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ABSTRACT

COSTS AND RETURNS OF ALTERNATIVE RICE PRODUCTION SYSTEMS
IN NORTHERN GHANA: IMPLICATIONS FOR OUTPUT,
EMPLOYMENT AND INCOME DISTRIBUTION

By

Fred Everett Winch III

In recent years the demand for food in Ghana has increased faster than the ability of the agricultural sector to meet domestic food requirements. As a consequence, Ghana is relying on imports to supplement domestic production, although there are local efforts to stem the crisis.

The National Redemption Council, one such effort, has attempted to achieve self-sufficiency in food production through the "Operation Feed Yourself" (OFY) Program, the focus of which is the rice industry in the Northern Region. The bottomlands in the region, well suited to the production of rain-fed paddy and rice acreage, expanded from 28,000 to 90,000 acres between 1968 and 1974. The principal reasons for this dramatic acreage expansion are: (1) access to idle bottomlands, (2) increased use of tractor mechanization for land preparation, (3) subsidized inputs such as improved seed, fertilizer, and a government operated combine harvesting service, (4) prestige associated with expanding farm size, and (5) high private returns from rice farming.

There is a general lack of quantitative data on the costs, returns, output, employment, and income distribution implications of alternative

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production technologies for major food crops. The objective of this study was to generate such micro data on the rice industry through a survey of 161 rice farms in the Northern Region. The Cost Route Survey Method was used to collect farm level data by continuously interviewing 161 farmers from May, 1973 through February, 1974. The costs and returns for five bottomland production systems and one upland rice system were then analyzed from both the financial (private) and economic, or national, point of view.

Financial rice enterprise budgets were prepared for each of the six production systems. A net cash return to operating capital, family labor and management was derived for each system. The budget data were also used to derive financial returns to (1) family labor, (2) operating capital expenditures, and (3) management, as well as cost of production.

Each production system was then analyzed from an economic point of view. The unsubsidized costs of nonlabor inputs were estimated, and the economic costs and returns were calculated for each of six rice production systems. The analysis showed that when market prices (financial analysis) are used to value resources, the 119 acre, capital intensive production system has the lowest cost of production (₵104 per ton). However, when economic prices are used, this system has the highest cost of production, the highest capital/labor ratio, and the largest government income transfer via capital input subsidies. Moreover, the economic analysis revealed that four of the five bottomland production systems are generating economic losses from the national point of view.

The next step was to compare the employment and income distribution implications of alternative rice production strategies. Our analysis revealed that there was a wide variation in the average man-hours per acre among the

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acre among the five bottomland systems, from a high of 220 man-hours per acre for the 16 acre tractor hire system to a low of 38 man-hours per acre for the 119 acre tractor owner system. About three-fourths of the labor were employed in harvest activities.

The employment and income distribution implications of a shift from hand harvesting to combine harvesting were analyzed in detail. Our data revealed that manual harvesting requires 142 man-hours per acre, whereas combine harvesting requires 10 man-hours per acre. At current levels of combine subsidies, farmers are encouraged to adopt combine services. Yet as combine harvesting expands, 22,000 man-days are potentially displaced per 1000 acres harvested by combine. Thus, if, on the average, 60 percent of the labor requirements for harvesting are hired, we estimated that about ₵12,700 would be lost by casual workers per 1000 acres harvested by combine.

The study also illustrates that the production strategies being pursued in the bottomlands of Northern Ghana are providing rice producers with high financial returns, but at a high cost to the Ghanaian economy. The key policy issue now facing Ghana is how to develop a low cost production strategy in light of a growing foreign exchange constraint and the need to reduce government subsidies to the rice industry. A hypothetical 35,000 acre Rice Production Campaign was used to illustrate the output, efficiency, employment, and income distribution implications of two production strategies: a small farmer strategy and a large farmer production strategy. Our analysis showed that with current input/output relationships, a large farm strategy would produce about 17 percent more output than a small farm strategy because of the higher yields on the large farms. Although there is only about a five percent difference in aggregate incom

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aggregate income between the two strategies, the income distribution implications are substantially different. A small farmer strategy based upon an average rice enterprise of four acres would provide a net farm income of ₵240 for 8700 small farmers, while the large-farm, capital intensive strategy of 100 acre farms would generate over ₵6000 in net farm income for each of 350 farmers. In addition, a small farm strategy would generate aggregate employment of about one million man-days, whereas a large farm strategy would employ only 240,000 man-days, or 77 percent less labor. And a small farm strategy would generate about ₵55,000 in wages for casual labor compared with ₵200,000 in wages for the large farm strategy. Finally, under current subsidy policies about ₵2.8 million would be required to subsidize capital inputs for a 35,000 acre capital intensive strategy, whereas ₵0.9 million would be required for a small farm rice production campaign.

The study concludes by recommending that the Ministry of Agriculture embark on a major Rice Production Campaign for small farmers; it discusses ten recommended components of a small farm production campaign and points up the need for more research on the benefit incidence of agricultural development projects.

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COSTS AND RETURNS OF ALTERNATIVE RICE PRODUCTION SYSTEMS

IN NORTHERN GHANA: IMPLICATIONS FOR OUTPUT,

EMPLOYMENT AND INCOME DISTRIBUTION

By

Fred Everett Winch III

A DISSERTATION

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CHAPTER I

INTRODUCTION

Ghana, a country on the West Coast of Africa which became independent in 1957, is divided into the following ecological zones: the savanna of the northern half of the country, the forest which covers much of the south, the southwest rain forest and a coastal savanna which surrounds the capital of Accra and extends eastward. The present population is approximated at 9.2 million and is growing at an estimated 2.8 percent per year.

Cocoa, which is produced by smallholders in the forest zone, is the major product and foreign exchange earner of the country. Cocoa production expanded rapidly at the turn of the century and has been the engine of Ghanaian growth for over 75 years. During the 1960's about 20 percent of the total labor force was engaged in cocoa production either as farm operators or as hired labor.

Despite this labor concentration, there is a substantial diversity in crop production, farm size, and the degree of market orientation within Ghanaian agriculture.[1] The typical farmer operates about five acres of land and has adapted his production practices to a relative abundance of land and labor, to meager capital resources, and to soils which become rapidly exhausted when farmed intensively.[2] However, there are a growing

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[1]For a good reference on the economy of Ghana and some aspects of social structure, see Walter Birmingham, I. Neustadt, and E. N. Omaboe, editors, Volumes One and Two, 1966 and 1967.

[2]Good references on Ghanaian agriculture include Wills, 1962; Killick, 1966.

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number of farmers who produce one to two cash crops on relatively large acreages. Capital inputs on these farms are, for the most part, in the form of tractor mechanization (owned or hired) and, to a lesser extent, improved seed and fertilizer.

Problem Setting

Over the 1900-1958 period food production in Ghana generally kept pace with the growing demand for food which was largely a function of population growth and modest increases in per capita income. However, since about 1958, domestic production has been augmented with increasing quantities of imported food. To stem increasing foreign exchange requirements for food imports and rising food prices, there was an attempt in the 1960's to expand domestic food production by means of opening new land through government tractor-hire services and public production units (e.g., State Farms). However, the approach required large amounts of domestic capital and foreign exchange while contributing little to increased domestic food production.

During the 1960's Ghana experienced a balance of payments crisis and import controls were introduced. However, over the 1968-72 period, import controls were liberalized. Ghana's debt burden expanded and food prices increased. In short, Ghana was living beyond its means. Then, in December 1971, the government devalued the cedi by 42 percent. The purpose of devaluation was to increase the domestic price of imported goods, but its magnitude was politically unsound. On January 13, 1972 a military coup d'etat took place. The new government, the National Redemption Council (NRC), immediately revalued the currency by 10 percent and imposed strict import licensing. Moreover, the NRC assigned agricultural development first priority and the government launched the

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"Operation Feed Yourself" (OFY) Program, a national program to increase domestic food production.

The purpose of OFY was to create a national awareness of the importance of agriculture and to stress the need for "self-reliance" and "self-sufficiency" in food production. OFY envisioned that increased production would be generated in the private sector, principally by means of acreage expansion by small farmers; hence, national and regional acreage targets were established. Import substitution was also an integral component of the OFY Program. The major commodities featured in OFY are rice, maize, livestock, sugar cane, oil palm,and cotton. In addition, emphasis was given to yam, sorghum and cassava production. Despite the reliance of the OFY Program on smallholders to increase food production, increased emphasis since 1973 has been placed on large farms which use relatively capital intensive production techniques. This shift to supporting large farms can be attributed to two factors. First, policy makers thought that output could be increased more rapidly on large farms. Second, given the progress in reducing the external debt burden and building up foreign exchange reserves over the 1972-74 period, the government believed it could afford to import more farm machinery and other capital inputs.[3] However, foreign exchange reserves have fallen drastically in 1975 because of falling world cocoa prices and rising prices of imported goods. Ghana again has a balance of payments deficit.

Although domestic food production has increased since 1972, food prices have continued to rise. While the government is pushing for

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[3]The reduction in the external debts was largely achieved, shortly after the 1972 coup, by a unilateral repudiation, of the debts arising out of the Nkruma era. The increase in foreign exchange reserves was due to an increase in the world cocoa and timber prices and reduced imports following import restrictions.

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"self-sufficiency," to date there is an unsatisfied demand for many of the basic food crops. In 1973 Ghana's total food import bill was $80.9 million, or 18.5 percent of its total merchandise imports.

Need for the Study

Rice production has been given major emphasis in the OFY Program. According to government statistics, 54 percent of the rice produced in Ghana in 1973 was produced in the Northern Region. Other regions, in their order of importance, are the Upper Region (16 percent) and the Volta Region (13 percent). In the Northern Region about 80 percent of the 6,100 rice producers have rice farms of less than 10 acres; about three percent of the farmers have rice farms above 50 acres; and there are about 100 producers with rice farms larger than 100 acres. The OFY Program has favored the rice farmers with 50 acres and above through the provision of subsidized inputs (seed, fertilizer, land preparation, and combine harvesting services). Small rice farmers have also been subsidized but, as will be shown in this study, to a far lesser extent.

There is a dearth of information about the costs and returns of the major food crops produced in Ghana. Agriculture in Ghana is not supported by an effected applied research base which can generate output increasing technologies adapted to the various ecological zones of the country and to the financial managerial conditions of smallholders. To guide agricultural development in Ghana over the next five to ten years, the government requires an agricultural development strategy which goes beyond establishing acreage targets for specific agricultural crops--a strategy which encompasses production, income, and employment goals with a short-run and medium-term perspective. Without data on costs and returns, it will not b

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Objectives of the Study

The objectives of this study were the following:

1. To provide the Ministry of Agriculture with relevant data on the rice industry in northern Ghana;

2. To determine the relative land, labor, and capital requirements for the major rice production systems;

3. To determine the cost of production and farm incomes for the major rice production systems;

4. To analyze direct and indirect effects of alternative rice production strategies, with particular emphasis on harvesting;

5. To identify rice production systems with high financial (private) and economic returns from the national point of view.

Scope of the Study and Research Approach

At the invitation of the Ministry of Agriculture, the author visited Ghana in January of 1971. During this visit the northern rice producing areas were toured and discussions were held with regional and central Ministry officials as well as with US/AID Mission personnel. The author submitted a report to the Ministry outlining applied economic research needs for the rice industry in northern Ghana. The main points of the report were: first, the Ministry did not have adequate economic data to formulate sound recommendations for rice farmers on improved technology; second, to obtain such data, farms would have to be surveyed to determine production costs and returns for the major production systems; third, an investigation of alternative mechanization strategies was required to determine th

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determine their feasibility from both a private and national point of view; and fourth, there were no data on the socio-economic effects of the rice program on community, regional, and national development.

The Ministry reviewed the report and offered the author a contract to undertake the proposed research as a Principal Agricultural Economist (OPEX). Thus, the author arrived in Ghana in December, 1971 and conducted the field research, in conjunction with other duties, until May, 1974, research which concentrated on collecting farm level input/output data for one farm enterprise--rice. The study was conducted over two years using a purposive, nonrandom sample of rice farms; during the 1973-74 crop season 160 farms were included in the sample. The research on rice production reported in subsequent chapters estimates farm level resource requirements, costs of production, and net income of the major rice production systems in northern Ghana.

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CHAPTER II

AN OVERVIEW OF RICE PRODUCTION IN NORTHERN GHANA

Introduction

The purpose of this chapter is to provide an overview of rice production in Northern Ghana. The salient features of the industry are briefly described to provide the reader with adequate background information on the industry to set the stage for the analysis which follows.

Physical Characteristics of the Rice Producing Areas

Climate

The Northern and Upper Regions of Ghana are in the Savanna Zone which is characterized by a dry tropical climate with two distinct seasons. The rains build up from April/May to a peak in September and then decline in October. The dry season extends from November to May. In the Upper Region the average annual rainfall is between 35 to 40 inches, and in the Northern Region average annual rainfall is between 40 to 50 inches. In the Northern Region the rainfall between June and October, which is the growing period for paddy, has averaged about 32 inches over a period of about 60 rainy days.

Noon-day temperatures vary between 75° F. in the rainy season to a maximum of 105° F in the dry season. Average monthly temperatures vary from 71° F. in the coldest month (December) to 92° F. in the warmest month (March). During the height of the dry season harmattan (December), early morning temperatures drop to 60° F. and below and noon-day temperatures average 95° F. The average relative humidity during the months

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June to September varies between 78-83 percent and then progressively declines to a low of about 26 percent in January.

The rainfall pattern is adequate to support rice production during the growing period; however, the climate directly following the rains creates serious harvesting problems which are discussed in a later section of this chapter.

Soil and Vegetation

The northern savannas are underlaid with Voltain sandstones and granites. The soil classification of the rice lands is known as Ochrosol-Groundwater Laterite intergrades. Their origin is due to poor internal drainage. The valley-bottom soils consist of grey, porous, structureless, silty loams to clays, rather loose at the surface but becoming very firm with depth. While these soils are low in humus and chemical nutrients, they are better provided with nutrients than adjoining upland soils. The nature of the soil and the terrain gives rise to natural flooding during the rains; thus, their main use has been for rain-fed, flooded, bottomland rice production.

The natural vegetation of the area is Guinean savanna characterized by tall grasses and short trees often widely spaced. In the bottomlands or fadamas many of the trees have been removed, opening up large areas for rice production. Prior to the spread of lowland rice production, the bottomlands were not used for crop production as seasonal flooding conditions are not suitable for the production of other crops.

In 1971 a Physical Land Survey was undertaken by the Ministry of Agriculture to estimate the acreage of bottomlands suitable for rice production.

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production. From this survey[1] it was estimated that there were 150,000 acres of bottomlands which were most suited for development of rice production. These lands were well flooded during the rains, required only minimal land clearing, were readily accessible, and were close to villages as a source of casual labor. The survey identified an additional 100,000 acres for rice production, but these lands were considered less desirable as they required more land clearing or were not readily accessible.

Agronomic Production Systems

There are two rain-fed agronomic systems of rice production in Northern Ghana: "upland" and "bottomland" (or "fadama") production systems. The upland system is dominant in the Upper Region and in parts of the Northern Region. The lighter upland soils are prepared using the handhoe or bullock plow. While upland soils are very wet during the growing season, water does not normally collect and stand for any extended period of time.

Bottomland production is centered in the Northern Region where tractor plowing is widely used for initial land preparation since it has adapted to the heavy soils of the naturally concave bottomland and riverain areas which are subject to temporary flooding.[2] In the bottomlands there is generally no standing water on the rice fields until the plant is about six inches tall. When the plant is about ten inches tall,

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[1]The Physical Survey was undertaken as part of a project identification study which the Ministry of Agriculture initiated to develop a rice development project to be submitted to the IBRD for partial financing.

[2]In the Northern Region rice is produced only under rain-fed conditions; irrigation has been used on a pilot basis only.

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water is standing on the field, and, at full plant height, there is as much as twelve to sixteen inches of standing water. After the plant has reached full height, water recedes and rice is harvested when the soil is dry.

The Number of Rice Producers and the Distribution of Farm Size

In 1971 it was estimated that there were 6,100 holders producing rice out of a total of 61,200 holders in the Northern Region.[3] Fifty-three percent of the rice farmers in 1971 were producing rice on five acres or less, and 90 percent were producing on 15 acres or less (Table 2.1). Approximately 10 percent of the farmers (670) who produced rice on more than 15 acres were, as a group, producing rice on about half of the total rice acreage. On the other hand, about 90 percent of the rice farmers (5,400) were producing paddy on about the same acreage (28,500 acres); see Table 2.2.

Acreage Expansion and Production Estimates

There has been a rapid increase in rice production in the Northern Region in recent years because of acreage expansion and to a lesser extent because of increases in yield per acre. Acreage expanded from 28,000 acres in 1968 to about 90,000 acres in 1974 (Table 2.3), an increase of about 220 percent over six years. During the same period it is estimated that average rice yields increased from 800 pounds per acre in 1968 to about 1,200 pounds per acre in 1974, an average yield

[3] As used by the Ghana Sample Census of Agriculture 1970, a "holder" is the person who has the responsibility for the agricultural "holding." A holding is all the land which is used for agricultural production and is operated as one technical unit. A holding generally consists of several fields or "farms" in the Ghanaian context. We will refer to holders as farmers and will refer to their rice farms which may be part or all of a farmers holding.

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Table 2.1. Distribution of Farm Size Among Rice Farmers in Northern Region, 1971

Acres	No. of Farms	Percent of Farms
0.1 - 2.0	1,200	20
2.1 - 5.0	2,000	33
5.1 - 10.0	1,600	26
10.1 - 15.0	700	11
15.1 - 50.0	400	7
50.1 - 100.0	100	2
More than 100 acres	100	1
	6,100	100

Source: Ministry of Agriculture, Economics and Marketing Division, Accra, mimeo, 1972.

Table 2.2. Number of Rice Farmers and Area Under Rice In Selected Districts of the Northern Region, 1971

	Less Than 15 Acres	More Than 15 Acres	Total
Number of Farmers			
Tamale District	2,500	405	2,905
Yendi District	1,200	118	1,318
Walewale	1,000	46	1,046
Other Districts	700	98	798
Total	5,400	667	6,067
Area Under Rice			
Tamale District	16,000	18,800	34,800
Yendi District	5,600	4,800	10,400
Walewale District	4,700	1,700	6,400
Other Districts	2,200	4,200	6,700
Total	28,500	29,500	58,300

Source: Ministry of Agriculture, Economics and Marketing Division, Accra, mimeo, 1972.

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increase of 80 percent over six years. The increase in total annual production in the Northern Region is therefore estimated to have increased from 10,000 metric tons to 58,300 metric tons of paddy, or an increase of 480 percent over the six-year period 1968 to 1974.

Table 2.3. Estimated Acreage and Rice Production in Northern Region of Ghana Between 1968 and 1974

Year	Acres	Average Yield Per Acre	Total Production of Rice
		(lbs./acre)	(long tons)
1968	28,000	800	10,000
1970	52,000	960	22,300
1972	65,000	1,100	31,900
1973	70,000	1,200	37,500
1974	90,000	1,450	58,300

Source: Ministry of Agriculture estimates.

The major reasons advanced for the impressive increase in rice production in the Northern Region are:

1. Easy access to free unutilized bottomlands not requiring a great deal of clearing;

2. Increased imports of tractors and associated equipment in recent years for sale to private farmers and individuals desiring to engage in private custom plowing;

3. Subsidized selling prices of tractors and associated equipment with resulting low custom plowing charges and land preparation costs for tractor owners;

4. An increasing guaranteed floor price for paddy as established by the Government Rice Mills Unit;

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5. Increased availability of subsidized improved seed and fertilizer;

6. Artificially high financial returns resulting from high input subsidies;

7. Prestige associated with land extension and large individual rice farms;

8. Subsidized combine harvesting services introduced by the Ministry of Agriculture.

Bottomland Production Practices

Land Clearing

Land clearing, normally done during the dry season between the end of January through March, is carried out for the most part by hand methods using cutlasses and hand axes. However, mechanized land clearing has been undertaken on many large farms. The Ministry of Agriculture (MOA) operates a land clearing service and charges ₵20 per acre for this service.[4] Small crawler tractors with conventional blades are used to push down trees and to push them to the farm boundaries. Official estimates on the amount of acreage mechanically cleared are not available; however, it is believed that no more than a quarter of the total acreage under cultivation in 1974 was mechanically cleared.

In 1974 the Ghanaian-German Agricultural Development Project, Northern and Upper Regions, provided the Ministry of Agriculture a grant for a new land clearing unit. The grant included two D9 Caterpillar crawler tractors, chain and ball clearing equipment, land clearing

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[4] A private contractor has recently offered land clearing services at ₵40 per acre using larger machines equipped with front-end rake blades.

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blades, two flat bed trucks to transport the tractors and equipment, plus associated equipment. During the 1975 land clearing season the unit cleared an estimated 5,000 acres.

Land Preparation

Data are not available on the number of acres plowed by tractor, prepared by hand hoe or prepared by Bullock plow. However, it is generally believed that about 90 percent of the land area devoted to rice production in the Northern Region is plowed by tractor.[5] For other crops in the region about 95 percent of the acreage is prepared by hand. In the Upper Region no estimates have been made, but it is probable that no more than 25 percent of the rice lands are prepared by tractor or bullock.

Again,while there are no official estimates, three-fourths of the farms that are plowed with a tractor are harrowed once and perhaps a third are harrowed twice. A few farmers harrow their fields three times. Large operators tend to harrow twice, whereas smaller farms are usually harrowed only once.

During the 1973-74 production season there were about 300-350 private tractors operating in the Northern Region.[6] Most private tractor owners engage in custom plowing and harrowing services. Private contractors charge six cedis per acre for plowing, three to four cedis for first harrowing,and two to three cedis per acre for second harrowing.[7]

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[5]The 10 percent not plowed by tractor is upland rice. Some uplands are mechanically plowed; however, most are prepared by hand hoe.

[6]My estimate was arrived at by reviewing sales records of the Tamale machinery dealers and by interviews with MOA personnel.

[7]The real financial charges are, however, greater as it was found during our study that custom tractor operators on the average over declared acreage by about 30 percent.

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Seed Varieties and Planting Practices

The improved variety C4-63 which was developed at the University of the Philippines was the first improved seed variety introduced in Northern Ghana. It was tested on a pilot basis in 1968 and was determined to be adaptable to local conditions. The variety was then multiplied by the MOA for sale to rice farmers. In 1971 local field trials were undertaken to select additional improved varieties. Two varieties, IR-5 and IR-20, developed at the International Rice Research Institute in the Philippines, were selected for multiplication and sale to local rice farmers.

In 1970 the MOA established a seed multiplication unit (SMU) to multiply improved seeds in various parts of the country. The initial focus of the Northern Region branch of the SMU was to multiply improved rice varieties. The Unit does not multiply seed directly but rather selects and supervises rice farmers known as Registered Seed Growers.

In 1970 the Northern Region SMU purchased 3,290 bags[8] of C4-63 from its Registered Seed Growers. By 1974 the SMU had increased the production of improved seed through its grower network to 30,600 bags, or 2,460 metric tons. The SMU purchases the improved seed from its growers and cleans and chemically treats the seed. The seed is then rebagged in 160 pound bags, stored,and finally sold the following year as certified seed.

Table 2.4 provides data on both the purchases and sales of improved seed by the Northern Regional Branch of the SMU. Up until 1974 the Unit sold all of its improved seed in stock. However, in 1974 the Unit had a carry-over stock of 4,970 bags of IR-5.

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[8] One bag of paddy weighs 180 lbs.

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Table 2.4. Purchase and Sale of Improved Rice Seed by the Northern Region Seed Multiplication Unit of the Ministry of Agriculture, 1970 and 1974

Year	Seed Varieties				
	C4-63	IR-5	IR-20	Alupi[1]	Total
	Purchase of 180 lb. Bags				
1970	3,290	---	---	---	3,290
1971	3,131	---	---	---	3,131
1972	7,421	482	395	---	8,298
1973	6,580	5,818	4,747	47	17,192
1974	1,154	14,436	13,858	1,152	30,600
	Sale of 160 lb. Bags				
1970	3,290	---	---	---	3,290
1971	3,131	---	---	---	3,131
1972	7,421	482	395	---	8,298
1973	6,580	5,818	4,747	47	17,192
1974	1,154	9,466	13,858	1,152	24,480

[1]Alupi is an improved seed variety with an estimated physiological maturity of 140-150 days. The original seed stock was imported from Nigeria.

