	Without							
	Improved seed	6	18.2	139.3	23.2	89.0	14.8	63.9
	Fertilizers	7	21.2	191.3	27.3	129.5	18.5	67.7
	Insecticides	28	84.8	954.8	34.1	693.5	24.8	72.6

[a]Percentage of total sales with respect to total output.

Table 6. Morogoro and Moshi Districts: Reasons given by farmers for selling maize, 1984-85 to 1985-86.

District	Reason for selling	Households	
		Number	Percentage
Morogoro	Cash requirement	21	67.7
	Excess amount	6	19.4
	Storage problems	2	6.5
Moshi	Cash requirement	20	60.6
	Excess amount	13	39.4
	Storage problems	3	9.1

Table 7. Morogoro and Moshi Districts: Constraints to increasing the marketable surplus of maize as indicated by surveyed households, 1984-85 to 1985-86.

District	Constraint	Number of households	Percentage
Morogoro	Input prices 26	83.9	
	Credit facility	20	64.5
	Timely mechanization	19	61.3
	Producer prices	8	25.8
	Consumer goods availability	8	25.8
	Timely input supply	7	22.6
	Vermin control measure	7	22.6
	Extension service	6	19.3
	Timely purchase of crop	3	9.7
Moshi	Consumer goods availability	33	100.0
	Timely input supply	29	87.9
	Input prices 17	51.5	
	Credit facility	15	45.5
	Producer prices	14	42.4
	Extension services	6	18.2
	Timely mechanization	1	3.0

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