Source: Seed Multiplication Unit, Ministry of Agriculture, Tamale.

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There are no official estimates available on the number of farmers or the number of acres upon which improved seed is planted. However, a rough acreage estimate can be derived from the sales records of the SMU. It is recommended that farmers apply improved seed varieties at the rate of 70-80 lbs. per acre. If farmers, on the average, had applied improved seed at the rate of 70 lbs. per acre, then the acreage planted to improved seed would have increased between 1970 and 1974 as follows:

1970	8,460 acres
1971	8,051 acres
1972	21,338 acres
1973	44,208 acres
1974	62,949 acres

In fact, however, the acreage planted to improved seed would have been greater than these figures imply because some farmers would have used a lower seeding rate and other would have produced and stored their own improved seed.

Except for Alupi, the improved seed varieties used in Northern Ghana have a physiological maturity or growth cycle of about 115 days. The Alupi variety has a growing period of about 150 days. The two common traditional seed varieties, D52-63 and D-99, have a physiological maturity of about 140 days.

The recommended planting date for all rice varieties is between June 15th and July 1st, before the onset of the heavy rains. The common planting technique is hand broadcasting, though seed drills are used by a few farmers on acreages of over 250 acres. A very small number of small farmers transplant rice.

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Use of Inorganic Fertilizer

Fertilizer sales in the Northern Region increased steadily from about 600 tons in 1969 to about 10,200 tons in 1974. The great bulk of this fertilizer has been sold to rice farmers; however, small quantities are used for maize, cotton, and groundnuts. The Ghanaian-German Agricultural Development Project, which started in 1970, has been the principal supplier of fertilizer. The objective of the project was to increase fertilizer use among rice farmers in Northern Ghana.[9] The project provides fertilizer as a grant to the MOA and, working through the Ministry, is responsible for the internal distribution and sales of fertilizer. The project personnel undertake fertilizer and seed trials and assist the extension service with promoting fertilizer use.

Two fertilizers are presently being promoted among rice farmers. It is recommended that farmers apply two cwt. bags of 15-15-15 compound fertilizer, one to two days before planting. Then, four to five weeks after planting, it is recommended that farmers apply one cwt. of ammonium sulfate as a top dressing. Fertilizer is applied by hand broadcasting, except on a few large farms where seed drills are used.

The Ghanaian-German Agricultural Development Project undertakes fertilizer trials on farmers' rice fields. Seed is applied at the recommended planting date and seed rate, and fertilizer at the recommended time. The plots are then manually weeded at the appropriate

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[9] The project has broadened its objectives to include the development of the regional seed multiplication unit, construction of district fertilizer depots, the development of an Extension Information Unit, the promotion of a small farmer silo building program, the development of a bullock plow training program, the financing of a Land Clearing Unit and, most recently, the development of a network of small, low cost rural input-supply depots to serve small farmers.

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stage and manually harvested at maturity before shattering has taken place. These trials show that high yields can be obtained if recommended production practices are followed. Trial results also illustrate that, at the recommended fertilizer treatment, yields with the promoted improved variety, IR-20, vary between about 3,500 to 4,300 lbs. per acre (Table 2.5). The average farmer, however, does not obtain these yields for reasons whhich are spelled out later in the study.

Fertilizer sales records indicate that there has been a dramatic increase in fertilizer use at heavily subsidized prices. However, data are not available on how many rice farmers use fertilizer nor on how many acres fertilizer is applied. It is known that until recently most of the fertilizer sold by the MOA was being used on large rice farms. Extension Officers report that by 1973 "many" farmers were applying compound fertilizer but generally at low application rates (0.5 to 1.0 bags per acre), and that only a "few" farmers applied ammonium sulfate. As a consequence, the overall application of nitrogen is believed to be much below the recommended rate.[10] The reasons for low application rates of fertilizer are not factually known; however, we believe the following contribute to low fertilizer use among large numbers of farmers in the study area:

1. Insufficient funds after paying for the costs of seed and mechanical cultivation;

2. Among nonusers, inadequate appreciation of the yield increasing benefits of fertilizer when applied at recommended rates;

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[10]This view is confirmed by the analytical chapters that follow.

Table 2.5. Results of Ministry of Agriculture Farm Location Fertilizer Trials With IR-20, 1974

Location	Treatment[1]	Yield	
		Qu/Ha	Lbs./Acre
Palbe	1	39.9	3,551
	2	48.5	4,318
	3	54.5	4,852
	LSD for Treatment:	5% = 18.1 qu/ha	
Nabogo	1	24.0	2,136
	2	39.9	3,552
	3	43.6	3,881
	LSD for Treatment:	5% = 9.2 qu/ha 1% = 13.9 qu/ha	
Demon	1	20.7	1,841
	2	39.1	3,478
	3	45.1	4,009
	LSD for Treatment:	5% = 11.9 qu/ha 1% = 18.1 qu/ha	
Nyankpala	1	na	
	2	39.9	3,548
	3	na	

[1]Three fertilizer treatments were used: Treatment 1 = Control; Treatment 2 = 51-30-30; Treatment 3 = 72-60-60.

Note: The following planting dates were observed: Palbe - June 26th, Nabogo - June 21st, Demon - June 25th, Nyankpala - not reported.

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3. Among the average user, a belief that some fertilizer is better than no fertilizer;

4. A lack of appreciation that improved seed varieties require relatively high dosages of fertilizer before a significant response to fertilizer can be obtained;

5. To date, an input distribution system with a limited outreach.

Weed Control

Two methods of weed control are used by rice farmers: mechanical harrowing and manual weeding. The Extension Service recommends two mechanical harrowing operations to control weeds; a first harrowing about 10-14 days after plowing and a second harrowing about two weeks after the first harrowing.

The second method of weed control is manual weeding. It is recommended that farmers undertake manual weeding between the period July 15th to August 15th. The Extension Service recommends a second weeding for farms with heavy weed infestation. It is estimated by the MOA that about 20 man-days per acre are required for the first weeding and about 10 man-days for the second weeding. It was observed that weeding problems were less severe on farms with higher standards of land preparation and on farms which had produced rice for less than three years.

Harvesting Methods

Hand harvesting methods, which have been the dominant method of harvesting, involve five sub-activities: cutting, heaping, threshing, winnowing and bagging. Using simple, locally made hand sickles for cutting, farmers cut low on the stalk, usually leaving a stubble of about fou

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about four inches. Cut paddy is placed in small piles or bunches during cutting. After a section of the farm has been cut, the bunches are collected and carried to an area of the field and placed in heaps. The heaps are generally very large; a typical heap of paddy will be about 15-20 feet long, 10 feet wide, and about 5-7 feet high. Hand threshing normally begins soon after heaping. An area close to the heap is cleared of rice stubble and stones. The paddy is taken from the heap, a little at a time, and laid on the ground, normally in an area about 10-20 feet square. The paddy is threshed by flailing with long sticks and is turned several times until the threshing is completed. The straw is then removed and the paddy is collected and piled. When there is a wind, the paddy is winnowed to remove the chaff and then bagged. The process is repeated until all the heaped paddy is threshed.

A few combines were in operation in the region before 1973; however, in 1973 the MOA imported and operated 31 self-propelled combines in the Northern Region which were hired to farmers at a heavily subsidized rate of ¢1.00 per bag. In 1973 there were also about 15 privately owned combines operating in the region.

The MOA experienced a number of organizational problems with its combines during its first year of operation. The combines operated at a very low rate of utilization. A financial analysis[11] of 24 of the 31 combines revealed the following information about the operation and costs of the MOA's combine service:

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[11]F. Winch, "A Financial Evaluation of Combine Harvesters Operated by the Ministry of Agriculture in the Northern Region, 1973/74." (Tamale: Ministry of Agriculture, 1974). Log books were maintained on only 24 of the 31 combines operating in the region.

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1. The total cost of 24 self-propelled combines at the official exchange rate was ¢491,600, or US$ 427,480;

2. Total bags harvested by 24 combines was 41,315, or 3,320 metric tons of paddy;

3. The self-propelled combines were used as stationary threshers for 20 percent of the bags harvested;

4. The total operating cost (fuel, lubricants, operators, and spare parts) of the 24 combines was ¢25,600, where 70 percent of the cost was for operator salaries and allowances and 12 percent was for spare parts.

5. Total operating revenue was ¢36,500, where ¢1.00 per bag was charged for complete harvesting and ¢0.60 per bag for stationary threshing;

6. Net operating revenue was -¢87,425, assuming a five year straight line depreciation schedule for the combines;

7. The combines, on the average, were operated for a period of 44 days. Also, on the average, the combines broke down and thus required repairs for 18 days, or 41 percent of the time.

8. The 24 combines worked on the farms of only 64 farmers. The average farm size of these farmers was 180 acres. Only 14 of these farms were entirely harvested by combine; on the remaining 50 farms a combination of combine and manual harvesting methods was used.

9. Total acreage harvested was 5,140 acres; on the average, each combine worked on only 2.7 farms.

10. Four months after the harvesting operations had been completed, only 32 percent of the revenue owed to the Ministry had been collected by the Ministry of Agriculture.

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During the 1973-74 rice harvesting season a large number of farmers used "tractor threshing." This procedure involved laying heaped paddy on cleared ground and having a tractor drive over the paddy several times until the paddy was threshed.

During the 1974-75 harvest season there was a major shift toward combine harvesting as there were 90 privately owned self-propelled combines in addition to the 31 MOA combines in the Northern Region.

Harvesting Problems Arising From Climatic Features and Seed Varieties

The rains normally end in October and from November to February the relative humidity dramatically declines and average day temperatures increase. Mature paddy dries very quickly and turns a light golden color and, if it is not harvested by the beginning of December, the grain will begin to shatter. Shattering is the process whereby the dry pinnacle of the paddy plant opens and the grain falls to the ground. If harvesting is delayed or prolonged through December, shattering becomes a major problem as a greater proportion of the yield is lost.

The shattering problem became more pronounced with the introduction of improved varieties in the 1960's because these varieties have a shorter growth cycle than traditional seed varieties. As a consequence, they mature earlier and shattering occurs if harvesting is delayed. On the other hand, traditional seed varieties have a longer growth cycle and are less susceptible to shattering. Consequently, some farmers are planting part of their farm to improved varieties and part to traditional varieties, the latter particularly in low lying areas of the farm. This practice eases the harvesting bottleneck and reduces th

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Historically, "bush fires" have been a seasonal activity in rural areas. Farmers and villagers have burned fields to get rid of unwanted crop residues (stalks and vines) and tall, dried grasses around the village. With the recent dramatic expansion of rice production, however, thousands of acres of paddy today surround rural villages. The very dry environmental conditions in December and January have thus become a major concern of the rice farmer, particularly the large-scale farmer, as a bush fire that is out of control can wipe out his entire harvest. As a result, before the 1973-74 harvest the government, with the use of radio, posters, and the Extension Service,embarked on a campaign to reduce the problem by outlawing burning until after the rice harvest.

Labor Shortage At Harvest

The expansion of rice production has dramatically increased the demand for labor in harvesting. Moreover, the adoption of improved varieties, which are susceptible to shattering, and the uncertainty of bush fires increase the importance of early harvesting. But in recent years the demand for casual labor in harvesting has been greater than the supply. As a consequence, various individuals (farmers, extension officers, machinery dealers, and various advisors) have urged the Ministry of Agriculture to make combine services available to rice farmers.

Yield Estimates

The MOA has not systematically estimated average paddy yields, nor the variance in yield associated with different cultural practices. However, in 1971 the Economics and Marketing Division (of the MOA) collect

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collected some yield information. Estimates vary depending on the procedure used to derive yield estimates. Table 2.6 gives estimated paddy yields in the Northern Region for improved and traditional seed varieties with and without the use of fertilizer. These yields are based on yield-cut surveys which estimate biological yields.[12]

In addition to the yield-cut procedure, the Economics and Marketing Division interviewed rice farmers in the Northern and Upper Regions immediately after the 1971-72 harvest (method of sample selection not reported) and asked them to declare the total number of bags harvested. The yields, as declared by farmers with 15 or more acres, are reported in Table 2.7 on the basis of seed variety and fertilizer use.

There is a wide variation in the yield estimates presented. The author believes that the yield-cut procedure greatly overestimated average yields for the Northern Region. This was probably due to two factors: first, the inherent over-estimation in the procedure by the inclusion of edge plants, and second, the tendency of junior staff to select plots on high yielding sections of land within a farm. In addition, most of the farms included in the Northern Region sample were in the Tamale District where the average farm yields are higher than in the outlying districts as these farms have greater access to improved inputs and the Extension Service. As a consequence, the MOA estimates

[12] The procedure followed in yield-cut surveys is to randomly select farms and then select randomly located 10' x 10' plots within each field. The plot is harvested at the recommended time. The crop is then weighed and the yield per acre is calculated.

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Table 2.6. Yield-Cut Estimates of Paddy in the Northern Region of Ghana

Seed	Fertilizer Applied	No. Plots in Sample	Yield in lbs. per Acre
Improved	Yes	74	3,900
Improved	No	81	3,500
Local	Yes	18	3,400
Local	No	24	2,700

Source: Ministry of Agriculture, Economics and Marketing Division, Accra, mimeo, 1972.

Table 2.7. Declared Yields[1] of Paddy in the Northern Region for Farms 15 Acres and Above, 1971

Seed	Fertilizer Applied	No. Plots in Sample	Yield in lbs. per Acre
Improved	Yes	15	1,400
Improved	No	15	1,000
Local	Yes	5	900
Local	No	9	600

[1]Declared Yields were determined by asking farmers to declare the number of bags per acre immediately following the harvest.

Source: Ministry of Agriculture, Economics and Marketing Division, Accra, mimeo, 1972.

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of average yields are believed to be high. This is not to deny that some farmers obtain yields ranging from 2,500 to 4,000 lbs. per acre, but these yields are obtained by a very few farmers.

There are two principal shortcomings of the yield data reported. First, the data do not differentiate among different levels of fertilizer use, and second, they do not reflect the cultural practices which are complimentary to the use of improved seed and fertilizer (e.g., standard of land preparation, planting date, and weeding practices).

Summary

The physical conditions in the Northern Region are well suited to the production of rain-fed paddy. There are about 150,000 acres of bottomlands which are well suited to rice development and an additional 100,000 acres which can be brought into production.

In 1971, it was estimated there were 6,100 holders producing paddy in the Northern Region. About 90 percent of these were producing paddy on 15 acres or less; about 50 percent of the holders were producing paddy on five acres or less. There were about 100 holders with rice farms larger than 100 acres.

In the Northern Region the acreage of rice expanded from about 28,000 acres in 1968 to 90,000 acres in 1974. During the same period it is estimated that average paddy yields increased from about 800 to 1,200 pounds per acre. The major factors that have contributed to a rapid increase in rice production in the Northern Region have been (1) an increasing availability of private contracting services for land preparation, (2) high direct or indirect subsidies for all factors of production except land and labor, (3) easy access to free bottomlands requiring minimum clearing, (4) increased availability of improved seed a

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seed and fertilizer, and (5) high producer returns.

Tractor mechanization is almost exclusively used for land preparation for bottomland rice production. In fact, during the 1973-74 crop season there were about 300-350 private tractors operating in the region. Most tractor owners are rice producers and private contractors. The majority of rice farmers, then, do not own tractors, but they are able to hire private contractors for initial land preparation.

There has been a rapid expansion in the use of improved seed and fertilizer among rice farmers in the region. In 1970 the MOA established a Seed Multiplication Unit which supervises the production of improved seed and purchases seed paddy from its Registered Seed Growers. The Unit also cleans and treats the seed and sells it to farmers at a subsidized rate. Sales of improved seed in the Northern Region expanded from about 3,300 bags (of 160 lbs. each) in 1970 to 24,500 bags in 1974. In fact, in 1974 it is estimated that improved seed was planted on about 63,000 acres.

Fertilizer sales in the region increased steadily from about 600 tons in 1969 to about 10,200 tons in 1974. Yet while fertilizer consumption has increased dramatically since about 1971, the average rice farmer applies fertilizer at low rates. Moreover, compound fertilizer is often applied at half the recommended rate and ammonium sulfate (top dressing) was used by only a small number of farmers in 1973. Nevertheless, Ministry fertilizer trials show that if fertilizer is applied at the recommended time and rate improved varieties can yield over 3,000 pounds per acre, or about three times the average farm yield.

Except for mechanized land preparation field activities, including

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the application of seed and fertilizer, weed control and harvesting have been undertaken manually by the vast majority of rice farmers. Few combines were in operation in the region before 1973, but in 1973 the MOA imported and operated in the Northern Region 31 large, self-propelled combines. These machines were hired to farmers at a heavily subsidized rate of ¢1.00 per 180-pound bag harvested. A financial analysis of 24 of the Ministry's combines indicated, however, that the service experienced a number of organizational problems and operational losses in its initial year of operation; among the problems was excessive machine breakdown time, as a result of which only about 5,100 acres were harvested by the 24 machines. The combines operated on only 64 farms with an average farm size of 180 acres, most of which were not completely harvested by combine. In addition, the Ministry had difficulties collecting outstanding revenue.

With the rapid expansion of rice production, the demand for casual labor to work on rice farms has dramatically increased in recent years. However, a shortage of labor during the harvest has developed and, as a consequence, combine harvesting was introduced into the region. The climatic conditions give rise to further harvesting complications among which are the very low humidity conditions at harvest time that create shattering losses for late harvesters and make bush fires a potential danger for unharvested rice farms.

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CHAPTER III

RESEARCH METHODOLOGY

Introduction

The purpose of this chapter is to describe (1) the purpose and scope of the survey, (2) the research design and methods used to organize and conduct the field survey, and (3) the analytical procedures adopted to analyze the data.

Purpose and Scope of the Survey

The purpose of the field survey was to obtain farm level input/output data in order to determine the relative importance of land, labor, and purchased inputs in the production of rice and to estimate the relative financial costs and returns of the major rice production systems in current use.

It was intended at the outset of the survey to collect cost and return data on two to three other crops grown by rice farmers; however, the Ministry of Agriculture was not interested in broadening the scope of the study. Rather the Ministry wanted to acquire as much information as possible on the costs and returns for the major rice production systems in order to evaluate its current rice production policies.

During the 1973-74 crop production season eleven enumeration areas were selected, three of which were in the Upper Region and the remaining eight in the Northern Region. Bullock power was a primary source of power for land preparation in three locations in the Upper Region and two

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and two locations in the Northern Region. At the other locations tractor mechanization was used for land preparation.[1] The map on the following page shows these enumeration areas.

Method of Primary Data Collection

Survey Method

Since this was the first economic study of rice production in Northern Ghana, it was not possible to draw on benchmark data from an earlier period. And since labor requirements for alternative production systems were a major focus of this study, it was decided that detailed data on labor utilization would be collected. Because rice production involves a large input of labor over a long production season, considerable thought was given to the farmer's ability to recall specific labor use and expenditures. As a result of these factors, the Cost Route Survey Method was chosen as the most appropriate framework for collecting field data.[2] This method involves continuous interviews from the sample of farmers rather than reliance on single interviews.

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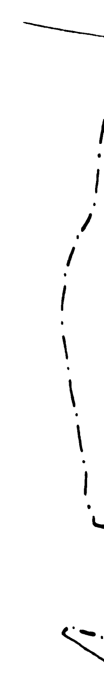
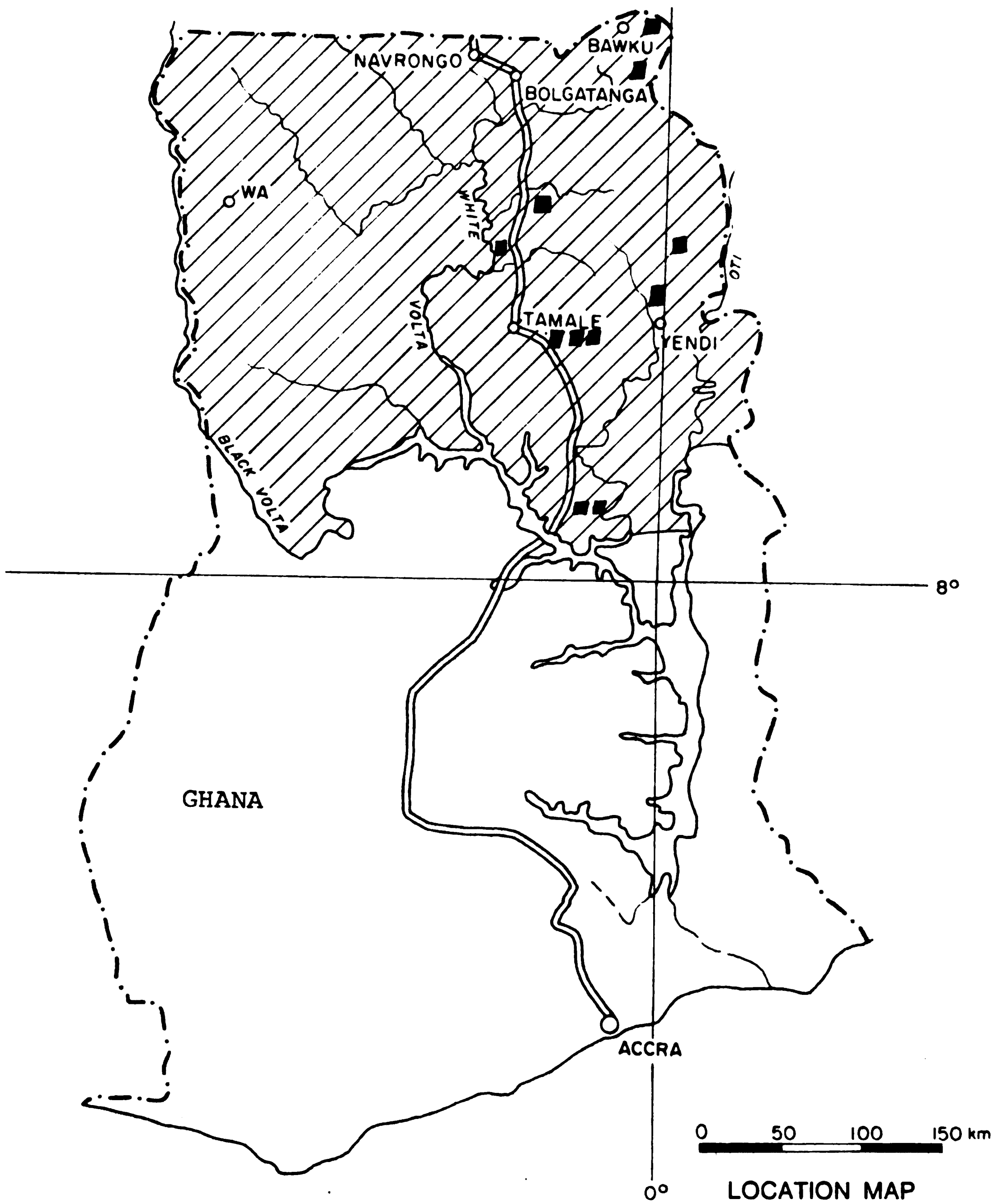
[1]For the 1972-73 crop production season five enumeration areas within Tamale District were selected, and 70 rice farmers were included in the sample. The 1972-73 crop season was poor in Northern Ghana because of a drought which depressed yields by an estimated 30-50 percent for rice and more for other crops such as maize. Since the drought conditions and resulting poor crop performance represented an abnormal production year for the study area, the data for this crop season are not analyzed in this study.

[2]For a discussion of several methods of farm management data collection under African conditions, see Dunstan S. C. Spencer, "Micro-Level Farm Management and Production Economics Research Among Traditional African Farmers: Lessons from Sierra Leone." African Rural Employment Paper No. 3, Department of Agricultural Economics, Michigan State University, September 1972.



Map 1.



Map 1. Location of Eleven Enumeration Areas in Northern Ghana for the 1973-74 Rice Production Survey (■).

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Selection of Enumeration Areas

The major rice producing areas in the Northern and Upper Regions were visited by the author soon after arriving in Tamale in 1972. At the time, the data for the 1970 Sample Census of Agriculture had been collected. However, the Census data were not available to derive a sample frame from which a sample of rice farmers could be drawn. Since there was not the time, nor did we believe the cost would be justified, to develop a list of rice farmers in each of the major districts, we undertook reconnaissance trips to the major rice producing areas.

After interviewing senior Ministry of Agriculture personnel and consulting production and soils maps at the Regional Headquarters of the Ministry, rice producing areas were selected for visits by the author. For about two weeks these areas were visited in order to develop familiarity with the salient features of the rice producing areas. The District Agricultural Extension Officer was contacted in each district and, in most cases, he accompanied the author to the production area; if the Extension Officer was not present or was unable to accompany us, a junior officer was solicited.

The following information was collected for each area: estimated total rice acreage, estimated number of farms, relative importance of rice production in the area, topography, standard of clearing, and distance from the nearest village. The latter was an important consideration in minimizing the anticipated travel time of the field enumerators during the course of the field survey. Extension officers served as interpreters and introduced the author to village chiefs and local farmers. The purpose of our trip and the field survey was outlined for each chief by our explanation that we were traveling to many rice

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rice-producing areas in the region and that we might wish to select the area under his jurisdiction to be included in our survey. The chief's cooperation was thus sought, and all, except one chief, agreed to have their areas included in the survey. They also offered or agreed to help locate accommodations for field enumerators in their villages.

By way of interviews with the chiefs and local farmers and discussions with the Extension officers, we were able to obtain insight into the nature of the production practices used in each area. Upon completion of the reconnaissance, we made a tentative selection of the enumeration areas on the basis of the following factors: (1) the number of rice farms in each major producing area, (2) the proximity of the farms to the nearest village, (3) anticipated production practices, (4) and the representativeness of the area with respect to topography, land clearing standards, and farm size.

Sampling Procedure and Sample Size

On the basis of the reconnaissance survey, representative rice production areas were selected, and we then proceeded to select a sample of rice farmers for the major production systems to be studied. By interviewing Senior Agricultural Officers, District Extension Officers, and expatriate advisors in the Ministry of Agriculture, it was learned that rice production systems were based upon the following five criteria:[3]

1. Power source for initial land preparation

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    - bullock plow
    - tractor hire services
    - tractor ownership

[3]These criteria were used to design a "Sample Identification Form" to establish a sample frame.

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2. Seed variety

   - improved
   - traditional

3. Fertilizer use

   - no fertilizer
   - compound fertilizer
   - compound fertilizer and top dressing

4. Method of harvesting

   - hand methods
   - combine harvesting
   - combination of hand and mechanical methods

5. Farm size

   - small farms (less than 10 acres)
   - medium size farms (11 to 50 acres)
   - large farms (over 50 acres).

One field enumerator was assigned to every two enumeration areas which were tentatively selected during the reconnaissance exercise. Enumerators interviewed 20-25 rice farmers with the Sample Identification Form and collected the following data: farmer's age, farm location, the years the farmer had produced rice, intended farm size, and intended production practices (method of land preparation, seed variety, fertilizer use, and method of harvesting). In addition, the enumerators asked farmers whether they would agree to being interviewed several times per week over the coming production season.[4]

During this phase of the sample selection, data were obtained from about 350 farmers. These data were then tabulated, and, from this sample frame, a purposive sample of 168 farmers was selected. Our intended sample size was 170 rice farmers (Table 3.1), but we had to

[4]Out of 350 farmers interviewed, only nine farmers refused to cooperate.

modify this goal because we did not identify as many farmers within some of the strata as we had hoped during the administration of the Sample Identification Form. For example, we did not identify a single farmer using hand methods of land preparation and improved seed. Then, later, we discovered that many farmers did not follow intended production practices. For example, many farmers switched seed varieties and did not follow intended fertilizer practices. In addition, the actual harvesting techniques frequently turned out to be different than intended as many sample farmers used partial mechanized harvesting techniques. The features of the actual sample are reported later in this chapter.

The sample size was determined by a fixed budget, which permitted hiring up to 15 field enumerators, and the perceived number of farmers that a field enumerator could effectively interview. Moreover, the relatively large number of laborers working on rice farms during critical field activities and the need to collect accurate labor utilization data influenced the sample size, and less weight was placed on number of sample units and more on data accuracy. Finally, in determining the number of farmers an enumerator should be assigned, we took into account (1) the need to obtain accurate labor data, (2) the relative skill of the enumerator, (3) the distance of the sample farm from the village in which the enumerator was to live, and (4) the relative distance of the sample farm from the village and the ease of travel and time necessary for visitation to the sample farms.

Table 3.1. Desired Stratified Purposive Sample of Rice Farmers for the 1973-74 Production Season

Power Source[1]

Table 3.1. Desired Stratified Purposive Sample of Rice Farmers for the 1973-74 Production Season

Power Source[1]	Seed Variety	Fertilizer Use[2]	Method of Harvesting	Range in Farm Size in Acres	No. of Farms
Hand	Traditional	0	Hand	0.3 - 1.0	10
Hand	Improved	+	Hand	0.3 - 1.0	10
Bullock	Traditional	0	Hand	0.5 - 3.0	15
Bullock	Improved	+	Hand	0.5 - 3.0	15
THS	Traditional	0	Hand	3.0 - 50.0	30
THS	Improved	+	Hand	3.0 - 50.0	30
THS	Improved	+	Combine	3.0 - 50.0	10
TO	Traditional	0	Hand	10.0 - 300.0	20
TO	Improved	+	Hand	10.0 - 300.0	20
TO	Improved	+	Combine	10.0 - 300.0	10
					170 Total

[1]Source of power for initial land preparation.

[2]0 = no intended fertilizer; + = intended fertilizer use.

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Selection and Training of Field Enumerators

The Economics and Marketing Division of the Ministry of Agriculture assigned 15 field assistants to our study who had previously served as enumerators for the 1970 Agricultural Census. All had received Middle School Certificates and were between the ages of 20 and 36. In the first year of study, they participated in a 10 day training course consisting of instruction in the purpose and importance of the survey, interviewing techniques, practice with using survey forms, identification of seed varieties and fertilizer types, administrative procedures,and practice in field measurement. The course was organized on the basis of lectures, discussions, field trips,and tests. Each participant was required to prepare his own Field Manual during the course and submit new sections twice a week for approval. Each trainee was also required to pass a final written exam and have his Field Manual approved. During this first year process, one of the assigned field assistants did not appear for the course, one trainee did not complete the training,and two did not pass. About half way through the survey, one enumerator was dismissed because he was submitting false data.

Preceding the second year of the survey, 22 young men with Middle School Certificates were interviewed for new positions, and five were invited to a 14-day training course along with the 10 enumerators who were employed during the first year. The course was designed along the same lines as that of the preceding year. All but two of the 15 (one from the old group) passed the training course. Thus, 13 enumeratos were employed during the second survey year.

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The enumerators were paid between 36 and 38 cedis per month, depending on their grade in the civil service, which was based primarily on years of service. But in order to be promoted to a new grade, an enumerator needed a good performance record. In addition to their salary, enumerators received a transport and travel allowance. The rate for transport depended on whether they owned or hired a bicycle, and a fixed nightly travel rate was given for nights spent away from post.

Enumerators were supplied with survey forms, field books, writing supplies, and a carrying case. In addition, at the time of Field Measurement, the enumerators were assigned to teams and each team was given a measuring wheel and a portable angle board.

Interviewing Procedures

Enumerators were required to interview farmers and to observe field activities on each farm a minimum of twice a week. It was learned that most enumerators interviewed their farmers on an average of three times a week, though there was not a general pattern among the field staff regarding the place of the interview. At some times farmers were interviewed in the village, while at others the farmers were interviewed at the farm. Generally, however, the enumerators preferred to interview at the farm because there they were able to observe field activities and to obtain more accurate information about the number of laborers working on the farm.

The frequency of farm visits and interviews was increased during broadcasting and harvesting activities in order to collect more accurate data on labor utilization and total production. The enumeration per

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period started in May (plowing time) and ended in February (towards the end of the selling period).

The basic survey form used for data collection was a slightly modified version of the Weekly Input-Output Record used by Spencer in his study of rice production in Sierra Leone.[5] Information acquired during the interviews was recorded in an enumerator's field book and then transferred by the enumerator to this "Weekly Input-Output Record." In an effort to minimize recall problems, this information was concerned with activities undertaken one to three days before the interview. The records were collected from the enumerators the following week.

Part I of the Weekly Input-Output Record was organized for recording field data about family labor. Data were obtained on the basis of: (1) field activity, (2) labor description (men, women, and children), and (3) field hours. Part II required recording data on hired labor. These data included: (1) field activity, (2) labor description, (3) hours of field work, (4) wage rates, (5) total expenditures, and (6) payments in kind (food). Finally, the purpose of Part III of the Record was to record purchases of inputs (excluding labor) and sales of paddy, and Part IV was a blank page provided for enumerators to elaborate on preceding parts, if necessary, and to report any problems they might have.[6]

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[5] See Dunstan S. C. Spencer, "The Efficient Use of Resources in the Production of Rice in Sierra Leone: A Linear Programming Study." Ph.D. dissertation, University of Illinois at Urbana-Champaign, 1973.

[6] All Weekly Input-Output Records were turned over to the Director of Agriculture before the author left Ghana in order that the Ministry would have all the raw data. It was agreed that the Ministry would also receive a copy of this dissertation and any other research reports which might be produced.

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Supervision of Field Staff

All enumerators (except those posted to the Upper Region) were visited weekly on an undetermined day by the author or his counterpart for the purpose of checking and collecting the field records. The enumerators in the Upper Region were visited twice a month. During these visits, we discussed any queries resulting from previous submissions, as well as field problems that might have arisen during the week. Field books were regularly checked to insure conformity between them and the Weekly Input-Output Records, and, periodically, sample farms were visited by the author to confirm the data being collected and to show interest in the individual enumerator's farms.[7]

Upon collection of the Weekly Input-Output Records, the data were transferred to a "Primary Tabulation Form" in the project office by the author and his counterpart. Tabulation forms were maintained on a farm-by-farm basis, and purchasing and field activities were periodically cross-checked for consistency. If discrepancies were found, queries were discussed with the appropriate enumerator the following week. At times, an enumerator was required to reinterview a farmer regarding particular information submitted.

The purposes of the Primary Tabulation Form were to greatly reduce the bulk of paper that had to be handled for each farm and to serve as a means of supervising the enumerators. The preparation of the Form on large paper (12 3/4" x 15 3/4") facilitated the review of individual farm activities and expenditures in that a single page contained data for several weeks and showed at a glance all farm activities and expenditures for those weeks.

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[7] It was found that farm visits were good for morale of the enumerators, and farmers often requested such visits.

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The Nature and Measurement of Input-Output Data

The classification and description of resources used in rice production and the corresponding variables measured during the field survey are given in Table 3.2. The method of classifying field activities involved in rice production and a list of individual activities under each classification are given in Table 3.3.

To measure labor utilization, data were collected separately for family and hired labor and were recorded on the basis of field hours and labor description (men, women,and children). Since rest and eating time was found to be virtually impossible to estimate, the measurement of field hours was based upon the time the worker entered (starting time) and left the field (finishing time). For hired labor information on wage rates (peswas per day), total expenditures and the estimated market value of payments in kind were collected. For each purchasing activity, data were obtained on the basis of a description of the item, quantity, unit price, total expenditure,and date of purchase, while for each field activity data were collected on the basis of labor utilization and/or mechanization services (owned or hired) used.

Total production estimates were determined by daily counts of bags of paddy. Information on the disposition of the crop was acquired by asking farmers the reasons for which bags of paddy left the farm (sale or various storage purposes). For the quantities sold, information was collected on the location of the sale, type of buyer, selling costs involved, unit selling price, and gross income.

To estimate farm size, each farm was measured after harvest by the triangulation method by which enumerators,working in teams, drew a map of each farm, depicting the shape of the farm and how it was

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Table 3.2. Classification and Listing of Activities Recorded on the Weekly Input-Output Record

Purchasing Activities	Field Activities	Disposition Activities
Mechanization services	Land clearing	Quantity sold; for each sale:
Hired Labor	Land preparation	- type of buyer
Seed	plowing	- unit price
Compound fertilizer	harrowing	- gross income
Top dressing	broadcasting	Stored for later sale
Tractors and equipment	- seed	Stored for seed
Bullocks and equipment	- compound fertilizer	Stored for home consumption
Spare parts	- top dressing	Gifts
Maintenance	Weeding	
Fuel, oil, lubricants	Harvesting	
	cutting	
	heaping	
	threshing	
	winnowing	
	bagging	

Table 3.3. Description of Resources Used in Rice Production and the Corresponding Variables Measured During the Field Survey

Resource Description	Variables Measured
Land	Acres
Capital	
- Farm Produced or Owned	Seed: variety, quantity Power: days, area, variable input requirements
- Purchased	Fertilizer and Mechanization Services: Description of item, quantity, price, total expenditure
Labor	
- Family: Men, women, children	Activity, field hours, estimated work done
- Hired: Men, women, children	Same as family labor, plus wage rates, total cash expenditure, and payments in kind

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divided in triangles. The measurement of the base and height of each triangle was recorded on the farm map. The equipment used to so measure the farms consisted of survey poles, a portable right angle board, and a measuring wheel.

Data Tabulation, Coding and Storage

Tabulation and Coding

Initial data tabulation was undertaken during the survey in that data submitted on the Weekly Input-Output Record were continuously recorded on the Primary Tabulation Forms separately maintained for each sample farm. Upon return to Michigan State University, the data on the Primary Tabulation Forms were first tabulated and then coded for punching. All data were tabulated and coded in the same units as they were collected during the field survey. For example, the labor data were coded in terms of field hours and fertilizer data as 112 pound bags.

The task of tabulation was broken into successive operations across sample farms rather than coding all data for each farm separately.[8] It was known at the outset that tabulation would take a great deal of time because of the detailed labor utilization data that were collected. Therefore, it was believed that the tabulation procedures should be specialized with regard to the different types of data in order to increase the efficiency and accuracy of the tabulation process.

[8] The Primary Tabulation Forms were designed solely for the purpose of condensing raw field data and for checking the accuracy of field submissions. They were not suitable for direct punching. As a consequence, a preliminary stage of tabulation was required before punching.

The tabulation of the labor data was very time-consuming. First, the labor data were aggregated on a field activity basis for each labor description category. For example, the total field hours of male family labor involved in the broadcasting of seed were aggregated along with female family labor and child family labor. In addition, the field hours for male, female,and child hired labor were separately aggregated along with the corresponding expenditures for each labor description category. The aggregated labor data were then coded on the basis of (1) farm identification number, (2) field activity code, (3) labor description code (family or hired labor),and (4) a sex code (men, women and,children).

In summary, then, the tabulation and coding process involved several phases based upon the nature of the data. For each phase the appropriate data for all forms were tabulated and coded before proceeding to the next phase. The phases were as follows:

- total production;
- mechanized land preparation;
- purchase of seed and fertilizer;
- labor utilization data for all field activities;
- mechanized harvesting;
- beginning and ending dates for all field activities.

Standard Data File

A Standard Data File was designed to organize and store data on tape for subsequent computer analysis. All data in the file were identified and organized by successive farm identification numbers and individual variable numbers. A Variable Code Book was developed for

all variables which were expected to be used in the analysis. Each variable was given a number, name, and description. A large number of variables were defined, many of which were created from the raw data. For example, a computer was used to convert all labor data for each farm from field hours to man-hours per acre on an activity-by-activity basis.[9] The same program was employed to calculate for each farm, on an activity-by-activity basis, the absolute number and relative percentage of man-hours per acre for (1) men, women, and children and (2) family and hired labor.

Mechanization expenditures for initial land preparation (plowing and harrowing) were re-calculated. Farmers who hired a private tractor operator were charged on the basis of an "unmeasured acre." During the field survey per acre charges were recorded as well as the total expenditure incurred by the farmer for each mechanization operation. Finally, at the end of the harvest season, all sample rice fields were measured. Using "measured acres," actual charges per acre were then calculated,[10] and these charges, along with the total expenditure for each mechanized operation, were entered in the Standard Data File.

Bags of seed and fertilizer were converted to pounds, and application rates for seed and fertilizer were then calculated. These application rates, in terms of pounds per acre, were entered in the Standard

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[9] The coefficients used to convert field hours to man-hours were 1.0, 0.75, and 0.50 for men, women, and children, respectively, for broadcasting of seed and fertilizer, cutting, and heaping. For weeding, threshing, and winnowing the conversion factor for women was 1.0, or equal to men.

[10] After measuring all sample farms and randomly remeasuring about 20 farms to confirm our measurements, we found that rice farmers over-declared their acreage by about 30 percent. Custom tractor operators are probably in part responsible as it pays them to over-estimate the amount of plowing done since they charge on a per acre basis.

Data File. In addition, variables were created in terms of pounds of nutrients from the two fertilizers used by rice farmers, and these application rates, in terms of nutrient pounds per acre, were entered in the File.

Principal Features of the Sample

Farms Excluded From the Sample

During the 1973-74 production season input-output data were collected for 161 rice farms. Of these, 143 farms were retained for analysis. The following 18 farms were excluded from the sample.

- 11 bullock farmers who hired tractor services for initial land preparation,[11]
- 5 bullock farmers who had mixed stands of paddy,[12]
- 1 tractor hire farmer whose farm was completely burned before harvest,
- 1 farm inadvertently excluded.

The 11 bullock farms were excluded from analysis because bullock power is limited to an upland rice production system, whereas tractor power is representative of a bottomland production system. It is assumed that land preparation by bullock and by tractor power is not the same, and, since the soil types are different for upland and bottomland paddy production, these 11 farms were not consistent with either production system. Given the variability in seed variety and fertilizer

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[11] These farmers did not intend, at the time the "Sample Identification Form" was administered, to use tractor services for initial land preparation.

[12] These farmers indicated that they would plant a pure stand but planted other food crops in the stand after paddy had been planted.

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use among these farms, the subsample of 11 was judged to be too small to be analyzed separately.

The five bullock farms with mixed stands (paddy mixed with other food crops) were excluded because the production system was not typical of the study area and the subsample was too small.

Sample Characteristics

It will be recalled that five criteria were used to design a stratified, purposive sample based upon farmers' intended production practices; however, not all farmers followed their intended practices. Table 3.4 shows the number of sample units within each strata for the sample. The table not only indicates how many sample farms used each power source, seed variety, fertilizer, and method of harvesting included in the study, but is also organized to illustrate the distribution of sample farms among four bases of stratification. For example, of the 83 farms that hired a tractor for initial land preparation, 28 used traditional seed (12 of these used compound fertilizer and no top dressing, and six harvested their crop by hand). Of the remaining 15 farms using traditional seed, in this power source group, 13 used no compound fertilizer and top dressing and eight harvested by hand methods.

The sample distribution of farm size and power source for land preparation for each acreage classification is reported in Table 3.5. The table also shows that the total acreage of the 143 farms was 4,520 acres. If the total acreage of the bullock farms from the Upper Region is subtracted from this total, then the acreage in the sample from the Northern Region is 4,504. During the 1973-74 production season, it was estimated that there were about 70,000 acres in the Northern Region.

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Table 3.4. Principal Features of the Stratified Sample of Rice Farms

Power Source	Seed Variety	No. of Obser.	Fertilizer Use[a]			Method of Harvesting[b]		
			Compound	Top Dressing	No. of Obser.	Hand	Combine	Other
						(No. of Observations)		
Hand	Traditional	4	X	0	1	1	--	--
			0	0	3	3	--	--
		(4)			(4)	(4)		
Bullock	Traditional	16	X	0	8	8	--	--
			0	0	8	8	--	--
	Improved	5	X	0	2	2	--	--
			0	0	3	3	--	--
	Mixed	2	0	0	2	2	--	--
		(23)			(23)	(23)		
Tractor Hire Service	Traditional	28	X	0	12	6	--	6
			0	X	3	3	--	--
			0	0	13	8	--	5
	Improved	44	X	X	12	4	2	6
			X	0	27	20	2	5
			0	0	5	3	--	2
	Mixed	11	X	X	5	3	--	2
			X	0	2	1	--	1
			0	0	4	1	--	3
		(83)			(83)	(49)	(4)	(30)
Tractor Owners	Traditional	10	X	X	1	--	--	1
			X	0	7	--	--	7
			0	X	1	--	1	--
			0	0	1	1	--	--
	Improved	19	X	X	9	2	5	2
			X	0	5	1	2	2
			0	X	1	--	--	1
			0	0	4	1	--	3
	Mixed	4	X	X	1	--	--	1
			X	0	2	--	--	2
			0	0	1	1	--	--
		(33)			(33)	(6)	(8)	(19)
	Total	143			143	82	12	49

[a] "X" = Fertilizer Used
"0" = Fertilizer Not Used.

[b] Hand: Farm entirely harvested by hand methods.
Combine: Farm entirely harvested with a self-propelled combine.
Other: Combination of hand and mechanized harvesting methods.

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Table 3.5. Sample Distribution of Farm Size and Source of Power for Land Preparation

No. of Farms	Range in Farm Size (Acres)	Average Farm Size	Total Acres	Power Source for Land Preparation[1]			
				H	B	THS	TO
45	0.1 - 5.0	2.5	111.6	4	22	18	1
50	5.1 - 20.0	11.6	577.5	-	1	41	8
35	20.1 - 80.0	39.6	1,386.4	-	--	24	11
7	80.1 - 150.0	92.8	649.5	-	--	--	7
6	150.1 +	299.2	1,795.2	-	--	--	6
143			4,520.2	4	23	83	33

[1]Codes for the Power source for initial land preparation:

H = Hand
B = Bullock
THS = Tractor Hire Service
TO = Own Tractor

Therefore, 6.4 percent of the estimated total paddy acreage in the Northern Region was included in the study sample. Given the estimated number of rice farmers in the region (6,100), the sample of 143 farmers represents about 2.4 percent of the region's rice farmers. The inclusion of a disproportionately large number of tractor owners (33 farms, or 23 percent of the sample) in the study explains why 2.3 percent of the rice producers account for as much as 6.4 percent of the estimated regional acreage.

With the introduction of the combine harvester and the large number of tractors in the study area, there were several combinations of harvesting methods used. Table 3.6 describes how paddy was harvested on the sample farms. All of the 27 farmers who used either the handhoe or the bullock plow for initial land preparation harvested their crop

Table 3.6. Method of Harvesting Used by All Sample Farms

Table 3.6. Method of Harvesting Used by All Sample Farms

Farms		Average Farm Size	Range in Farm Size	Number of Farms Classified by Power Source Using Each Method[2]				Proportion of Farm Harvested by Each Method[1]			
No.	%	(Acres)	(Acres)	H	BO	THS	TO	HC	CC (Percent)	CST	TT
27	18.8	1.7	0.3 - 10.5	4	23	--	--	100			
55	38.5	12.8	3.2 - 52.7			49	6	100			
12	8.4	131.3	8.0 - 469.7			4	8		100		
2	1.4	104.3	40.9 - 167.8			1	1			100	
20	14.0	27.4	3.8 - 143.1			15	5				100
9	6.3	20.2	7.4 - 37.9			7	2	46	---	---	54
4	2.8	62.1	29.1 - 122.6			1	3	55	---	45	---
3	2.1	70.0	60.5 - 86.9			1	2	17	46	16	21
2	1.4	77.2	48.9 - 105.5			1	1	51	14	---	35
2	1.4	61.8	49.6 - 74.0			1	1	22	78	---	---
2	1.4	42.9	41.4 - 44.3			2	--	30	---	47	23
2	1.4	164.4	22.3 - 306.4			-	2	---	74	26	---
1	0.7	40.0				-	1	---	31	58	11
1	0.7	10.5				1	--	---	69	---	31
1	0.7	34.5				-	1	---	---	37	63
143	100.0			4	23	83	33				

[1] HC = Harvested by hand; CC = Harvested by combine; CST = Combine used as a stationary thresher; TT = Tractor threshing.

[2] H = Hand; BO = Bullock Operator; THS = Tractor hire service; TO = Tractor Owner.

by hand methods. The farm size in this subsample ranged from 0.3 to 10.5 acres and averaged 1.7 acres. There were 55 farms (39 percent of the sample) utilizing tractors for land preparation that also used hand methods of harvesting exclusively. The average size of these farms was 12.8 acres, which is small compared with the size of farms which used tractor power for land preparation and combine harvesting.

The average size of a farm on which only a combine was used for harvesting was 131.3 acres. Of the 12 sample farms in this category, eight were operated by farmers who owned tractors. On two farms, a self-propelled combine was used as a stationary thresher, all other harvesting activities being done by hand (i.e., cutting and heaping). On 20 farms (14 percent of the sample) "tractor threshing" was used for all threshing activities. The other harvesting activities (i.e., cutting, heaping, winnowing and bagging) were done by hand. The average size of farms in this group was 27.4 acres.

The remaining 27 farms (19 percent of the sample) used various combinations of harvesting methods as shown in Table 3.6 which indicates the percentage of the total farm acreage harvested by each method within each harvesting classification. For example, the nine farms which used a combination of hand harvesting (HC) and tractor threshing (TT) harvested, on the average, 46 percent of the acreage completely by hand. On the remaining 54 percent of the acreage farmers used a tractor for threshing, although on this latter acreage cutting, heaping, winnowing and bagging were done by hand. In general, as farm size increases, the degree of mechanized harvesting increases.

Defining the Production Systems

Since sample farmers did not in many cases follow intended production practices, we ended up with too few observations for many of our intended strata. As a consequence, we were forced to redefine our production systems on the basis of only two criteria: (1) power source for initial land preparation and (2) seed variety. These two criteria were used to delineate six rice production systems for the analysis:

(a) System I: THS - Traditional Seed

This subsample consists of 28 bottomland rice farms where farmers hired private tractor services for initial land preparation and used traditional seed varieties.

(b) System II: THS - Improved Seed

This subsample consists of 44 bottomland rice farms where farmers hired private tractor services for initial land preparation and used improved seed varieties.

(c) System III: THS - Mixed Seed

This subsample consists of 11 bottomland rice farms where farmers hired private tractor services for initial land preparation and used a combination of improved and traditional seed varieties.

(d) System IV: TO - Traditional Seed

This subsample consists of 10 tractor owners who produced rice on bottomlands and used traditional seed varieties.

(e) System V: TO - Improved Seed

This subsample consists of 19 tractor owners who produced rice on bottomlands and used improved seed varieties.

(f) System VI: BO - Traditional Seed

This subsample consists of 14 upland rice producers who used traditional seed varieties and a bullock team and plow for land preparation.

Summary

The purpose of the field survey was to obtain farm level data in order to estimate the financial costs and returns of the major rice production systems in current use in Northern Ghana. The Cost Route Survey Method was used to collect input-output data from 161 farmers during the 1973-74 crop season.

The sample size was determined by a fixed budget, which permitted the hiring of 15 field enumerators, and by the number of farmers that a field enumerator could effectively interview. Enumerators had Middle School Certificates and were between the ages of 20 and 36, and all participated in a 10-day training course before the survey year. The training course concentrated on the purpose and importance of the survey, on interviewing techniques, on practice in using survey forms, on administrative procedures, and on practice in field measurement. Each enumerator was required to prepare his own Field Manual and to pass a final exam.

Enumerators were also required to interview farmers a minimum of twice a week. The frequency of farm visits and interviews was increased during broadcasting and harvesting activities in order to obtain accurate data on labor utilization and output. A Weekly Input-Output Record was used to record farm data. Furthermore, enumerators were visited weekly for the purpose of checking and collecting input-output records. Upon collection of the field records, the data were transferred to Primary Tabulation Forms in the project office which were maintained on a farm-by-farm basis to facilitate supervision of field staff. Field data were periodically cross-checked for consistency.

Labor utilization data were collected on an activity-by-activity basis, separately for family and hired labor. Data were recorded on the basis of field hours and labor description (men, women, and children). For hired labor, information regarding wage rates, total labor expenditures,and the estimated value of payments in kind were also collected. Total production estimates were determined by physically counting bags of paddy on a daily basis. To estimate farm size each sample farm was measured after harvest by the triangulation method.

Finally, five bottomland systems and one upland rice production system were defined on the basis of (1) power source used for initial land preparation and (2) seed variety. Three bottomland systems were based upon farmers hiring private tractor hire services (traditional, improved, and mixed seed varieties); two bottomland systems were based upon tractor owners (traditional and improved seed varieties); and one upland system was based upon farmers using traditional seed varieties and a bullock plow for land preparation.

CHAPTER IV

A FINANCIAL AND ECONOMIC ANALYSIS OF THE MAJOR RICE PRODUCTION SYSTEMS IN NORTHERN GHANA

Introduction

There are two principal objectives of this chapter. The first is to estimate the private costs and returns to rice farmers using current production technologies. Towards this end, rice enterprise budgets were developed for five tractor mechanized bottomland production systems and one upland rice enterprise system which used a bullock team for land preparation. The second objective of the chapter is to estimate the economic costs and returns of the major rice production systems from the point of view of the national economy.

Distinctions Between the Financial and Economic Analysis

Financial Analysis

The financial analysis is based upon budgets for each of six rice production systems. All budgets were constructed from survey data drawn from a subsample of farms for each system. Moreover, each budget was developed by deriving mean farm estimates for (1) input quantities, (2) factor prices, and (3) physical output. Factors of production were priced or valued at 1973-74 market prices, namely, the prices actually paid for mechanization services, fertilizer, labor, etc. For the five bottomland production systems, output was valued at the floor price as established by the Government Rice Mills Unit (RMU).

For the upland system, output was valued at the average price which bullock farmers received for their output.[1]

For each enterprise budget a net cash return was computed for operating capital, family labor, and management. The budget data were used to derive financial returns to (1) family labor, (2) operating capital expenditures, and (3) management, as well as cost of production.

Economic Analysis

The factor prices of all resources used in rice production in northern Ghana, except hired labor, contain subsidies. As such, subsidized factors were not priced nor valued in the market at costs which reflect real scarcity values. To eliminate the factor-price distortions, subsidies were estimated and market prices were increased by the amount of the subsidy to arrive at real economic resource values, or unsubsidized costs.

Two types of factor subsidies were computed in our analysis: implicit subsidies, resulting from an overvalued exchange rate[2], and explicit or budgetary subsidies. After these subsidies were computed,

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[1]About 75 percent of the total output of bottomland rice producers was sold to the RMU at the floor price of ₵12.00 per 180 lb. bag. Virtually all of the output of farms greater than 50 acres was sold to the RMU. Farmers with less than 50 acres sold part of their output to private traders at prices ranging from ₵13.00 to ₵15.00 per bag. The upland bullock farmers sold all of their output to private traders at an average price of about ₵14.50 per 180 lb. bag. Private traders were purchasing for the small-scale millers who cater to the local market (as opposed to the Southern market for the RMU). In addition, private traders were purchasing paddy for neighboring country markets (illegal trade) in producing areas where the RMU did not have buying stations.

[2]The official exchange rate is GH₵1.15 = US$1.00. It is estimated by the Ministry of Finance and Economic Planning and the IBRD that the Ghanaian cedi is about 35 percent overvalued. The shadow exchange used in the economic analysis is therefore GH₵1.55 = US$1.00.

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they were added to financial costs to arrive at economic factor costs. Physical output was valued at its estimated import parity price.[3]

A Financial Analysis of Six Rice Production Systems

Calculation of Budgets

This study is the first attempt to quantify the physical resources used and the corresponding financial costs and returns of rice production systems in Northern Ghana. In order to estimate costs and returns of rice production, survey data were employed to derive enterprise budgets for the six rice production systems. Sufficient detail was incorporated in the budgets (1) to estimate physical and financial resource requirements on an activity-by-activity basis in order to compare resource use among activities and production systems (e.g., labor utilization in harvesting), and (2) to derive financial returns to selected factors of production (e.g., returns to family labor).

Aggregation of Inputs and Factor Costs

For each sample farm, specific resource quantities and costs were estimated on a per acre basis for each field activity.[4] For each of the six production systems, mean acre input quantities and expenditures

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[3]For the calculation of the import parity price of domestic farm output, see Appendix I. The import parity price is estimated taking into account projected world rice prices, domestic milling and transport costs, and the shadow rate of exchange.

[4]All factor costs are determined on a per acre basis except seed and fertilizer and combine harvesting which are both calculated on a per unit bag basis. Seed is sold in bags of an average weight of 160 pounds; fertilizer is sold in 112 pound bags, and combine services are charged on the basis of 180 pound bags harvested. The average cost per 160 pound bag of seed was calculated among all sample farms and the resulting average cost was used in the budgets. The MOA fertilizer price and combine harvesting charges are the unit prices used in the budgets. The average cost of hiring a combine as a stationary thresher (CST) was

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were computed as a simple average of the individual farm means of all farms of a given production system. Thus, mean farm estimates rather than mean acre estimates were used. This procedure weighs individual farm resource requirements within each production system equally. As a result, for each production system an average farm budget is developed rather than an average acreage budget because the objective of this study is to estimate average farm resource use rather than to identify one or two production systems which would provide the greatest short-run supply response.[5] This weighting procedure also permits the analyst and planner to identify farm level trade-offs among often conflicting goals of increased farm (1) output, (2) income, and (3) employment.

Derivation of the Costs of Land Preparation Among Tractor Owners and Bullock Operators

The costs of land preparation for farmers hiring private contract services were treated as an operating expenditure item.[6] The owning and operating costs of a tractor and associated equipment were estimated for an average tractor owner in Northern Ghana. The capital stock in equipment was reduced to a capital flow, and the cost of land preparation has been expressed in terms of costs per acre.[7] The resulting cost

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an average cost paid by sample farmers as our survey data revealed that the fixed price of ₵0.60 per bag was not accurate as many farmers were charged above the fixed price.

[5]If supply response were the sole objective, then average acreage budgets as opposed to average farm budgets would have been derived.

[6]Private contractors normally charge farmers on a per acre basis. Farm measurement revealed that private contractors over-declared acreage by about 30 percent. During the process of tabulating and coding the farm data, per acre contract charges were adjusted by actual (measured) farm acreage.

[7]The derivation of the owning and operating costs of a tractor and associated equipment in Northern Ghana and the conversion to average costs per acre are reported in Appendix C.

per acre was operating capital costs which include an estimated value of the capital stock consumed or used during an average year over the life of the equipment. Similarly, the cost of owning and operating a bullock team and plow in Northern Ghana has been computed, and the derivation of the costs per acre for bullock plowing is reported in the Appendix.[8]

Derivation of Land Clearing Costs

Since land clearing is a required activity for farmers establishing new rice farms, or extending their present farms, this cost was included in all budgets. During the 1973-74 production season about 30 percent of the sample farmers were engaged in land clearing. In all cases the clearing activity was for farm extension and not the establishment of a new farm. The estimated cost of land clearing by hand methods and by a combination of machine and hand methods was derived from sample data. These average per acre costs were amortized over a five-year period, and the annual cost has been included in the budgets.[9]

Costs and Returns of Six Production Systems

The major features of each rice production system are briefly described in this section. The reader desiring more detail about a production system is referred to the enterprise budgets presented in the following pages.

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[8]See Appendix D, "Calculation of Land Preparation Costs for Bullock Operators."

[9]See Appendix F, "Estimated Land Clearing Costs Per Acre on Bottomland Rice Farms in Northern Ghana, 1973."

System I: Farmers Hiring Tractor Services and Using Traditional Seed

A financial budget representing the average physical resource utilization and corresponding expenditures for 28 sample farms using hired tractor services for land preparation and traditional seed is reported in Table 4.1. The average sample farm size for this production system is 12.8 acres.

Pre-Harvest Activities

The farmers in this subsample undertook, on the average, first harrowing and second harrowing on about 90 and 40 percent of their acreage, respectively. There was virtually no third harrowing undertaken. Traditional seed varieties were applied at slightly above the recommended rate of 70 pounds, or 0.44 bags per acre. The mean application rate of compound fertilizer was only 42 percent of the recommended one cwt. bag per acre.

Harvest Activities

Most harvesting activities were done by hand methods. Of the 10.3 acres cut by hand, 6.3 acres were threshed by hand, and a hired tractor was used for "tractor threshing" on 4.0 acres. In addition, 2.5 acres were completely harvested with a self-propelled combine.

Labor Utilization

The mean labor utilization per acre in all field activities was 116 man-hours per acre, of which 24 percent were for pre-harvest activities and 76 percent for harvesting activities. Thirty-eight percent of the total farm man-hours were hired labor; 81 percent of the hired labor were employed for harvest activities, and 14 percent were hired for weeding.

Table 4.1. Rice Enterprise Budget for a 12.8 Acre Farm Based on Survey Data from Twenty-eight Farms in Northern Ghana Using Traditional Seed Varieties and Tractor Hire Services, 1973-74 System I

Activity		Operating Expenditures and Labor Utilization by Activity											
		Non Labor Expenditures					Labor Utilization and Expenditures						
							Manhours				Wage Rate	Expenditure	
Item	Acres	Units	Rate Per Acre	Total Units	Cost Per Unit	Total Cost	Per Activity Acre	Total	Family Labor	Hired Labor	Per Hour	Per Acre	Total
					¢	¢					¢	¢	¢
A. Land Clearing[a/]	12.8	acres	1.00			12.80							
B. Pre-harvest													
Plowing	12.8	acres			9.00	115.20							
1st Harrowing	11.6	acres			4.44	51.50							
2nd Harrowing	5.3	acres			4.16	22.05							
3rd Harrowing	0.7	acres			2.37	1.66							
Sub-Total						190.41							
Seed	12.8	bags	0.45	5.8	14.00	81.20	9.4	120.3	96.0	24.3	0.10	.18	2.30
Comp. Fertilizer	12.8	bags	0.42	5.4	2.80	10.80	1.5	19.2	15.4	3.8	0.30	.09	1.15
Ammon. Sulfate	12.8	bags	0.09	1.2	2.00	2.40	0.7	9.0	7.7	1.3	0.88	.09	1.15
1st Weeding	12.8						14.0	179.2	112.7	66.5	0.15	.76	9.73
2nd Weeding	12.8						2.2	28.2	17.9	10.3	1.37	1.88	24.06
Sub-Total						94.40	27.8	355.9	249.7	106.2	0.36	3.00	38.39
C. Harvest													
1. Mechanical													
Combine	2.5	bags		13.0	1.00	13.00							
Bagging	2.5	acres					0.2	0.5	0.0	0.5	2.50	0.50	1.25
Tractor Threshing[b/]	4.0	acres			4.09	16.36	4.5	18.0	12.8	5.2	0.25	0.29	1.31
Sub-Total						29.36		18.5	12.8	5.7			2.56
2. Hand													
Cutting	10.3	acres					44.1	454.2	195.7	258.5	0.14	3.59	36.98
Heaping	10.3	acres					24.1	248.2	144.2	104.0	0.12	1.24	12.77
Threshing	6.3	acres					27.9	175.8	151.9	23.9	0.17	0.68	3.97
Winnowing & Bagging	10.3	acres					22.5	231.8	172.0	59.8	0.09	0.52	5.36
Sub-Total							109.5[c/]	1110.0	663.8	446.2	0.13		59.08
3. Bags[g/]					0.50	33.30							
Sub-Total of Harvesting Expenditures						62.66	88.2[d/]	1128.5	676.6	451.9	0.14	4.82[e/]	61.64
D. Total Expenditures and Labor Utilization						360.27	116.0	1484.4	926.3	558.1	0.18	7.82	100.03

Income and Expenditure Summary

Summary of Income

a. Total Production
5.2 bags/acre x 12.8 acres = 66.6

b. Value of Production
66.6 bags x ¢12.00 = ¢ 799.20

c. Less Total Farm Expenditures 460.30

d. Farm Gate Income 338.90

e. Less Estimated Selling Costs[f/] 19.98

f. Net Return to Operating Capital, Family Labor and Management ¢ 318.92

Summary of Expenditures

a. Non Labor Expenditures

1. Land Clearing ¢ 12.80
2. Land Preparation 190.41
3. Seed & Fertilizer 94.40
4. Mechanical Harvesting 29.36
5. Bags 33.30 ¢ 360.27

b. Labor Expenditures

1. Pre-harvest Activity 38.39
2. Harvest Activity 61.64 ¢ 100.03

c. Total Farm Expenditures ¢ 460.30

[a/] The cost of land clearing is the average annual amortized cost. See Appendix F for the calculation of land clearing costs.

[b/] "Tractor Threshing" involves driving over paddy several times with a tractor.

[c/] The 109.5 total manhours per acre is the labor requirement for 10.3 acres cut by hand. A weighted average man hours per acre for one sub-activity, threshing, is included in this total. A weighted average is used because the "activity acres" for hand threshing is not equal to the 10.3 acres cut by hand. The weighted average manhours per acre of 10.3 acres of threshing is 18.8 manhours which is based upon 6.3 acres threshed by hand and 4.0 acres of tractor threshing.

[d/] Average total manhours per acre used for mechanical and hand harvesting activities on 12.8 acres.

[e/] Total expenditures per acre for labor used for hand and mechanical harvesting activities (¢61.64 divided by 12.8 acres).

[f/] Cost of transporting paddy from farm to market at ¢0.30 per bag.

[g/] Cost of one bag is ¢1.00 and assumed to last two crop seasons.

Costs and Returns

The mean farm expenditures for this production system were ¢460. Land preparation was the largest expenditure item, accounting for 41 percent of the total farm expenditures, followed by hired labor (22 percent), and seed and fertilizer (21 percent).

The mean yield for this system was 5.2 bags, or 936 lbs. per acre, the lowest of the six systems. Total production was 66.6 bags, or 5.35 metric tons. The gross income was ¢799, and the net return to operating capital, family labor, and management was ¢319.

System II: Farmers Hiring Tractor Services and Using Improved Seed

A financial budget representing the average physical resource utilization and corresponding expenditures for 44 sample farms using improved seed varieties is reported in Table 4.2. The average sample farm size for this system is 21.2 acres.

Pre-Harvest Activities

First harrowing was undertaken by these farmers on virtually their entire farms and about half the farms were harrowed a second time. For all practical purposes, no third harrowing was done. Seed was applied at the recommended rate for improved seed varieties, and the mean application rate of compound fertilizer was 1.27 bags per acre as opposed to the recommended rate of 2.0 cwt. bags for improved seed varieties. On the average, farmers applied ammonium sulfate as a top dressing at a quarter of the recommended rate.

Table 4.2. Rice Enterprise Budget for a 21.2 Acre Farm Based on Survey Data from Forty-Four Farms in Northern Ghana Using Improved Seed Varieties and Tractor Hire Services, 1973-74 (System II)

Activity		Operating Expenditures and Labor Utilization by Activity											
		Non Labor Expenditures					Labor Utilization and Expenditures						
							Manhours				Wage Rate	Expenditure	
Item	Acres	Units	Rate Per Acre	Total Units	Cost Per Unit	Total Cost	Per Activity Acre	Total	Family Labor	Hired Labor		Per Acre	Total
					¢	¢					¢	¢	¢
A. Land Clearing a/	21.2	acres	1.00			21.20	--						
B. Pre-harvest													
Plowing	21.2	acres			9.05	191.19							
1st Harrowing	20.9	acres			4.16	86.94							
2nd Harrowing	10.9	acres			4.12	44.91							
3rd Harrowing	0.7	acres			5.67	3.97							
Sub-Total						327.01							
Seed	21.2	bags	0.47	10.0	14.00	140.00	4.1	86.9	42.4	44.5	0.17	.35	7.40
Comp. Fert.	21.2	bags	1.27	26.9	2.80	75.32	2.6	55.1	29.7	25.4	0.28	.34	7.21
Ammon. Sulfate	21.2	bags	0.25	5.3	2.00	10.60	1.1	23.3	10.6	12.7	0.39	.66	4.90
1st Weeding	21.2						13.7	290.4	133.6	156.8	0.06	1.32	9.79
2nd Weeding	21.2						9.9	207.8	61.5	146.3	0.20	1.97	41.76
Sub-Total						225.92	31.5	603.5	277.8	385.7	0.10	3.35	71.08
C. Harvest													
1. Mechanical													
Combine	3.0	bags		18.6	1.00	18.60							
Bagging	3.0						1.1	3.3	1.3	2.0	2.00	1.33	3.99
CST b/	2.5	bags		12.7	0.80	10.16	1.5	2.5	0.2	2.3	1.13	1.04	2.60
Bagging	2.5						1.2	3.0	0.0	3.0	0.46	2.41	2.89
Tractor Threshing c/	4.4	acres			3.70	16.28	1.7	7.5	3.1	4.4	0.37	0.37	1.63
Sub-Total						47.04		16.3	4.6	11.7	0.75		11.11
2. Hand													
Cutting	18.2						29.1	529.6	220.3	309.3	0.14	2.45	44.59
Heaping	18.2						16.2	294.8	109.1	185.7	0.13	1.32	24.02
Threshing	11.3						34.9	394.4	176.3	218.1	0.10	1.39	21.56
Winnowing & Bagging	15.7						15.9	296.7	116.3	180.4	0.09	1.07	16.50
Sub-Total							83.8 d/	1515.5	622.0	893.5	0.12		106.77
3. Bags					0.50	65.70							
Sub Total of Harvesting Expenditures						112.74	72.3 e/	1531.8	626.6	905.2	0.13	f/	117.88
D. Total Expenditures and Labor Utilization						686.87	103.6	2135.3	904.4	1290.9	0.15	5.91	188.96

Income and Expenditure Summary

Summary of Income

a. Total Production 6.2 bags/acre x 21.2 acres = 131.4	
b. Value of Production 131.4 bags x ¢12.00 =	¢1576.80
c. Less Total Farm Expenditures	875.83
d. Farm Gate Income	700.97
e. Less Estimated Selling Costs g/	39.42
f. Net Return to Operating Capital, Family Labor and Management	661.55

Summary of Expenditures

a. Non Labor Expenditures		
1. Land Clearing	21.20	
2. Land Preparation	327.01	
3. Seed & Fertilizer	225.92	
4. Mechanical Harvesting	47.04	
5. Bags	65.70	¢686.87
b. Labor Expenditures		
1. Pre-harvest Activity	71.08	
2. Harvest Activity	117.88	¢188.96
c. Total Farm Expenditures		¢875.83

a/ The cost of land clearing is the average annual amortized cost. See Appendix F for the calculation of land clearing costs.

b/ CST represents a self-propelled combine used as a stationary thresher. The man-hours per acre to feed heaped paddy into the combine is 1.0 and bagging requires 1.2 man-hours per acre.

c/ See Table 4.1, footnote b.

d/ The 83.8 total man-hours per acre is the labor requirement for 18.2 acres cut by hand. A weighted average is used because the "activity acres" for threshing and winnowing and bagging are not equal to the 18.2 acres cut by hand. The weighted average man-hours per acre for 18.2 acres of threshing is 22.2 man-hours which is based upon 11.3 threshed by hand and 4.4 acres of tractor threshing. The weighted average man-hours per acre for winnowing and bagging is 16.3 man-hours. This is based upon 15.7 acres of paddy threshed by hand and the bagging requirements of 2.5 acres of paddy threshed by a combine used as a stationary thresher.

e/ Average total man-hours per acre for mechanical and hand harvesting activities for 21.2 acres.

f/ Total labor expenditure per acre for hand and mechanical harvesting activities (¢117.88 divided by 21.2 acres).

g/ Cost of transporting paddy from farm to market at ¢0.30 per bag.

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Harvest Activities

Of the mean farm size of 21.2 acres, 18.2 acres were cut by hand and 3.0 acres were harvested by a hired self-propelled combine. For the threshing sub-activity, 11.3 acres were threshed manually; "tractor threshing" was undertaken on 4.4 acres, and a combine as a stationary thresher was used for 3.0 acres.

Labor Utilization

The mean labor utilization per acre in all field activities was 103.6 man-hours, of which 70 percent were for harvesting activities and 30 percent for pre-harvest activities. Fifty-nine percent of the total farm man-hours were hired labor; 70 percent of the hired labor were employed in harvest activities, and 23 percent were hired for weeding activities.

Costs and Returns

The mean farm expenditures for this production system were ¢876. Land preparation was the largest expenditure item, accounting for 37 percent of total farm expenditures, followed by seed and fertilizer (26 percent), and hired labor (22 percent).

The mean farm yield for this sytem was 6.2 bags, or 1,116 pounds per acre. Total production was 131.4 bags, or 10.56 metric tons. The gross income to the system was ¢1,577, and the net return to operating capital, family labor, and management was ¢662.

System III: Farmers Hiring Tractor Services and Using Mixed Seed Varieties

The average farm size for the 11 farms in this subsample is 16.9 acres. The farmers within this subsample used a mixture of improved

and traditional seed varieties. A financial budget representing the average physical resource utilization and corresponding expenditures is reported in Table 4.3.

Pre-Harvest Activities

The farmers in this subsample undertook first harrowing on virtually their entire farms, and second harrowing was undertaken on 4.6 acres, or 27 percent of the farm acres. Little third harrowing was undertaken. The mean application rate of seed was 0.55 bags, or 88 lbs. per acre which is the highest seed rate among all production systems. On the average, 49 percent of the seed applied was improved seed. The mean application rate of compound fertilizer was 0.8 bags which is 20 percent below the recommended rate for traditional varieties and 40 percent below the rate recommended for improved varieties. Nitrogen was applied by farmers at the rate of 24 pounds per acre, or 66 percent below the recommended rate of 36.4 pounds per acre, after the recommended application rate of nitrogen for improved and traditional seed varieties and the farm seed mixture used were taken into account.

Harvest Activities

Among the five bottomland systems, the least amount of mechanical harvesting was undertaken among the farms in this subsample. Of the 16.9 acres,on the average, 16.4 were cut by hand. Hand threshing was done for 8.8 acres, "tractor threshing" for 5.4 acres, and a combine was used as a stationary thresher for 2.5 acres.

Table 4.3. Rice Enterprise Budget for a 16.9 Acre FArm Based on Survey Data from Eleven Farms in Northern Ghana, Using Improved and Traditional Seed Varieties and Tractor Hire Services, 1973-74 (System III)

Activity		Operating Expenditures and Labor Utilization by Activity											
Item	Acres	Non Labor Expenditures					Labor Utilization and Expenditures						
		Units	Rate Per Acre	Total Units	Cost Per Unit	Total Cost	Manhours				Wage Rate Per Hour	Expenditure	
							Per Activity Acre	Total	Family Labor	Hired Labor		Per Acre	Total
					¢	¢					¢	¢	¢
A. Land Clearing[a]	16.9	acres	1.00			16.90							
B. Pre-harvest								--					
Plowing	16.9	acres			11.46	193.67							
1st Harrowing	16.7	acres			5.82	97.19							
2nd Harrowing	4.6	acres			3.56	16.38							
3rd Harrowing	1.8	acres			6.18	11.12							
Sub-Total						318.36							
Seed	16.9	bags	0.55	9.3	14.00	130.20	4.9	82.8	44.0	38.8	0.16	0.37	6.25
Comp. Fert.	16.9	bags	0.80	13.5	2.80	37.80	1.6	27.0	25.3	1.7	0.10	0.01	0.17
Ammon. Sulfate	16.9	bags	0.47	7.9	2.00	15.80	1.5	25.4	25.4	--	--	--	--
1st Weeding							60.2	1017.4	501.6	515.8	0.08	2.35	39.72
2nd Weeding							2.1	35.5	11.8	23.7	0.09	0.13	2.20
Sub-Total						183.80	70.3	1188.1	608.1	580.0	0.08	2.86	48.34
C. Harvest													
1. Mechanical													
Combine	0.5	bags		4.2	1.00	4.20							
Bagging	0.5						4.3	2.2	1.2	1.0	1.17	2.34	1.17
CST b/	2.5	bags		20.8	0.80	16.64	0.8	2.0	--	2.0	0.28	0.22	0.55
Bagging	2.5						1.2	3.0	0.5	2.5	1.44	1.44	3.60
Tractor Threshing[c]	5.4	acres			3.04	16.42	4.6	24.8	6.5	18.3	0.08	0.28	1.51
Sub-Total						37.26		32.0	8.2	23.8	0.29		6.83
2. Hand													
Cutting	16.4						55.7	913.5	339.8	573.7	0.15	5.32	87.25
Heaping	16.4						25.8	423.1	300.0	123.1	0.14	1.07	17.55
Threshing	8.5						71.2	605.2	428.5	176.7	0.10	2.09	17.77
Winnowing & Bagging	13.9						39.5	549.1	339.3	209.8	0.12	1.76	24.46
Sub-Total							153.5[d]	2490.9	1407.6	1083.3	0.14		147.03
3. Bags					0.50	90.15							
Sub Total of Harvesting Expenditures						107.41	149.3[e]	2522.9	1415.8	1107.1	0.14	9.10[f]	153.86
D. Total Expenditures and Labor Utilization						626.47	219.6	3711.0	2023.9	1687.1	0.12	11.96	202.20

Income and Expenditure Summary

Summary of Income

a. Total Production 5.3 bags/acre x 16.9 acres - 140.3 bags	
b. Value of Production 140.3 bags x ¢12.00 =	¢1683.60
c. Less Total Farm Expenditures	828.67
d. Farm Gate Income	854.93
e. Less Estimated Selling Costs[g]	42.09
f. Net Return to Operating Capital, Family Labor and Management	¢ 812.84

Summary of Expenditures

a. Non Labor Expenditures		
1. Land Clearing	¢ 16.90	
2. Land Preparation	318.36	
3. Seed & Fertilizer	183.80	
4. Mechanical Harvesting	37.26	
5. Bags	90.15	¢626.47
b. Labor Expenditures		
1. Pre-harvest Activity	48.34	
2. Harvest Activity	153.86	¢202.20
c. Total Farm Expenditures		¢828.67

[a] The cost of land clearing is the average annual amortized cost. See Appendix F for the calculation of land clearing costs.

[b] See Table 4.2, footnote b.

[c] See Table 4.1, footnote b.

[d] The 153.5 total man-hours per acre is the labor requirement for 16.4 acres cut by hand. A weighted average man-hours per acre for two subactivities, (i) threshing and bagging, and (ii) winnowing and bagging, are included in this total. A weighted average is used because the "activity acres" by hand harvesting methods for these two subactivities are not equal to 16.4 acres cut and heaped by hand. The weighted average man-hours per acre for 16.4 acres of threshing is 38.5 man-hours which is based upon 8.5 acres of hand threshing, 5.4 acres of tractor threshing, and the labor requirements for feeding 2.5 acres of heaped paddy into a combine used as a stationary thresher. The weighted average man-hours per acre for winnowing and bagging 16.4 acres of threshold paddy is 33.5 manhours per acre. This is based upon winnowing and bagging 13.9 acres of paddy threshed by hand and the bagging requirements of 2.5 acres of paddy threshed by a combine used as a stationary thresher.

[e] Average total manhours per acre used for mechanical and hand harvesting activities on 16.9 acres.

[f] Total expenditures per acre for labor used for hand and mechanical harvesting activities (₵153.86 divided by 16.9 acres).

[g] Average transport costs from farm to market at ₵0.30 per bag.

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Labor Utilization

The mean labor utilization per acre was 220 man-hours, the highest of all bottomland systems. Sixty-eight percent of the total man-hours were used for harvest activities and 28 percent were used in weeding. Among the bottomland systems, this system used the greatest number of man-hours per acre in weeding activities (62 man-hours per acre). Forty-five percent of the man-hours were hired labor; 66 percent of the hired labor were used in harvesting activities and 32 percent were employed for weeding activities.

Costs and Returns

The mean farm expenditures were ₵829. Land preparation was the largest expenditure item (38 percent), followed by hired labor (24 percent), and seed and fertilizer (22 percent).

The mean farm yield was 8.3 bags, or 1,494 pounds per acre--the largest yield per acre of all systems. Total production was 140.3 bags, or 11.27 metric tons. The gross income to the system was ₵1,684, and the net return to operating capital, family labor, and management was ₵813.

System IV: Tractor Owners Using Traditional Seed

A financial budget representing the average physical resource utilization and corresponding expenditures for the 10 sample farms on which tractor owners used traditional seed varieties is reported in Table 4.4. The average sample farm size for this production system is 41.6 acres.

Table 4.4. Rice Enterprise Budget for a 41.6 Acre Farm Based on Survey Data From Ten Farms in Northern Ghana Using Traditional Seed Varieties and Own Tractor and Equipment, 1973-74 (System IV)

Activity		Operating Expenditures and Labor Utilization by Activity											
Item	Acres	Operating Expenditures b/					Labor Utilization and Expenditures						
		Units	Rate Per Acre	Total Units	Cost Per Unit	Total Cost	Manhours: Per Activity Acre	Manhours: Total	Manhours: Family Labor	Manhours: Hired Labor	Wage Rate Per Hour	Expenditure: Per Acre	Expenditure: Total
					¢	¢					¢	¢	¢
A. Land Clearing a/	41.6	acres	5.55			230.88	--						
B. Pre-harvest													
Plowing	41.6				8.10	336.96							
1st Harrowing	41.6				5.16	214.66							
2nd Harrowing	24.9				3.13	77.94							
3rd Harrowing	2.3				3.13	7.20							
Sub-Total						636.76 b/							
Seed	41.6	bags	0.52	21.6	14.00	302.40	5.5	228.8	87.4	141.4	0.13	.45	18.72
Comp. Fert.	41.6	bags	0.83	34.5	2.80	96.60	1.9	79.0	25.0	54.0	0.15	.19	7.90
Ammon. Sulfate	41.6	bags	0.23	9.6	2.00	19.20	0.8	33.3	20.8	12.5	0.93	.28	11.65
1st Weeding	41.6						11.0	457.6	187.2	270.4	0.14	.93	38.69
Sub-Total						418.20	19.2	798.7	320.4	478.3	0.16	1.85	76.96
C. Harvest													
1. Mechanical													
Combine	5.0	bags		32.5	1.00	32.50							
Bagging	5.0						1.0	5.0	5.0	--	--	--	--
CST c/	21.7	bags		141.1	0.80	112.88	5.9	128.0	6.5	121.5	0.28	1.55	33.64
Bagging	21.7						0.4	8.7	4.3	4.4	1.88	0.38	8.25
Tractor Threshing d/	12.7	acres			3.11	39.50	2.2	27.9	11.4	16.5	0.18	0.23	2.92
Sub-Total						184.88		169.6	27.2	142.4	0.31		44.81
2. Hand													
Cutting	36.5						42.6	1554.9	273.7	1281.2	0.14	4.93	179.95
Heaping	36.5						24.1	879.7	219.1	660.6	0.11	2.02	73.73
Threshing	2.2						23.3	51.3	11.4	39.9	0.16	2.95	6.49
Winnowing & Bagging	14.9						16.0	238.4	111.8	126.6	0.11	0.96	14.30
Sub-Total							79.2 e/	2724.3	616.0	2108.3	0.13		274.47
3. Bags					0.50	135.20							
Sub Total of Harvesting Expenditures						320.88	69.6 f/	2893.9	643.2	2250.7	0.14	7.68 g/	319.28
D. Total Expenditures and Labor Utilization						1605.92	88.8	3692.6	963.6	2729.0	0.15	9.53	396.24

Income and Expenditure Summary

Summary of Income

a.	Total Production 6.5 bags/acre x 41.6 acres - 270.4	
b.	Value of Production 270.4 bags x ¢12.00 =	¢ 3,244.80
c.	Less Total Farm Expenditures	2,002.16
d.	Farm Gate Income	1,242.64
e.	Less Estimated Selling Costs h/	81.12
f.	Net Return to Operating Capital, Family Labor and Management	¢ 1,161.52

Summary of Expenditures

a.	Non Labor Expenditures		
	1. Land Clearing	¢ 230.88	
	2. Land Preparation	636.76	
	3. Seed & Fertilizer	418.20	
	4. Mechanical Harvesting	184.88	
	5. Bags	135.20	¢ 1,605.92
b.	Labor Expenditures		
	1. Pre-harvest Activity	76.96	
	2. Harvest Activity	319.28	¢ 396.24
c.	Total Farm Expenditures		¢ 2,002.16

a/ The cost of land clearing is the average annual amortized cost. See Appendix F.

b/ Unit costs of mechanized land preparation are based upon computed owning and operating costs of a tractor and associated equipment in Northern Ghana. See Appendix C, Table 2.

c/ See Table 4.2, footnote b.

d/ See Table 4.1, footnote b.

e/ The 79.2 total manhours per acre is the labor requirement for 36.5 acres cut by hand. Weighted average manhours per acre for two sub-activities, (i) threshing and (ii) winnowing and bagging, are included in this total. The weighted average manhours per acre for 36.5 acres of threshing is 5.7 manhours which is based upon 2.2 acres of hand threshing, 12.7 acres of tractor threshing, and the labor requirements for feeding 21.7 acres of heaped paddy into a combine used as a stationary thresher. The weighted average manhours per acre for winnowing and bagging 36.5 acres of threshed paddy is 6.8 manhours. This is based upon winnowing and bagging 14.9 acres of paddy threshed by hand and the bagging requirements of 21.7 acres of paddy threshed by a combine used as a stationary thresher.

f/ Average total manhours per acre for mechanical and hand harvesting activities on 41.6 acres.

g/ Total expenditure per acre for labor used for hand and mechanical harvesting activities (¢ 319.28 divided by 41.6 acres).

h/ Average cost of transporting paddy from farm to market at ¢ 0.30 per bag.

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Pre-Harvest Activities

On the average, first harrowing was undertaken on the entire farm, and 60 percent was harrowed a second time. Traditional seed varieties were applied at the rate of 83 pounds per acre which is above the recommended rate of 60 to 70 pounds per acre for traditional varieties. Compound fertilizer was applied at 83 percent of the recommended rate of one cwt. bag per acre, and ammonium sulfate, which is not recommended for traditional varieties, was applied at the rate of 0.23 bags per acre. As a result, the mean application rate of nitrogen was 19.2 pounds per acre which is about 14 percent above the recommended rate for traditional seed varieties.

Harvesting Activities

Of the mean farm size of 41.6 acres, five acres, or 12 percent of the farm was harvested with a self-propelled combine and 36.5 acres, or 88 percent of the farm was cut by hand. Very little hand threshing was undertaken. About 60 percent of acres cut by hand were threshed with a combine used as a stationary thresher; "tractor threshing" was employed for 35 percent of the acres cut by hand, and the remainder was threshed manually.

Labor Utilization

The mean labor utilization per acre for this system was 88.8 man-hours, of which 78 percent were used for harvest activities and about half were for cutting. Seventy-four percent of the total labor were hired labor; 82 percent of the hired labor were employed in harvest activities and about 10 percent in weeding activities.

Costs and Returns

The mean farm expenditures for the system were ¢2,002. Land preparation accounted for 32 percent of the total expenditures, followed by seed and fertilizer (21 percent), hired labor (20 percent), land clearing (12 percent), and mechanical harvesting (nine percent).

The mean farm yield was 6.5 bags, or 1,170 pounds per acre. Total production was 41.6 bags, or 21.73 metric tons. Gross income to the system was ¢3,245, and the net return to operating capital, family labor, and management was ¢1,162.

System V: Tractor Owners Using Improved Seed

A financial budget representing the average physical resource utilization and corresponding expenditures for 19 sample farms on which tractor owners used improved seed varieties is reported in Table 4.5. The average sample farm size for this production system is 119.3 acres.

Pre-Harvest Activities

On the average, first harrowing was undertaken on the entire farm, and 82 percent of the farm was harrowed a second time. Twelve percent of the acres were harrowed a third time. Improved seed was applied at 0.53 bags, or 83 pounds per acre which is slightly above the recommended rate of 70 to 80 pounds per acre for improved varieties. Compound fertilizer was applied at 60 percent of the recommended rate for improved varieties, and the application rate of ammonium sulfate was about 40 percent below the recommended rate.

Table 4.5. Rice Enterprise Budget for a 119.3 Acre Farm Based on Survey Data from Nineteen Farms in Northern Ghana Using Improved Seed Varieties and Own Tractor and Equipment, 1973-74 (System V)

Activity		Operating Expenditures and Labor Utilization by Activity											
Item	Acres	Non Labor Expenditures					Labor Utilization and Expenditures						
		Units	Rate Per Acre	Total Units	Cost Per Unit	Total Cost	Manhours: Per Activity Acre	Manhours: Total	Manhours: Family Labor	Manhours: Hired Labor	Wage Rate Per Hour	Expenditure: Per Acre	Expenditure: Total
					¢	¢					¢	¢	¢
A. Land Clearing[a]	119.3	acres	5.55			662.12							
B. Pre-harvest													
Plowing	119.3				8.10	966.33							
1st Harrowing	119.3				5.16	615.59							
2nd Harrowing	97.8				3.13	306.11							
3rd Harrowing	8.0				3.13	25.04							
Sub-Total						1313.07[b]							
Seed	119.3	bags	0.52	62.0	14.00	868.00	3.8	453.3	155.0	298.3	0.16	.40	47.72
Comp. Fert.	119.3	bags	1.20	143.2	2.80	400.96	2.4	286.3	71.6	214.7	0.21	.38	45.33
Ammon. Sulfate	119.3		0.59	70.4	2.80	140.80	1.3	155.1	35.8	119.3	0.32	.32	38.18
1st Weeding	119.3						7.6	906.7	155.0	751.7	0.17	1.07	127.65
2nd Weeding	119.3						3.0	357.9	35.8	322.1	0.44	1.18	140.77
Sub-Total						1409.76	18.1	2159.3	453.2	1706.1	0.23	3.35	399.65
C. Harvest													
1. Mechanical													
Combine	92.0	bags		653.2	1.00	653.20							
Bagging	92.0						5.2	478.4	215.3	263.1	0.34	0.97	89.24
CST[c]	7.6	bags		54.0	0.80	43.20	2.1	16.0	1.5	14.5	0.39	0.74	5.62
Bagging	7.6						1.9	14.4	0.7	13.7	1.31	2.36	17.94
Tractor Threshing[d]	6.4	acres			3.95	25.28	2.1	13.4	1.9	11.5	1.00	1.79	11.46
Sub-Total						721.68		522.2	219.4	302.8	0.41		124.26
2. Hand													
Cutting	27.3						31.2	851.7	92.8	758.9	0.22	6.22	169.81
Heaping	27.3						15.9	434.1	101.1	333.0	0.25	3.10	84.63
Threshing	13.3						14.2	188.9	30.6	158.3	0.23	2.74	36.44
Winnowing & Bagging	19.7						18.1	356.6	236.4	120.2	0.29	1.78	35.07
Sub-Total							68.5[e]	1831.3	460.9	1370.4	0.24		325.95
3. Bags					0.50	423.50							
Sub Total of Harvesting Expenditures						1145.18	19.7[f]	2353.5	680.3	1673.2	0.27	3.77[g]	450.21
D. Total Expenditures and Labor Utilization						5130.13	37.8	4512.8	1133.5	3379.3	0.25	7.12	849.86

Income and Expenditure Summary

Summary of Income

a. Total Production
   7.1 bags/acre x 119.3 acres = 847.0 bags

b. Value of Production
   847.0 bags x ¢ 12.00 = ¢ 10,164.00

c. Less Total Farm Expenditures 5,979.99

d. Farm Gate Income 4,184.01

e. Less Estimated Selling Costs 254.10

f. Net Return to Operating Capital, Family Labor and Management ¢ 3,929.91

Summary of Expenditures

a. Non Labor Expenditures
   1. Land Clearing ¢ 662.12
   2. Land Preparation 1,313.07
   3. Seed & Fertilizer 1,409.76
   4. Mechanical Harvesting 721.68
   5. Bags 423.50 — ¢ 5,130.13

b. Labor Expenditures
   1. Pre-harvest Activity 399.65
   2. Harvest Activity 450.21 — ¢ 849.86

c. Total Farm Expenditures ¢ 5,979.99

[a] The cost of land clearing is the average annual amortized cost. See Appendix F for the calculation of land clearing costs.

[b] The unit costs of mechanized land preparation is based upon computed owning and operating costs of a tractor and associated equipment in Northern Ghana. See Appendix C, Table 2.

[c] See Table 4.2, footnote b.

[d] See Table 4.1, footnote b.

[e] The 68.5 total manhours per acre is the labor requirement for 27.3 acres cut by hand. A weighted average manhours per acre for two sub-activities, (i) threshing and (ii) winnowing and bagging, are included in this total. A weighted average is used because the "activity acres" by hand harvesting methods for these two sub-activities are not equal to the 27.3 acres cut and heaped by hand. The weighted average manhours per acre for 27.3 acres of threshing is 8.0 manhours which is based upon 13.3 acres of hand threshing, 6.4 acres of tractor threshing and the labor requirements for feeding 7.6 acres of heaped paddy into a combine used as a stationary thresher. The weighted average manhours per acre for winnowing and bagging 27.3 acres of threshed paddy is 13.4 manhours. This is based upon winnowing and bagging, 19.7 acres of paddy threshed by hand and the bagging requirements of 7.6 acres of paddy threshed by a combine used as a stationary thresher.

[f] Average total manhours per acre and mechanical and hand harvesting activities on 119.3 acres.

[g] Total expenditure per acre for labor for hand and mechanical harvesting activities (¢ 450.21 divided by 119.3 acres).

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Harvest Activities

This system was characterized by more mechanized harvesting than all the other systems studied. Of the mean farm size of 119.6 acres, 92 acres were harvested with a self-propelled combine. Of the 27.3 acres cut by hand, 13.3 acres were threshed manually, a combine as a stationary thresher was used for 7.6 acres, and "tractor threshing" was employed for 6.4 acres.

Labor Utilization

The mean labor utilization per acre for this system was 37.8 man-hours which is the lowest labor utilization per acre among all of the production systems. Fifty-two percent of the total man-hours were used in harvesting activities and 28 percent for weeding. Seventy-five percent of the labor were hired labor; 50 percent of the hired labor were used in harvest activities, 40 percent for broadcasting seed and fertilizer, and 10 percent for weeding activities.

Costs and Returns

The mean farm expenditures among tractor owners using improved seed were ¢5,980. The largest proportion of total farm expenditures was land preparation which accounted for 32 percent of the total. This expenditure item was followed by seed and fertilizer (24 percent), hired labor (14 percent), and mechanical harvesting (12 percent).

The mean farm yield for the system was 7.1 bags, or 1,278 pounds per acre which is the second highest yield among the bottomland systems. Total production was 847 bags, or 68.1 metric tons. Gross income was ¢10,164, and the net return to operating capital, family labor, and management was ¢3,930.

System VI: Upland Rice Farmers Using a Bullock Plow and Traditional Seed Varieties

The vast majority of farmers in the Northern and Upper Regions produce crops on small, upland holdings of four to five acres. Among these farmers, rice is typically cultivated in pure stand on one-quarter to one acre of land. Most farmers producing upland rice are using traditional seed varieties and the handhoe to prepare the soil. However, in the Wa, Navrongo, and Bawku Districts of the Upper Region and in the Yendi District of the Northern Region many farmers are utilizing bullocks to prepare their crop land. The purpose of this section is to compare the costs and returns of bullock farmers producing rice on uplands with the five bottomland production systems.

The average size holding of 14 sample bullock farmers was 7.7 acres, of which 1.1 acres, or 14 percent of the holding was a rice enterprise. These farmers had bullock teams consisting of two West African shorthorns. Also, among these farmers, the common implement was a small tool frame upon which a plow or a ridger is attached. The plow attachment is then used to prepare rice lands and the ridger attachment for other crops (e.g., sorghum, millet, and groundnuts). In the analysis which follows only the rice enterprise is investigated. A rice enterprise budget based upon 14 sample farmers in the Bawku and Yendi Districts using traditional seed and bullocks as a source of draft power for land preparation is reported in Table 4.6.

Pre-Harvest Activities

The 14 bullock farmers in this subsample plowed their rice farms with a bullock team, and of the mean farm size of 1.1 acres, 0.4 acres were hand-harrowed. A distinguishing features of this system is the

Table 4.6. **Rice Enterprise Budget for a 1.1 Acre Rice Farm Based Upon Survey Data from Fourteen Farmers in Northern Ghana Using Traditional Seed Varieties and Bullock Power for Land Preparation (System VI)**

Activity		Operating Expenditures and Labor Utilization by Activity											
Item	Acres	Non Labor Expenditures					Labor Utilization and Expenditures						
		Units	Rate Per Acre	Total Units	Cost Per Unit	Total Cost	Manhours				Wage Rate Per Hour	Expenditure	
							Per Activity Acre	Total	Family Labor	Hired Labor		Per Acre	Total
					¢	¢					¢	¢	¢
A. Land Clearing a/	1.1	acres	1.00			1.10							
B. Pre-Harvest													
Plowing	1.1	Acres		1.1	4.60	5.06	30.7	33.8	33.8	—		—	
Hand Harrowing	0.4						26.6	10.6	9.5	1.1	0.08	0.23	0.09
Sub-total						5.06	57.3	44.4	43.3	1.1		0.23	0.09
Seed	1.1	Bags	0.57	0.63	14.00	8.82	5.6	6.2	6.2	—			
Comp. Fertilizer	1.1	Bags	0.83	0.91	2.80	2.55	2.2	2.4	2.4	—		—	
1st Weeding	1.1						98.1	107.9	56.1	51.8	0.11	5.15	5.67
2nd Weeding	1.1						43.8	48.2	36.9	11.3	0.27	2.80	3.08
3rd Weeding	1.1						26.6	29.3	17.5	11.8	0.30	3.22	3.54
Sub-total						11.37	176.3	194.0	119.1	74.9	0.16	11.17	12.29
C. Harvest Labor													
Cutting	1.1						140.8	154.9	76.3	78.6	0.08	6.04	6.64
Heaping	1.1						56.8	62.5	52.6	9.9	0.18	1.59	1.75
Threshing	1.1						211.0	232.1	227.0	5.1	0.14	0.66	0.73
Winnowing and Bagging	1.1						48.5	53.4	48.8	4.6	0.12	0.52	0.57
Sub-total							457.1	502.9	404.7	98.2	0.10	8.81	9.69
D. Bags b/					0.50	3.75							
D. Total Costs and Labor Utilization						21.28	690.7	741.3	567.1	174.2	0.13	20.21	22.07

Income and Expenditure Summary

Summary of Income

a. Total Production
   7.5 bags/acre x 1.1 acres = 8.3 bags
b. Value of Production
   8.3 bags x ¢14.50 = ¢ 120.35
c. Less Total Farm Expenditures 44.16
d. Farm Gate Income 76.19
e. Less Estimated Selling Costs c/ 2.49
f. Net Return to Operating Capital, Family Labor and Management ¢ 73.70

Summary of Expenditures

a. Non Labor Expenditures
   1. Land Clearing ¢ 1.10
   2. Land Preparation 5.87
   3. Seed and Fertilizer 11.37
   4. Bags 3.75 ¢22.09
b. Labor Expenditures
   1. Pre-harvest Activity ¢ 12.38
   2. Harvest Activity 9.69 ¢22.07
c. Total Farm Expenditures ¢44.16

a/ The cost of land clearing is the average annual amortized cost. See Appendix F.
b/ Cost of one bag is ¢1.00 and assumed to last two crop seasons.
c/ Cost of transporting paddy to market at ¢0.30 per bag.

high application rate of seed in that the mean application rate of the seed was 0.57 bags, or 91 pounds per acre which is about 20 pounds above the recommended application rate for traditional seed varieties. Compound fertilizer was applied at the rate of 9.83 bags per acre which is 17 percent below the recommended rate for traditional varieties.

Labor Utilization

The total labor utilization per acre in all field activities was 633 man-hours, the largest labor utilization of all systems studied. About 28 percent of the total man-hours were used for pre-harvest activities, including five percent for land preparation and 72 percent for harvest activities. About 70 percent of the total labor was used for three activities: threshing (33 percent), cutting (22 percent), and first weeding (15 percent). Unlike the other production systems, three separate weeding activities were undertaken here. The total labor-use involved in the three weedings was 169 man-hours per acre (27 percent of the total labor-use) which is more labor utilization for weeding than any other production system studied.

An explanation is required for the higher labor utilization by the upland system as compared with the bottomland systems. An upland rice production system requires more weeding than a bottomland system because the uplands have been continuously cropped over a longer period of time. As a result, soil fertility is lower which is more conducive to weed growth than a newer field, or newly cleared field.[10]

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[10] In fact, some bottomland rice producers have abandoned their farms after three to five years because of weed infestation. It is known that soil fertility on these farms at the time of abandonment is low principally because many farmers did not apply fertilizer until the second year when it was observed that fertility was declining.

In addition, given the small size of the holding, farmers may believe that they can better cope with weeds than the large-scale farmers who do not have much hope of hand-weeding their entire farm well.

Upland farms require more man-hours in cutting for two reasons. First, traditional varieties are tall-stalked and susceptible to lodging if fertilizer is applied above the recommended rate. Second, many upland farmers do not use the sickle for cutting the entire stalk. Rather, many either cut bunches of paddy with a long knife or cut only the pinnacles which contain the grain and not the entire stalk. Farmers who use this method argue that it requires more time than using a sickle, but higher recovery is achieved because less shattering occurs. Farmers utilizing traditional seed varieties are also likely to require more labor for threshing than farmers with improved varieties because traditional varieties are more difficult to thresh than improved varieties as the grain is not easily released by threshing. In addition, bullock farmers have labor requirements associated with team driving and hand-harrowing which farmers using tractor services do not. Finally, this author has observed that small holders utilize labor less productively than the more capital intensive bottomland producers.

Hired labor accounted for 25 percent of the total labor utilization; about 73 percent of the hired labor were employed for cutting (44 percent) and first weeding (29 percent).

Costs and Returns

The mean farm expenditures for the upland system were ₵44, of which hired labor was the largest expenditure item (50 percent), followed by seed and fertilizer (26 percent), and land preparation (13 percent). The mean farm yield of this system was 7.5 bags, or

1,350 pounds per acre which is the second highest yield per acre among the six production systems studied. The mean output of the system was 8.3 bags, and the gross income was ₵120. The net return to operating capital, family labor, and management was ₵74.

Comparative Financial Analysis of Six Rice Production Systems

The purpose of this section is to compare the financial returns to the production systems. Five measures of economic efficiency have been computed for each system, and the results are analyzed to identify production strategies with the highest financial returns and lowest cost of production.

Net Cash Income[11]

Among the five bottomland systems the variation in net cash income was from ₵319 to ₵3,930, or, on a per acre basis, from ₵25 for System I to ₵48 for System III. Net Cash Income for the 1.1 acre bullock system was ₵73.70; on a per acre basis, System VI had the highest cash income (Table 4.7).

Return to Family Labor

In order to compute the return to family labor, an opportunity cost must be assigned to operating capital expenditures. Working capital is defined as that portion of capital investment (stock) which

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[11]The operating expenditures for land preparation for the tractor owners (Systems IV and V) and the bullock farmers (System VI) include as a cost a proportion of the stock of physical assets (tractor and associated equipment; bullock team and plow) consumed in an average year. Namely, capital stocks have to be converted to a flow of services in which the average depreciation of the capital stock is included as a fixed cost per acre.

Table 4.7. A Comparative Financial Analysis of Six Major Rice Production Systems in Northern Ghana

Item	Production Systems					
	System I	System II	System III	System IV	System V	System VI
A. General Characteristics						
Number of Farms	28	44	11	10	19	14
Agronomic System	Bottomland	Bottomland	Bottomland	Bottomland	Bottomland	Upland
Power Source	THS	THS	THS	TO	TO	BO
Seed Variety	Traditional	Improved	Mixed	Traditional	Improved	Traditional
Average Farm Size (Acres)	12.8	21.2	16.9	41.6	119.3	1.1
Total Production (180 lb. bags)	66.6	131.4	140.3	270.4	847.0	8.3
Average Yield Per Acre (180 lb. bags)	5.2	6.2	8.3	6.5	7.1	7.5
B. Summary Financial Information						
1. Gross Income[1]	¢799	¢1577	¢1684	¢3245	¢10164	¢120.35
2. Operating Expenditures[2]	480	915	871	2083	6234	46.65
3. Opportunity Costs						
a) Family labor[3]	167	136	243	146	283	68.09
b) Operating capital	67[4]	128[4]	122[4]	194[5]	583[5]	5.58[6]
4. Total Costs[7]	714	1179	1236	2423	7100	120.32
C. Measures of Efficiency						
1. Net Cash Income[8]						
a) Farm	319	662	813	1162	3930	73.70
b) Per acre	25	31	48	28	33	67.00
2. Return to Family Labor[9]						
a) Total	252	534	691	968	3347	68.12
b) Per man-hour	0.27	0.59	0.34	1.01	2.95	0.13
c) Per man-day	1.62	3.54	2.04	6.06	17.70	0.78
3. Return to Operating Capital						
a) Total[10]	155	532	575	1079	3828	6.77
b) Percent of costs[11]	32.5	58.5	66.4	53.4	63.2	14.9
4. Return to Management[12]						
a) Total	85	398	448	822	3064	0.03
b) Per acre	6.60	18.70	26.50	19.60	25.70	--
5. Opportunity Cost of Production[13]						
a) Per 180 lb. bag	10.70	9.00	8.80	9.00	8.40	14.50
b) Per metric ton	133	112	110	112	104	179

[1] Output for the five bottomland systems is valued at ₡12.00 per bag. For the upland system output is valued at ₡14.50 per bag.

[2] Total farm expenditures plus estimated selling costs as reported in the rice enterprise budgets.

[3] Where family labor is valued at the average wage rate for hired labor as reported for each enterprise budget.

[4] For the three THS systems, the opportunity cost of operating capital is calculated at the rate of 15 percent of total farm expenditures excluding land clearing costs as the latter include opportunity costs.

[5] Fifteen percent of total farm expenditures, excluding land clearing and land preparation costs, plus 15 percent of that portion of land preparation costs which are operating expenses (25 percent). Operating expenses were not charged an opportunity cost in deriving the per acre estimates for land preparation costs for tractor owners (See Appendix C, Table 2).

[6] For the upland bullock system, the opportunity cost of operating capital is calculated at the rate of 15 percent of total farm expenditures excluding land clearing and plowing costs, as the latter two already include opportunity costs.

[7] The sum of operating expenditures plus the sum of the opportunity costs of family labor and operating capital.

[8] Gross Income (B-1) less Operating Expenditures (B-2).

[9] Gross Income less the sum of 1) Operating Expenditures (B-2) and 2) the opportunity cost of operating capital (B-3-b).

[10] The reader will recall that certain capital stocks were converted to flows and these costs were, in turn, used in the preparation of the rice enterprise budgets. In order to do this, assumptions about the source of financing were made. The undepreciated value of owners equity was charged an opportunity cost of 15 percent. The portion of fixed assets financed by bank credit was charged an interest rate of six percent, the subsidized bank lending rate. The opportunity cost of owners equity in fixed assets is part of his normal return to capital and as a result, it must be deducted from operating expenditures before computing the total return to operating capital (assumed to be 100 percent equity). For all six production systems, 100 percent of land clearing costs are assumed to be financed out of owner's equity. For the bullock system, one-half of the average undepreciated value of fixed assets used in plowing and harrowing is assumed to be owner equity. All fixed capital items underlying plowing and harrowing activities of the tractor owners are assumed to be financed entirely from bank credit. The total amount of opportunity cost or return to equity included in the operating expenditures summarized in B-2 is as follows:
System I ₡3.49; System II ₡5.79; System III ₡4.61; System IV ₡63.93; System V ₡180.76; System VI ₡1.16.
The return to operating capital, therefore, is Gross Income (B-1) less the sum of 1) Operating Expenditures (B-2) and 2) the opportunity cost of family labor (B-3-a), plus the adjustments itemized above.

[11] Calculated as total return to operating capital divided by operating expenditures revised according to footnote #10.

[12] Gross Income less Total Costs (B-4) where total costs are operating expenditures plus the opportunity costs of family labor and operating capital.

[13] Total Cost (B-4) divided by total physical output.

is required to finance operating expenditures (flows) over an accounting period. Normally, operating expenditures are treated as inputs having no opportunity costs in the accounting period. However, since the rice enterprise budgets cover one accounting period (an average year) and since most operating inputs or operating capital items are tied up for a period of six to ten months in practice and a full year in effect, they effectively become operating capital expenditures. Hence, the budget expenditures for nonlabor items and hired labor are treated as capital expenditures which have an opportunity cost. In our analysis the private opportunity costs of operating capital expenditures are assumed to equal 15 percent, which is the social opportunity cost of capital as estimated by the Ministry of Finance and Economic Planning.[12]

The return to family labor for the five bottomland systems ranged from ₵252 to ₵3,347. For all bottomland systems the return per man-hour of family labor was significantly greater than the average wage rate paid to hired labor; for the upland bullock system, however, the return to family labor per man-hour was equal to the wage rate.

The relative importance of labor (and family labor) is largely explained by the importance of manual harvesting and the hours of weeding undertaken.[13] For the systems where family labor is a relatively small

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[12] The social opportunity cost of capital in Ghana is estimated to be 15 percent. See Romer, Michael and Stern, Joseph J. "Project Appraisal: Notes and Case Studies." Unpublished paper. Accra, Ghana: Ghana Institute of Management and Public Administration. May, 1972.

[13] For the two most labor-intensive bottomland systems (Systems I and III), the opportunity cost of family labor accounts for, on the average, 21 percent of total costs; family labor accounts for 12 percent

component of total cost, the returns to family labor are, of course, high, given the financial profitability of the systems. A return to family labor as such is not as meaningful as the return to management. However, the returns to family labor per man-day indicate that family labor can earn more per day when employed on the family rice farm than it can when employed elsewhere. Family labor in all systems, except System VI, earned more than the minimum wage rate for unskilled labor employed in the public sector.[14] Thus, there is little financial advantage in family members seeking wage employment on other rice farms or in urban areas, except for the days or weeks when family labor is not required on the family farm.[15]

Return to Operating Capital

In computing a return to operating capital a value must be assigned to family labor. In the analysis which follows it is assumed that the opportunity costs of family laobr are equal to the local agricultural wage rate.[16] The return to operating capital among the five bottomland

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of the total cost of System II and, on the average, five percent of total is family labor for Systems IV and V; for the upland bullock system, 57 percent of the total cost is the opportunity cost of family labor (Table 4.7).

[14]In 1974 the minimum wage rate for unskilled laborers employed in the public sector was ¢1.00 per day.

[15]Exceptions would include family members who do not share in the distribution of the return to family labor and when immediate cash is desired, as the return to family labor is not realized until the sale of the harvest.

[16]For each production system, the wage used in the computation is the overall system mean wage rate for all field activities as reported in the enterprise budgets. The variation in mean wage rates among production systems is from ¢0.12 (System III) to ¢0.25 (System V) per man-hour. This variation is due to (a) a variation in nominal wage rates and payments in kind (food), and (b) the composition of labor in terms of men, women, and children, each of which has different coefficients for the conversion from field-hours to man-hours.

production systems ranged from 32.5 to 63.2 percent of total operating expenditures; for the upland system the return was 14.9 percent. Except for the latter system, the percentage return to operating capital for all production systems was significantly greater than the estimated private opportunity cost of capital, which is estimated to be 15 percent.

For the upland bullock system the return to operating capital was essentially equal to the estimated private opportunity cost of capital. The case of the upland bullock farmers appears to be the system closest to a state of equilibrium. There has been virtually no expansion of rice acreage among the sample bullock farmers over the past two years. That the return per man-hour of family labor equals the wage rate, and that the rate of return to capital is equal to the estimated opportunity cost of capital are both indicative of the fact that capital and labor resources have been correctly valued. The assumptions that (1) the opportunity cost of family equals the average wage rate for hired labor[17] and (2) the opportunity cost of capital resources is equal to the social opportunity cost of capital, in combination, exhaust the total value of the product. Consequently, there was a zero return to management as would be anticipated from an equilibrium condition.

System VI provided us with the only objective basis upon which to estimate the private opportunity cost of capital resources. As a consequence, our estimated opportunity cost of private capital appears reasonable.

[17] It is assumed that the average wage for hired labor is equal to the average value of marginal product of hired labor.

Return to Management

After opportunity costs were assigned to both family labor and operating capital, all bottomland production systems had a high return to management. For the upland bullock system, however, there was zero return to management (Table 4.7).

Cost of Production

Among the five bottomland systems, there was a 28 percent variation in the financial cost of production. The 119.6 acre tractor owner system using improved seed had the lowest cost of production (¢104 per ton), while the 12.8 acre tractor-hire, traditional seed system had the highest cost of production (¢133 per ton). There was little difference in the financial cost of production among the other three bottomland systems where the average cost was ¢111 per ton.

Finally, the upland bullock system had the highest cost of production of all systems (¢179 per ton). The high cost of this system was due to the large quantity of labor inputs.[18] Even if the opportunity cost of family labor for the upland system was half the bullock system mean wage rate, then the estimated cost of production would be ¢10.40 per bag, or about equal to the highest cost bottomland production system (System I).

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[18]The mean wage rate paid for hired labor by bullock farmers is ¢0.13 per man-hour which is the second lowest of the six systems (the mean wage rate for System I is ¢0.12 per man-hour). The opportunity cost of family labor for the bullock system is 57 percent of total costs. For System I to V the proportion that opportunity cost of family labor is of total cost is, respectively, 23, 12, 20, 6, and 4 percent.

Summary of Financial Analysis

The returns to management among the six production systems give the planner a good indication of the shifts farmers are likely to make if present subsidy policies are continued. Specifically, the following shifts can be expected to occur:

1) Widespread adoption of combine harvesting by farmers with access to combine services;

2) A shift toward very large farms (100 acres or more) by producers with the required equity and access to combine harvesting services;

3) Increased use of fertilizer;

4) Increased adoption of improved seed or a combination of improved and traditional seed varieties among small to medium sized rice farmers.

An Economic Analysis of the Six Rice Production Systems

The purpose of this section is (1) to determine the economic costs of the resources used by rice farmers in Northern Ghana, (2) to determine the economic costs and benefits for each of the six production systems, and (3) to compare the production systems in order to identify rice production strategies with high economic returns to the Ghanaian economy.

Theoretical Framework

In an economy with no factor price distortions, prevailing market prices for factors and the real economic costs of the factors are equal. However, in Ghana factor price distortions exist because of various subsidies, tariffs, duties, taxes, and an over-valued exchange rate. In an economic analysis factors of production are valued at costs which reflect real scarcity values.

In Ghana the factor price distortions facing rice producers are budget subsidies on selected inputs (e.g., fertilizer) and an overvalued exchange rate (an implicit subsidy).[19] These factor-price distortions or subsidies increase the demand for artificially cheap capital resources over and above what the demand would be if factors were priced at their higher economic costs. The overall effect is that northern rice producers are encouraged to adopt production techniques which are more capital intensive than they would be if factors were priced at their real economic costs.

Calculation of Unsubsidized Factor Prices and the Percent of Subsidy for Each Factor

Farmers in Ghana pay subsidized prices for all capital inputs used in production. Rice farmers who have adopted capital using technologies (e.g., mechanical plowing, combine harvesting, and fertilizer) are paying artificially low prices for these purchased inputs (Table 4.8).

Fertilizer is illustrative of the implicit and explicit subsidies embodied in rice production. The explicit subsidy on fertilizer is a budgetary subsidy administered by the Ministry of Agriculture. The financial cost to the Ministry of importing and transporting compound fertilizer to the Central Fertilizer Depot in Tamale was in 1973, ¢234 per ton, or ¢11.70 per cwt. bag. The Ministry of Agriculture, however, sold compound fertilizer to farmers at a fixed price of ¢56.00 per ton,

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[19]The official exchange rate is GH¢1.15 = US$1.00 and the shadow rate of exchange is GH¢1.55 = US$1.00.

Table 4.8. Subsidized and Unsubsidized Prices and Percent of Subsidy for Selected Inputs Used in Rice Production in Northern Ghana, 1973-74

Capital Input	Unit	Subsidized Prices Paid by Farmers[1]	Unsubsidized Price[2]	Percent of Subsidy
1. Fertilizer				
a. 15-15-15	112 lbs.	2.80	15.63	82
b. 20-0-0	112 lbs.	2.00	9.89	80
2. Improved Seed	160 lbs.	12.00	20.60	42
3. Land Preparation				
a. Tractor Owners[3]				
1) Plowing	acre	8.10	10.76	25
2) 1st Harrowing	acre	5.16	6.77	24
3) 2nd Harrowing	acre	3.13	4.08	24
b. Contract Charges[4]				
1) Plowing	acre	9.36		
2) 1st Harrowing	acre	4.48		
3) 2nd Harrowing	acre	4.07		
4. Mechanized Harvesting				
a. Combine	180 lbs.	1.00	4.20	76
b. Combine as Stationary Thresher	180 lbs.	0.80	2.55	69
c. Tractor Threshing	acre	3.78	4.84	22

[1]Actual prices paid by farmers during the 1973-74 production season.

[2]Computed. See the appendices for calculations of the economic costs of each factor.

[3]Based upon computed owning and operating cost for Northern Region tractor owners. See Appendix C.

[4]The actual financial cost-price of contract charges is the computed average charge per measured acre for 83 sample farms hiring tractor services. We did not have the required data to estimate the unsubsidized cost of private contract plowing. As a consequence, the estimated unsubsidized cost of land preparation for tractor owners is used in the economic analysis.

or ₵2.80 per bag. Thus, the Government was directly subsidizing fertilizer at a rate of 76 percent during the 1973-74 production season.

There is also an implicit subsidy on fertilizer due to the over-valued official exchange rate. When the implicit subsidy is removed, the cost of one ton of compound fertilizer is ₵313 per ton, or ₵12.80 per bag. When the over-valued official exchange rate is taken into account, the total subsidy for compound fertilizer is 82 percent.[20]

The factor price distortions arising from an overvalued exchange rate and budget subsidies were taken into account when computing the unsubsidized costs of factors of production.[21] The unsubsidized cost-prices and rates of subsidy of all factors used by northern rice farmers during the 1973-74 production season are reported in Table 4.8.

Method of Calculating the Economic Cost of Rice Production

In the subsequent analysis economic costs rather than market prices are used to value resources engaged in rice production. The economic benefits to be assessed are the alternative net benefits realized by each of the six rice production systems.[22]

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[20] In 1973 about 90 percent of the fertilizer sold in the north was imported by the Ghanaian-German Agricultural Development Programme (GADP). The c.i.f. price is a grant by German aid. The GADP pays for the internal distribution of the fertilizer imported under the program. As a consequence, the actual budget subsidy applies only to the quantities imported by the Ghana Government. However, if the Government imported all of the fertilizer used in the north, compound fertilizer would be subsidized at the rate of 76 percent at the official rate of exchange, or 82 percent at the shadow rate of exchange.

[21] See Appendix C for the computation of the unsubsidized factor cost of mechanized land preparation, improved seed, fertilizer, and the Ministry of Agriculture's combine harvesting service.

[22] However, if a production system realizes an economic loss (e.g., System I), one can state that the returns to the factors employed in the

For the subsequent economic analysis the rice enterprise budgets are based on the physical resources used by each production system. However, the prices or values used in the economic analysis were derived in the following manner:

Nonlabor Costs. Nonlabor items are valued by the unsubsidized prices reported in Table 4.8, except for the land preparation charges of the three THS production systems. For the three THS systems the unsubsidized cost of land preparation for a tractor owner is used.[23]

Hired Labor Costs. The financial cost incurred for hired labor is used in the economic analysis of each production system. The wages paid to casual labor working on northern rice farms are free market wages, and it is assumed that the MVP of hired labor in rice production is equal to its wage rate.[24] A lower shadow wage rate is not justified because there is not a regional surplus of labor available to work on rice farms during the harvest period.

Opportunity Costs of Capital. The opportunity costs of capital resources engaged in rice production are determined on the basis of the economic opportunity costs of capital in Ghana. The Ministry of Economic Finance and Planning has estimated that the economic opportunity costs of capital in Ghana are 15 percent. This means that capital resources directed toward investment opportunities with the greatest

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production system not only do not cover total economic costs, but also, if diverted to some alternative employment, may earn higher net returns.

[23]Private contract charges contain a profit component, which is a return to a resource used in rice production and therefore is not a cost to be included in the economic costs. Since the profit component in private contract charges is not known, the estimated land preparation costs per acre for tractor owners are used.

[24]There are no minimum wages for casual labor working on private farms. A minimum wage does apply for publicly owned farms.

economic use or benefit would earn at least a 15 percent economic rate of return over the life of the investment. We assume in the analysis that the opportunity costs of capital resources in rice production are at the rate of 15 percent of the unsubsidized factor costs. All capital stocks have been converted to flows and expressed in terms of annual operating capital expenditures,[25] all of which have been assigned a 15 percent opportunity cost.

Opportunity Costs of Family Labor. The economic opportunity cost of family labor is assumed to equal the average wage rate paid to hired labor working on rice farms.

Total Economic Cost of Production. For each system the total economic costs are estimated by adding (a) nonlabor costs, (b) the cost of hired labor, and (c) the opportunity costs of operating capital and family labor. The economic cost of production for each system is reported both as a cost per metric ton and per 180 pound bag (Table 4.8).

A Comparative Analysis of the Economic Benefits and Economic Costs of Production of Six Rice Production Systems

Given the rates of subsidy on capital resources reported in Table 4.8, the economic costs of production were substantially higher than the financial costs when economic prices were used to value the factors of production.

From a national point of view, five of the six production systems generated economic losses (Table 4.9). In fact, the 16.9 acre tractor-hire, mixed seed system (System III) was the only system which generated

[25]See Appendix C, Table 3 for the calculation of the land preparation costs per acre for a tractor owner.

Table 4.9. A Comparative Economic Analysis of Six Rice Production Systems in Northern Ghana

Item	Production Systems					
	System I THS Traditional Seed (12.8 Acres)	System II THS Improved Seed (21.2 Acres)	System III THS Mixed Seed (16.9 Acres)	System IV TO Traditional Seed (41.6 Acres)	System V TO Improved Seed (119.3 Acres)	System VI BO Traditional Seed (1.1 Acres)
A. Gross Economic Benefit[1]	₵799	₵1,577	₵1,684	₵3,245	₵10,164	₵120.35
B. Resource Costs						
1. Nonlabor[2]						
a. Land Clearing	13	21	17	283	811	1.10
b. Land Preparation	241	417	332	840	2,533	10.25
c. Seed and Fertilizer	196*	679*	481*	969*	4,212*	24.00*
d. Mechanical Harvesting	74	138	97	558	2,912	----
e. Bags	43*	84*	90*	123*	542*	5.30*
f. Sub Total	557	1,339	1,017	2,773	11,010	40.65
2. Hired Labor[3]						
a. Pre-Harvest Activities	38	71	48	76	400	12.40
b. Harvest Activities	62	118	154	319	450	9.70
c. Sub Total	100*	189*	202*	395*	850*	22.10*
3. Opportunity Costs						
a. Operating Capital[4]	61	161	131	270	1,019	7.70
b. Family Labor[5]	167	136	243	146	283	68.10
c. Sub Total	228	297	374	416	1,302	75.80
4. Total Economic Costs[6]	₵985	₵1,825	₵1,593	₵3,584	₵13,162	₵138.60
5. Economic Profit or Loss[7]	₵-86	₵- 248	₵ 91	₵- 339	₵-2,998	₵-18.25
6. Economic Cost of Production						
Per Metric Ton	₵165	₵ 173	₵ 141	₵ 165	₵ 193	₵207
Per 180 lb. Bag	13.30	13.90	11.40	13.30	15.50	16.70

[1]Gross Economic Benefit is toatl physical production times the estimated economic import parity price of domestic production (See Appendix I).

[2]The estimated economic costs per unit for nonlabor items are reported in Table 4.8.

[3]The economic opportunity cost of labor and the market wage rate for hired labor are equal as explained in the text of this chapter.

[4]The opportunity cost of operating capital (the sum of nonlabor and hired labor costs) is calculated in the following manner. First, the starred (*) items are summed and multiplied by 15 percent since they do not include any opportunity costs. The nonstarred items are treated differently since they already include an opportunity cost for that portion of the itemized cost arising from fixed assets. Only that portion arising from operating costs remains to be charged an opportunity cost. Operating costs represent 25 percent of land preparation costs (Appendix C, Table 3) and 19 percent of combine harvesting costs (Appendix E). None of the land clearing costs is an operating cost. Therefore, both the 25 percent of land preparation costs and the 19 percent of combine harvesting costs are charged 15 percent opportunity cost. This is added to the 15 percent computed for the starred items to arrive at the economic opportunity costs of operating capital not yet included in expenditures.

[5]The hours of family labor times the average wage rate paid to hired labor by the farmers in the system. The social economic opportunity cost of family labor is assumed to equal the wage rate for hired labor.

[6]The sum of the costs of (1) nonlabor items, (2) hired labor and (3) opportunity costs.

[7]Gross Economic Benefit less Total Economic Costs.

economic profits from the national point of view. The 119 acre tractor owner, improved seed system, the one with the greatest returns to management from a private point of view, had the greatest economic loss (₵-2998).

A Comparison of Financial and Economic Costs of Production of the Six Production Systems

The comparative costs of production per ton from both the financial and economic point of view are reported in Table 4.10. The economic costs of production for the five bottomland systems were, on the average, 47 percent higher than the financial costs. This increase in economic costs over financial costs for the five bottomland systems (Systems I-V) ranged from 24 to 86 percent and 16 percent for the upland bullock system. Following is a discussion of the reasons for the increased costs.

Capital-Labor Ratios

The reason why the economic costs of production were significantly greater than the financial costs was mainly due to the high rates of subsidy on capital resources.[26] Further, the economic costs were greater than the financial costs depending on the mix of capital resources and the relative rates of subsidy among the various capital resources. The financial and economic capital-labor ratios for the six systems are reported below (Table 4.11).

The capital-labor ratios show that the capital intensities of the two tractor owner systems were relatively high, particularly for

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[26] Where capital resources are defined as the operating capital expenditures for land preparation, seed and fertilizer, and mechanized harvesting.

Table 4.10. Financial and Economic Costs of Production of Six Rice Production Systems in Northern Ghana, 1973-74

Production System	Financial Costs[1]		Economic Costs[2]		Percent Increase
	(¢/Ton)	Rank[3]	(¢/Ton)	Rank	
System I:					
THS - Traditional Seed (12.8 acres)	133	5	165	3	24
System II:					
THS - Improved Seed (21.2 acres)	112	4	173	4	54
System III:					
THS - Mixed Seed (16.9 acres)	110	2	141	1	28
System IV:					
TO - Traditional Seed (41.6 acres)	112	4	165	3	47
System V:					
TO - Improved Seed (119.3 acres)	104	1	193	5	86
Average for Systems I-V[4]	114		167		47
System VI:					
BO - Traditional Seed (1.1 acres)	179	6	207	6	16

[1]Factors of production are priced at market prices. The financial costs of production are drawn from Table 4.7.

[2]Drawn from Table 4.9, where resources are valued at their real economic costs.

[3]Ranking is from one or lowest cost of production to six, the highest cost of production.

[4]Average for the five bottomland production systems.

Table 4.11. Financial and Economic Capital-Labor Ratios for Six Rice Production Systems in Northern Ghana, 1973-74

Production System	Capital-Labor Ratio[1]		Relative Change
	Financial	Economic	Percent
System I:			
THS - Traditional Seed (12.8 acres)	1.2	1.9	58
System II:			
THS - Improved Seed (21.2 acres)	1.9	3.8	100
System III:			
THS - Mixed Seed (16.9 acres)	1.2	2.0	67
System IV:			
TO - Traditional Seed (41.6 acres)	2.3	4.4	91
System V:			
TO - Improved Seed (119.3 acres)	3.6	8.5	136
System VI:			
BO - Traditional Seed (1.1 acres)	0.2	0.4	100

[1]The capital-labor ratios are computed as follows: "Capital" includes the operating capital expenditures for land preparation, seed and fertilizer,and mechanical harvesting. Labor includes the cost of hired labor plus the opportunity cost of family labor.

A capital-labor ratio of 1.9 means that for each ¢1.00 of labor costs there is ¢1.90 of costs for capital resources.

the 119.6 acre tractor owner system (System V). The reader will note that the tractor owner systems also had the highest costs of production among the bottomland systems. On the other hand, the upland bullock system had the lowest capital-labor ratio because of very high labor utilization by this system. However, it also had the highest cost of production of all systems studied.

Underlying Reasons for Variation in Economic Costs

Table 4.12 is designed to identify the underlying reasons for variation in the capital-labor ratios and economic costs of production among the six production systems. The large capital inputs in mechanical harvesting were the main reason for the increase in economic costs compared to financial costs. The two tractor owner production systems had the highest capital-labor ratios and the greatest cost per acre for mechanical harvesting, as well as the lowest cost per acre for labor. As one would expect, there was also a direct relationship between the cost per acre for land preparation and the ratio, with the underlying reason for the variation in the costs of land preparation among the systems being the amount of harrowing done. Finally, the overriding cause of a high capital-labor ratio among bottomland rice production systems in Northern Ghana was the use of combine harvesters on large farms.

Producer Income Support Derived from Capital Input Subsidies

Rice farmers are receiving substantial income transfers from the government as a result of subsidized (1) land preparation, (2) seed and fertilizer,and (3) combine harvesting services (Table 4.13). The proportion of financial net income provided by these subsidies in 1973-74

Table 4.12. A Comparison of the Costs Per Acre for Capital Resources and the Capital-Labor Ratios of Six Rice Production Systems in Northern Ghana, 1973-74

Production System	Acres	Capital-Labor Ratio	Costs Per Acre for Capital Resources[1]					Total Cost of Labor Per Acre[3]
			Seed	Fertilizer	Land Preparation[2]	Mechanical Harvesting	Total	
			------------Cedis------------					
System I: THS - Traditional Seed	12.8	1.9	7.00	7.50	18.80	5.80	39.10	20.90
System II: THS - Improved Seed	21.2	3.8	9.70	22.30	19.70	6.50	58.20	15.30
System III: THS - Mixed Seed	16.9	2.0	11.30	17.10	19.60	5.70	53.70	26.30
System IV: TO - Traditional Seed	41.6	4.4	8.0	15.20	20.20	13.40	56.80	13.00
System V: TO - Improved Seed	119.3	8.5	10.70	24.60	21.20	24.40	80.90	9.50
System VI: BO - Traditional Seed	1.1	0.4	8.90	12.90	9.30	---	31.10	82.00

[1] Based upon economic costs.

[2] Cost per acre for land preparation among the bottomland systems vary due to the amount of harrowing done. Per acre economic costs for plowing and harrowing are the same among all bottomland production systems.

[3] Includes the opportunity cost of family labor.

Table 4.13. Comparative Capital Subsidy Producer Income Support Among Six Rice Production Systems in Northern Ghana During the 1973-74 Production Season

Production System	Capital Subsidies		Net Income		Total Subsidy As A Proportion of Net Farm Income[3]
	Farm[1]	Per Acre	Farm[2]	Per Acre	
	------------Cedis------------				--Percent------
System I: THS - Traditional Seed (12.8 acres)	197	15.40	319	24.90	62
System II: THS - Improved Seed (21.2 acres)	652	30.80	662	31.20	99
System III: THS - Mixed Seed (16.9 acres)	391	23.10	813	48.10	48
System IV: TO - Traditional Seed (41.6 acres)	1,167	28.00	1,162	27.90	100
System V: TO - Improved Seed (119.3 acres)	5,880	49.30	3,930	32.90	150
System VI: BO - Traditional Seed (1.1 acres)	19	17.30	74	67.30	26

[1]Capital subsidies are computed by subtracting total financial nonlabor expenditures (enterprise budgets) from total economic nonlabor resource costs (Table 4.9).

[2]Financial net farm income is the net return to operating capital, family labor, and management as reported in the rice enterprise budgets.

[3]By computing what proportion capital subsidies per farm are of net return to operating capital, family labor, and management.

ranged from 26 percent for the upland bullock system (System VI) to 150 percent for the 119 acre tractor owner system (System V). In fact, the latter system would realize a negative financial income (¢-1950) if there were zero factor subsidies.

The income distribution impact of the current subsidy policy is well illustrated by Table 4.13. The absolute subsidy for the 119.3 acre system is ¢5,880. About 100 of the 6,100 rice producers in the Northern Region were receiving these transfers as factor subsidies. The smaller systems received a much smaller transfer. In fact, it is important to note that the bottomland production system with the lowest economic cost of production (System III) had the lowest proportion of its financial income derived from capital input subsidies (48 percent), whereas the bottomland system with the highest economic costs of production (System V) had the highest proportion of its financial income (150 percent) derived from subsidies.

Comparison Between Small Farm and Large Farm Rice Production Strategies

The economic analysis convincingly points to the need to re-evaluate the current capital intensive rice production strategy being pursued in Northern Ghana which stresses heavy capital-input subsidies. By indirectly subsidizing land preparation services and directly subsidizing mechanical harvesting, farmers are encouraged to expand farm size, thereby using land extensive, capital intensive,and labor-saving production practices as opposed to land and labor intensive production practices. These subsidies result in artificially high incomes which, in turn, provide incentives for farmers to adopt uneconomic production practices. The current capital intensive, labor-saving production

systems are thus yielding economic losses as shown in the economic analysis.

Ghana's rice production strategy in the future should be based, in part, on a production system which would foster high yields, low economic costs of production, and attractive private returns to rice farmers. It is assumed that Ghana would find it advantageous to identify rice production systems with relatively low capital-labor ratios and high economic payoffs since the country faces (1) a critical foreign exchange gap, (2) employment problems, and (3) an agricultural production which is not keeping pace with the increased demand for food. In order to augment production and farm income for a majority of the 6,100 rice producers and to generate rural employment, large numbers of producers need to have available improved output increasing and labor intensive production technologies which are consistent with their managerial and financial capacity.

In order to contrast farm level trade-offs more clearly, two production systems were selected for special study. The objective was to identify from the sample of farms (1) small farms using only manual methods of harvesting and (2) large farms using only combine harvesting. In addition, we required that for both systems sample farms use improved seed and have above average yields.

The two production systems--small farms and large farms--were analyzed from both a financial and economic point of view in order to illustrate the differences in output, employment, and returns to society.

A Large-Scale Capital Intensive Rice Production System Using Combine Harvesting

From the sample of 19 tractor owners using improved seeds, farms were selected that (a) had above average yield per acre and (b) were completely harvested by a self-propelled combine.[27] Four farms met these criteria and were thus selected as models from which to identify the production practices which resulted in high yields and to illustrate the level of capital use, labor utilization, and income received by large rice producers using these production techniques.

A financial budget representing the average physical resource utilization and corresponding expenditures for this special case of four high yielding farms as defined above is reported in Table 4.14. The average farm size of these four farms is 287.5 acres.

Labor Utilization

The total mean labor utilization per acre among the four farms was 40.5 man-hours per acre. Sixty-six percent of the total man-hours were used in pre-harvest activities (and 58 percent in weeding activities). The labor in harvesting was used for bagging combined paddy. Seventy-five percent of the total labor were hired labor; of these, 45 percent were used in weeding, 28 percent for harvesting, and 27 percent for broadcasting seed and fertilizer.

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[27]The average yield of the 19 farms was 7.1 bags per acre. Ten farms had yields above the mean, of which seven harvested with a combine, one used hand harvesting methods, and three used a combination of hand and mechanical methods of harvesting. Of the seven farms harvesting with a combine, two did not use fertilizer and were considered unrepresentative of the group and were excluded.

Table 4.14. Rice Enterprise Budget for a 287.5 Acre Farm Based on Survey Data from Four Selected Farms in Northern Ghana Using Improved Seed and Own Tractor and Equipment and Having Above Average Yield

Activity		Operating Capital and Labor Utilization by Activity												
Item	Acres	Capital					Labor							
		Units	Rate Per Acre	Total Units	Cost Per Unit	Total Cost	Manhours				Wage Rate	Expenditures		
							Per Activity Acre	Total	Family Labor	Hired Labor	Per Hour	Per Acre	Total	
					¢	¢					¢	¢	¢
A. Land Clearing a/	287.5	acres	5.5			1,5[illegible]							
B. Pre-harvest													
Plowing	287.5	acres			[illegible]	[illegible]							
1st Harrowing	287.5	acres			[illegible]	1,[illegible]							
2nd Harrowing	287.5	acres			[illegible]	[illegible]							
Sub-Total						[illegible] b/							
Seed	287.5	bags	0.44	126.5	14.00	1,771.00	2.1	[illegible]	316.4	[illegible]	0.10	0.19	[illegible]
Comp. Fert.	287.5	bags	2.31	664.1	2.80	1,8[illegible]	4.8	1,[illegible].0	374.0	1,[illegible].0	[illegible]	0.[illegible]	71.[illegible]
Ammon. Sulfate	287.5	bags	0.95	27[illegible].1	[illegible]	[illegible]	3.2	[illegible]	17[illegible].0	[illegible]	[illegible]	[illegible]	1[illegible].13
1st Weeding							11.3	3,[illegible]	437.3	2,7[illegible].5	0.1[illegible]	1.[illegible]	[illegible]
2nd Weeding							[illegible]	[illegible]	--	1,[illegible].5	[illegible]	[illegible]	[illegible]
Sub-Total						4,176.20	[illegible]	7,[illegible]	1,349.7	[illegible]	[illegible]	4.[illegible]	1,1[illegible]
C. Harvest													
1. Mechanical													
Combining	287.5	bags		2932.5	1.00	2,932.50							
Bagging							13.9	3,[illegible]	1,550.6	2,44[illegible].7	0.11	0.97	[illegible]
Sub-Total													
2. Bags					0.50	1,[illegible]							
Sub Total of Harvesting Expenditures						4,398.75	13.9	3,996.3	1,550.6	2,445.7	0.11	0.97	278.88
D. Total Expenditures and Labor Utilization						14,[illegible].71	40.5	11,[illegible]	2,[illegible]	8,743.6	[illegible]	5.01	1,440.40

Income and Expenditure Summary

Summary of Income

a. Total Production
10.2 bags x 287.5 acres = 2932.5 bags

b. Value of Production
2932.5 bags x ¢ [illegible] = ¢ [illegible]

c. Less Total Expenditures 16,323.11

d. Farm Gate Income [illegible]

e. Estimated Selling Costs [illegible]

f. Net Cash Return to Operating Capital, Family Labor and Management ¢ 17,[illegible].14

Summary of Expenditures

a. Non Labor Expenditures
1. Land Clearing ¢ 1,5[illegible]
2. Land Preparation 4,71[illegible]
3. Seed & Fertilizer 4,176.20
4. Mechanical Harvesting 2,932.50
5. Bags 1,466.25 ¢ 14,88[illegible].71

b. Labor Expenditures
1. Pre-harvest Activity 1,1[illegible].52
2. Harvest Activity 278.88 1,440.40

c. Total Farm Expenditures ¢ 16,[illegible].11

a/ The cost of land clearing is the average annual amortized cost. See Appendix F for the calculation of land clearing costs.

b/ Unit costs of mechanized land preparation are based upon computed owning and operating costs of a tractor and associated equipment in Northern Ghana. See Appendix C, Table 2.

Costs and Returns

The mean total farm expenditures among these farms were ₵16,323. The largest expenditure item was land preparation (29 percent), followed by seed and fertilizer (26 percent), combine harvesting (18 percent), land clearing (10 percent), bags (9 percent), and hired labor (9 percent).

The mean farm yield was 10.2 bags, or 1,836 pounds per acre. Total production was 2,933 bags, or 235.65 metric tons. Gross income was ₵35,190, and the net return to operating capital, family labor, and management was ₵17,987.

A Small-Scale Labor Intensive Rice Production System Using Manual Methods of Harvesting

From the sample of 44 farms utilizing tractor-hire services and improved seed, farms were selected that (a) had above average yield per acre and (b) were completely harvested by hand methods.[28] Five farms met these criteria and were thus selected for special analysis as models from which to identify the production practices which resulted in high yields and to illustrate the yield and income that can be obtained by farmers using improved production techniques on relatively small rice farms.

A financial budget representing the average physical resource utilization and corresponding expenditures for the special case of five high yielding small rice farms as defined above is reported in Table 4.15. The average farm size of these five farms is 3.9 acres.

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[28] The average yield of the 44 farms was 6.2 bags per acre. Thirteen (13) farms had yields above the average, of which 11 farms applied fertilizer. Among these 11 farms, three harvested with a combine, five harvested by hand, and three used a combination of hand and mechanical methods of harvesting.

Table 4.15. Rice Enterprise Budget for a 3.9 Acre Farm Based on Survey Data from Five Selected Farms in Northern Ghana Using Improved Seed and Tractor Hire Services and Having Above Average Yield

Activity		Operating Capital and Labor Utilization by Activity											
		Capital					Labor						
							Manhours				Wage Rate	Expenditure	
Item	Acres	Units	Rate Per Acre	Total Units	Cost Per Unit	Total Cost	Per Activity Acre	Total	Family Labor	Hired Labor	Per Hour	Per Acre	Total
					¢	¢					¢	¢	¢
A. Land Clearing	3.9[a]	acres			1.00	3.90							
B. Pre-Harvest													
Plowing	3.9	acres			9.59	37.40							
1st Harrowing	3.9	acres			4.65	18.14							
Sub-Total						55.54							
Seed	3.9	bags	0.36	1.4	14.00	19.60	1.6	6.2	6.2	—			
Comp. Fert.	3.9	bags	1.34	5.2	2.80	14.56	1.9	7.4	7.4	—			
Ammon. Sulfate	3.9	bags	0.36	1.4	2.00	2.80	1.0	3.9	3.9	—			
1st Weeding							14.4	56.2	32.4	23.8	0.14	0.88	3.43
2nd Weeding							36.5	142.4	46.0	96.4	0.13	3.33	12.99
Sub-Total						36.96	55.4	216.1	95.9	120.2	0.14	4.21	16.42
C. Harvest													
Cutting	3.9	acres					29.1	113.5	56.5	57.0	0.11	1.53	5.97
Heaping	3.9	acres					13.2	51.5	25.7	25.8	0.26	1.73	6.75
Threshing	3.9	acres					45.9	179.0	55.3	123.7	0.09	2.80	10.92
Win. & Bagging	3.9	acres					40.8	159.1	34.7	124.4	0.07	2.19	8.54
Sub-Total							129.0	503.1	172.2	330.9	0.10	8.25	32.18
Bags					0.50	16.95							
D. Total Expenditures and Labor Utilization						113.35	184.4	719.2	268.1	451.1	0.11	12.46	48.60

Income and Expenditure Summary

Summary of Income

a. Total Production
8.7 bags x 3.9 acres = 33.9 bags

b. Value of Production
33.9 bags x ¢ 12.00 = ¢ 406.80

c. Less Total Expenditures 161.95

d. Farm Gate Income 244.85

e. Less Estimated Shipping Costs[b] 10.17

f. Net Cash Returns to Fixed Capital, Family Labor and Management ¢ 234.68

Summary of Expenditures

a. Non Labor Expenditures
1. Land Clearing ¢ 3.90
2. Land Preparation 55.54
3. Seed and Fertilizer 36.96
4. Bags 16.95
¢113.35

b. Labor
1. Pre-harvest Activities 16.42
2. Harvest Activities 32.18
¢ 48.60

c. Total Farm Expenditures ¢ 161.95

[a] Cost of land clearing is the average annual amortized cost. See Appendix F for the calculation of land clearing costs.

[b] Average cost of hiring a transporter to convey paddy from farm to market is ¢0.30 per bag.

Labor Utilization

The mean labor utilization per acre for this group of farms was 184.4 man-hours per acre. Seventy percent of the total labor were employed in harvest activities and 28 percent in weeding. The mean labor employment in weeding was 51 man-hours per acre which is second highest to System III (62 man-hours per acre) analyzed previously. Sixty-three percent of the labor were hired; of these, seventy-three percent were used for harvesting activities and the remaining in weeding activities.

Costs and Returns

The mean total farm expenditures among the five farmers were ₵162, of which 34 percent was for land preparation, 30 percent for hired labor,and 23 percent for seed and fertilizer.

The mean farm yield was 8.7 bags, or 1,566 pounds per acre. Total production was 33.9 bags, or 2.72 metric tons. Gross income was ₵407, and the net return to operating capital, family labor,and management was ₵235.

A Comparative Financial and Economic Analysis

The most salient results of an analysis of the two contrasting systems are described. The reader desiring more detail is referred to the enterprise budgets reported above and the tables reported in this section.

Financial Analysis of the Two Systems

From a financial point of view, both the labor intensive and capital intensive systems had higher returns to management per acre and lower costs of production than the five bottomland systems previously analyzed (Table 4.16).

The greatest contrasting features of the two budgets are (1) the relative nonlabor expenditures per acre and (2) the average labor utilization per acre. The large-scale capital intensive system had expenditures of ¢52 per acre for nonlabor items, whereas the labor intensive system had nonlabor expenditures of ¢29 per acre. This difference can be explained, for the most part, by combine harvesting and additional harrowing done by the large scale tractor owner system. On the other hand, the greater labor utilization per acre by the small-scale system can be explained by manual harvesting and the greater labor utilization in weeding.

As a result of the contrasting factor proportions between the two systems and the high factor subsidies as previously described, the relative proportion of net income derived from subsidies was 45 percent of the net income[29] realized by the labor intensive system and 129 percent for the large scale, capital intensive system. The absolute amount of capital subsidy support for the labor intensive system was ¢105, whereas the level of subsidy for the capital intensive system was ¢23,195.[30]

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[29]Where net income is net return to operating capital, family labor and management as returned in the enterprise budgets.

[30]The absolute level of subsidy and the relative proportion of income support from factor subsidies are calculated in the same manner as reported earlier in the chapter; see Table 4.13.

Table 4.16. A Comparative Financial Analysis Between Small Farm and Large Farm Rice Production Strategies Using Survey Data

Item	Production Systems	
	Small-Scale Labor Intensive	Large-Scale Capital Intensive
A. General Characteristics		
Number of Farms	5	4
Agronomic System	Bottomland	Bottomland
Power Source	THS	TO
Seed Variety	Improved	Improved
Acres in Rice	3.9	287.5
Total Production (180 lb. bags)	33.9	2932.5
Average Yield Per Acre (bags)	8.7	10.2
B. Summary Financial Information		
1. Gross Income	₵407	₵35,190
2. Operating Expenditures	172	17,203
3. Opportunity Costs		
a) Family Labor	29	493
b) Operating Capital	20	679
4. Total Costs	221	18,375
C. Measures of Efficiency[1]		
1. Net Cash Income		
a) Farm	235	17,987
b) Per Acre	60	63
2. Return to Family Labor		
a) Total	215	17,308
b) Per Man-Hour	0.80	5.97
c) Per Man-Day	4.80	35.82
3. Return to Operating Capital		
a) Total	206	17,494
b) Percent of Op. Exp.	120	102
4. Return to Management		
a) Total	186	16,815
b) Per Acre	48	58
5. Opportunity Cost of Production		
a) Per 180 lb. Bag	6.50	6.30
b) Per Metric Ton	81	78
6. Man-hours Per Acre	184	40

[1]For the methods used to calculate the measures of efficiency, refer to the footnotes accompanying Table 4.7.

Economic Analysis of the Small Farm and Large Farm Systems

The economic capital-labor ratio of the capital intensive system was 17.7, or six times greater than the ratio of the labor intensive system (2.5).[31] And it is the relative economic costs of production and economic profits generated by the two systems which reflect the contrasting ratios.

From a financial point of view, there is only a four percent difference in the costs of production between the two systems. However, when economic prices are used to value resources,the relative costs of production diverge. The cost per bag by the large farm, capital intensive system was ₵14.80, which is 53 percent greater than ₵9.70,the cost of the small farm, labor intensive system (Table 4.17).

The economic profit generated by the labor intensive system was ₵79. On the other hand, the large farm, capital intensive system generated an economic loss of ₵-8,261 from society's point of view. Moreover, the benefits of the capital intensive system not only do not cover the opportunity costs of operating capital and family labor, but also do not cover roughly ₵4300 in unsubsidized factor costs.

Summary

The purpose of this chapter was to estimate both financial (private) and economic costs and returns for six rice production systems in current use in Northern Ghana. Financial rice enterprise budgets were constructed from survey data for five bottomland production systems

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[31] Calculated in the same manner as reported earlier in the chapter; see Table 4.11.

Table 4.17. A Comparative Economic Analysis of Small Farm and Large Farm Rice Production Strategies Using Survey Data[1]

Item	Production Systems	
	Small-Scale Labor Intensive (3.9 Acres)	Large-Scale Capital Intensive (287.5 Acres)
A. Gross Economic Benefits	₡407	₡35,190
B. Resource costs		
1. Nonlabor		
a. Land clearing	4	1,955
b. Land preparation	68	6,213
c. Seed and fertilizer	124*	15,687*
d. Mechanical harvesting	---	12,317
e. Bags	22*	1,906*
f. Sub Total	218	38,078
2. Hired Labor		
a. Pre-Harvest activities	16	1,162
b. Harvest activities	32	279
c. Sub Total	48*	1,441
3. Opportunity Costs		
a. Operating capital	32	3,439
b. Family Labor	30	493
c. Sub Total	62	3,932
4. Total Economic Costs	328	43,451
5. Economic Profit or Loss	₡ 79	₡-8,261
6. Economic Cost of Production		
Per metric ton	121	184
Per 188 lb. bag	9.70	14.80

[1]For the method used to caluclate economic costs and benefits, the reader is referred to the footnotes accompanying Table 4.9.

which used tractor mechanization for initial land preparation and for one upland system in which the bullock plow was used.

Among the five bottomland systems, there was a 28 percent variation in the financial costs of production. The 119-acre tractor owner system using improved seed had the lowest financial cost of production (₵104 per ton), while the 12.8-acre tractor-hire traditional seed system had the highest cost of production (₵133 per ton). The upland bullock system had the highest financial cost of production of all systems studied (₵179 per ton).

A net cash return to operating capital, family labor,and management is reported for each of the six systems. The budget data were used to derive financial returns to (1) family labor, (2) operating capital expenditures, and (3) management. The returns to family labor among the five bottomland systems ranged from ₵252 for System I to ₵3347 for System V. For all bottomland systems, the financial return per man-hour of family labor was greater than the average wage rate paid to hired labor. For the upland bullock system, however, the return to family labor was equal to the wage rate. The return to operating capital varied from 15 percent of total operating expenditures (System VI) to 66 percent (System III). All five bottomland production systems had a high return to management after opportunity costs were assigned to family labor and operating capital. However, for the upland bullock system, there was a zero return to management.

An economic analysis of each production system was undertaken to determine the economic profitability of each system from the national point of view. All nonlabor cost items were valued by estimated unsubsidized cost-prices, and the cost of hired labor was valued at the actual financial cost incurred. The economic opportunity cost of all operating capital expenditures was valued at 15 percent, and the opportunity cost of family labor was assumed to be equal to the local agricultural wage rate.

The economic costs of production for the five bottomland systems were, on the average, 47 percent higher than the financial costs. This relative increase in economic costs of production among the systems is due to the mix of capital resources used in production and the relative rates of subsidy among nonlabor resources.

When market prices were used to value resources (financial analysis), the large-scale capital intensive system (System V) had the lowest cost of production (¢104 per ton). However, when economic prices were used, this system had the highest cost of production (¢193). System V also had the second highest yield among the bottomland systems, the highest C/L ratio, the largest acreage, the greatest degree of combine harvesting, and the lowest labor inputs per acre. In contrast, System III had the lowest economic cost of production (¢141 per ton), the highest yield per acre, the lowest C/L ratio, the second lowest acreage, and the highest average labor utilization, per acre. The upland bullock system had the highest cost of production from both the financial and economic points of view, primarily because of the large labor inputs of this system.

Our analysis showed that small number of the 6,100 rice farmers under present policies are receiving substantial income transfers in the form of subsidized (1) combine harvesting services, (2) seed and fertilizer, and (3) land preparation. The variation in income support from factor subsidies ranges from 26 percent (System VI) to 150 percent for the large-scale, capital intensive system (System V). The system with the lowest economic cost of production has the lowest government transfer in terms of factor subsidies, while the system with the highest economic costs of production has the highest government transfer by way of factor subsidies.

The economic analysis also illustrated that all production systems, except the 16.9-acre THS-system (System III), generated economic losses from the national point of view. The large-scale, capital intensive system (System V) generated very high economic losses from the national point of view.

The analysis in this chapter thus convincingly points to the need to re-evaluate the government's production strategy. Current policies encourage farmers to expand farm size, thereby using subsidized capital intensive and labor-saving production practices which are financially profitable but uneconomic from the national point of view.

In order to identify more clearly the trade-offs among (1) capital requirements, (2) farm employment, (3) producer income, and (4) output, two contrasting production systems were analyzed in detail. One system was based upon tractor ownership, high yields, and combine harvesting. This system is typical of the large-scale, capital intensive production approach. The second system was based upon the hiring of mechanized land preparation services, high yields, and manual harvesting. This system represents small farm, labor intensive rice production.

The analysis of these two systems showed that, from a financial point of view, the returns to management were high and the cost of production about equal. However, from an economic point of view, the costs of production differed substantially. The small farm, labor intensive system produced rice at ¢121 per ton as compared with ¢184 per ton for the large-scale, capital intensive system. Hence, the small farm approach produced substantial output and income to farmers and generated economic profits, from the national point of view, while the large farm system generated substantial economic losses. Our analysis thus demonstrates the need for reorienting the government's rice production strategy to include a substantial small farm emphasis.

CHAPTER V

EMPLOYMENT AND INCOME DISTRIBUTION IMPLICATIONS OF ALTERNATIVE RICE PRODUCTION SYSTEMS

Introduction

Planners in Ghana are in need of data on the efficiency, output, employment, and income distribution implications of alternative production systems.[1] The purpose of this chapter is to describe the relative labor requirements for six rice production systems. Labor supply is analyzed in terms of (a) family and hired labor, and (b) men, women, and children. We compare the employment and income distribution implications of a hypothetical expansion of combine harvesting in two production systems; one is a small farm, labor intensive production approach and the second is a large farm, capital intensive approach representing the present harvesting strategy in the study area.

Labor Utilization Among Six Rice Production Systems

Five Bottomland Systems

There was a wide variation in the average man-hours per acre among the five bottomland systems. The variation ranged from a high of 220 man-hours per acre for the 16.9 acre tractor-hire system to a low of 38 man-hours per acre for the 119.3 acre tractor owner system. The principal reasons for the marked differences are the intensity of weeding and the degree of mechanical harvesting.

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[1]There is a growing awareness of the need for more data on the direct and indirect implications of alternative production systems. See Byerlee, 1973 and Steele and Mabey, 1973.

Pre-Harvest Activities

Pre-harvest activities consisted of the broadcasting of seed and fertilizer and weeding. The variation in man-hours for pre-harvest activities ranged from a low of 18 man-hours per acre for the 119.3-acre tractor owner system to 70 man-hours per acre for the 16.9-acre tractor-hire service system (Table 5.1).

For broadcasting activities, all production systems used about the same man-hours per acre. Excluding System III, which used 12 man-hours per acre, the average man-hours per acre in broadcasting activities (seed and fertilizer) was about eight man-hours.

Weeding activities for all systems accounted for the greatest proportion of labor utilization in pre-harvest activities. The variation ranged from 58 percent of the total pre-harvest hours for the THS-Traditional Seed System to 89 percent for the THS-Mixed Seed System. The two tractor owner systems used only 11 man-hours per acre for weeding; the 16.9-acre THS system employed 62 man-hours, and the 12.8- and 21.2-acre THS systems utilized 16 and 24 man-hours per acre, respectively. With the exception of System I, as farm size increased, the man-hours per acre in weeding declined.

Harvest Activities

Harvest activities accounted for the greatest proportion of the total labor utilization among the five bottomland systems, all of which used a combination of manual and mechanized methods of harvesting. Table 5.2 reveals that the variation in labor utilization in harvesting was most directly related to the degree of mechanical harvesting. Labor utilization in harvesting ranged from a high of 149 man-hours for the 16.9-acre system to a low of 20 man-hours per acre for the 119.3-acre system.

Table 5.1. Summary of Labor Utilization for Six Rice Production Systems in Northern Ghana[1]

Labor Activity and Source / Power Source / Seed	System I THS Traditional Manhours Per Acre	%	System II THS Improved Manhours Per Acre	%	System III THS Mixed Manhours Per Acre	%	System IV TO Traditional Manhours Per Acre	%	System V TO Improved Manhours Per Acre	%	System VI BO Traditional Manhours Per Acre	%
A. Field Activity												
1. All Field Activities	116.0	100	103.6	100	219.6	100	88.8	100	37.8	100	690.7	100
a. Pre-Harvest	27.8	24	31.8	31	70.3	32	19.2	22	18.1	48	233.6	34
b. Harvest	88.2	76	72.3	69	149.3	68	69.6	78	19.7	52	457.1	66
2. Pre-Harvest Activities	27.8	100	31.8	100	70.3	100	19.2	100	18.1	100	233.6	100
a. First Weeding	14.0	50	13.7	43	60.2	86	11.0	57	7.6	42	98.1	42
b. Second Weeding	2.2	8	9.8	31	2.1	3	0.0	0	3.0	17	70.4[2]	30
c. All Other	11.6	42	8.3	26	8.0	11	8.2	43	7.5	41	65.1	28
3. Harvest Activities	88.2	100	72.3	100	149.3	100	69.6	100	19.7	100	457.1	100
a. Mechanical Harvesting	1.5	2	0.8	1	1.9	1	4.1	6	4.4	22	---	---
b. Hand Harvesting	86.7	98	71.5	99	147.4	99	65.5	94	15.3	78	457.1	100
B. Source of Labor												
1. All Field Activities	116.0	100	103.6	100	219.6	100	88.8	100	37.8	100	690.7	100
Family		62		41		55		26		25		77
Hired	44.1	38	61.1	59	98.8	45	65.7	74	28.4	75	158.9	23
2. Pre-Harvest Activities	27.8	100	31.8	100	70.3	100	19.2	100	18.1	100	233.6	100
Family		70		42		52		40		21		68
Hired	8.3	30	18.4	58	33.7	48	11.5	60	14.3	79	74.8	32
3. Harvest Activities	88.2	100	72.3	100	149.3	100	69.6	100	19.7	100	457.1	100
Family		60		41		56		22		29		80
Hired	35.3	40	42.7	59	65.7	44	54.3	78	14.0	71	91.4	20

[1]Computed from Rice Enterprise Budgets.

[2]THS = Tractor Hire Service; TO = Tractor Owner; and BO = Bullock Operator

[3]Includes labor used for second and third weeding.

Table 5.2. The Relationship Between the Method of Harvesting and Average Labor Requirements for Five Bottomland Rice Production Systems in Northern Ghana

Production System	Acres	Method of Harvesting			Total Man-Hours Per Acre in Harvesting
		Combine Harvesting	Cut by Hand	Mechanically Threshed[1]	
		---Percent of Total Acreage-----			
System I:					
THS-Traditional Seed	12.8	20	80	31	88
System II:					
THS-Improved Seed	21.2	14	86	33	72
System III:					
THS-Mixed Seed	16.9	3	97	47	149
System IV:					
TO-Traditional Seed	41.6	12	88	83	70
System V:					
TO-Improved Seed	119.3	77	23	12	20

[1]Includes using a combine as a stationary thresher and tractor threshing.

Since many farmers used a combination of manual and mechanized methods of harvesting, it is difficult to directly estimate the labor requirement for manual and combine harvesting from the enterprise budgets. As a consequence, we estimated the average man-hour requirements using labor data from 112 bottomland rice farms. We assumed that man-hour requirements per acre depend in part on yield. To estimate man-hour requirements per acre and the variation in yields, we sorted the sample farms into three yield levels and calculated the mean man-hours per acre for each harvest subactivity. For manual harvesting techniques, we found that the man-hour requirements increased with yield per acre; however, the man-hours for labor associated with mechanized techniques were not related to change in yields. At a yield level of 6.0 to 8.9 bags per acre,[2] it is estimated that 142 man-hours are required to harvest one acre of paddy using hand harvesting methods (Table 5.3). However, if a combine is hired to harvest paddy, only 10 man-hours per acre are required (for bagging only).

Upland Bullock System

Labor utilization per acre for the upland bullock system was three times greater than that for the most labor intensive bottomland system (System III) for the following reasons. First, about 57 man-hours per acre were used for land preparation in association with bullock plowing and hand harrowing, whereas tractor mechanization was employed for land preparation among the bottomland systems. Second, about 169 man-hours per acre were utilized in weeding activities on the upland system which is about two and one-half times the man-hours employed in weeding by the bottomland system with the greatest number of man-hours in weeding. Third, about three times as much labor was used for manual harvesting activities as compared with the most labor intensive bottomland system. The reasons for the greater labor utilization in weeding and harvesting have been previously described.

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[2] One bag of paddy is 180 pounds.

Table 5.3. Average Man-Hour Requirements Per Acre for Manual Harvesting Activities at Three Yield Levels

Activity	Bags Per Acre		
	3.0-5.9	6.0-8.9	9.0-12.0
	------(Man-Hours Per Acre)-------		
Cutting	33.9 (2.8)[1]	49.8 (7.6)	43.5 (7.3)
Heaping	15.9 (1.8)	24.4 (3.6)	37.8 (7.6)
Threshing	28.9 (4.5)	41.2 (9.0)	79.4 (21.1)
Winnowing and Bagging	19.5 (2.0)	26.8 (2.7)	35.9 (6.8)
Total	98.2	142.2	196.6

[1]Figures in parentheses are one standard deviation.

The Composition of the Labor Force

Family Versus Hired Labor

All five bottomland production systems relied on hired labor to supplement family labor. For all field activities, the proportion of the man-hours hired to total labor requirements varied from a low of 38 percent for the 12.8-acre system (System I) to a high of 75 percent for the 119.3-acre system (System V). For all systems more labor was hired for harvest activities than pre-harvest activities (Table 5.1). A review of the individual enterprise budgets reveals that the greatest proportion of hired labor was utilized for cutting (34 percent), following by weeding (22 percent), and heaping (15 percent).

For the bullock system, 23 percent of the total labor requirements were hired. About 45 percent of the hired labor were employed in cutting, followed by 43 percent in weeding and 11 percent in other harvesting activities.

Importance of Men, Women, and Children

As one would expect, there is a wide variation in the relative importance of men, women, and children in various activities in rice farming. Despite this variation, it is possible to identify the relative overall importance of each and the activities which are dominated by men or women. For all bottomland production systems the average proportion of the total man-hours supplied by men, women, and children was, respectively, 57, 33, and 10 percent (Table 5.4).

For pre-harvest activities[3] women provided a greater proportion of the total labor requirements for the 119.3-acre system than for the other four bottomland production systems. For this large-scale system the proportion of the total labor utilization supplied by men, women, and children was 44, 49, and 7 percent, respectively. Also for this system, men provided 58 percent of the labor for seed broadcasting, whereas 39 percent of the man-hours were supplied by women and three percent by children. Women provided about 50, 54, and 51 percent, respectively, of the total labor in the broadcasting of compound fertilizer, the broadcasting of top dressing, and weeding, while children supplied about five percent of the total man-hours for fertilizer broadcasting and about nine percent of the man-hours for weeding.

For the other four bottomland production systems men, women, and

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[3]The coefficients used to convert field hours to man-hours were 1.0, 0.75, and 0.50 for men, women, and children, respectively, for broadcasting of seed and fertilizer, cutting, and heaping. For weeding, threshing, and winnowing the conversion factor for women was 1.0, or equal to men.

Table 5.4. The Relative Importance of Men, Women, and Children as Sources of Labor for Field Activities Among Six Rice Production Systems in Northern Ghana

Production Systems	Total Manhours	All Activities			Pre-Harvest Activities[1]			Harvest Activities[2]		
		Men	Women	Children	Men	Women	Children	Men	Women	Children
System I:										
THS-Traditional Seed	1484									
(12.8 acres)										
Man-hours		868	407	209	257	15	83	611	392	126
Percent		59	27	14	72	5	23	54	35	11
System II:										
THS-Improved Seed	2195									
(21.2 acres)										
Man-hours		1032	838	326	365	144	155	667	694	171
Percent		47	38	15	55	22	23	44	45	11
System III:										
THS-Mixed Seed	3711									
(16.9 acres)										
Man-hours		2267	1189	253	908	122	159	1360	1067	95
Percent		61	32	7	76	10	13	54	42	4
System IV:										
TO-Traditional Seed	3693									
(41.6 acres)										
Man-hours		2499	956	238	537	241	21	1963	715	217
Percent		68	26	6	68	26	6	68	26	6
System V:										
TO-Improved Seed	4513									
(119.3 acres)										
Man-hours		2281	1847	347	954	1050	155	1327	798	229
Percent		51	41	9	44	49	7	56	34	10
System VI:										
Bullock System										
Traditional Seed	741									
Man-hours		362	295	84	190	39	10	172	257	74
Percent		49	40	11	80	16	4	34	51	15

[1] Pre-harvest activities include the broadcasting of seed and fertilizer and weeding. In addition, for the bullock system only, bullock plowing and hand harrowing are included.

[2] Harvest activities include manual harvesting requirements (cutting, heaping, threshing, winnowing and bagging) and labor associated with mechanized techniques.

children supplied 68, 16, and 16 percent of the labor for pre-harvest activities, respectively. On the average, men accounted for 75, 75, 67, and 64 percent of the man-hours involved in the broadcasting of seed, broadcasting compound fertilizer, broadcasting top dressing, and weeding, respectively. For these four production systems there was too much variation in the labor utilization of women and children to generalize about their relative importance in specific pre-harvest activities.

Hand harvesting activities consisted of cutting, heaping, threshing, and winnowing and bagging. Mechanized harvest techniques requiring labor consisted of (1) bagging combine harvested paddy, (2) feeding paddy into a combine, which is used as a stationary thresher, and then bagging the machine-threshed paddy and (3) "tractor threshing" which involves turning paddy and removing the straw after a tractor has driven over the paddy. For all harvesting activities the average proportion of the total labor provided by men, women, and children among the five bottomland systems was 55, 36, and 8 percent, respectively (Table 5.4).

For the hand harvesting activities among the five systems, men provided on the average 83, 40, 29, and 19 percent of the total labor requirements for cutting, heaping, threshing, and winnowing and bagging, respectively. In the same order of activity, women provided 9, 41, 65, and 80 percent of the total labor requirements and children 8, 20, 6, and 1 percent. Thus, cutting was mainly the work of men; heaping cut paddy was about equally shared between men and women; and threshing and winnowing and bagging were predominantly the work of women. Children contributed most to heaping activities. For mechanized harvesting, men provided the bulk of the labor. However, for tractor threshing operations, women supplied about 30 percent of the labor and children about seven percent.

For the upland bullock system, 49 percent of the total labor was provided by men, 40 percent by women, and 11 percent by children. Preharvest activities were dominated by men who provided 80 percent of the total labor in these activities. Women were the most important source of labor for harvest activities,providing 51 percent of the total labor requirements; however, men dominated the cutting activity, followed by women (34 percent) and children (15 percent).

Employment Implications of Expanding Combine Harvesting

At the time this study was conducted, no more than an estimated 10 percent (9000 acres) of the total rice acreage in the Northern Region was harvested by combine. However, the Ministry of Agriculture through "Operation Green Harvest" had a short-run goal to increase combine harvesting and to harvest 35,000 acres by combine within three years. The purpose of this section is to identify the direct employment implications of a shift from hand harvesting to combine harvesting.[4]

Potential Labor Displacement

The analysis which follows assumes an average yield of eight bags, or 1440 pounds of paddy per acre.[5] The labor requirements for manual and combine harvesting are based upon survey data. We have estimated

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[4]The indirect employment implications are not considered in this analysis.

[5]As shown, labor requirements for manual harvesting depend on yield per acre; the higher the yield, the greater the labor displacement by a shift to combine harvesting.

that at a yield level of eight bags per acre, 142 man-hours are required to harvest one acre of paddy manually and 10 man-hours per acre for bagging combined grain.

For every 1000 acres harvested by combine, 22,000 man-days of labor are potentially displaced. Given a harvesting period of 60 days, the labor of 367 man-equivalents per day for 60 days is displaced. If the Ministry's goal of 35,000 combined acres is achieved, then 770,000 man-days of labor would be displaced by a shift from manual to combine harvesting (Table 5.5).

The loss in income to casual laborers seeking employment on rice farms depends on the going wage rate and the relative use of hired and family labor. The average wage rate in harvest activities among the five bottomland systems was ₵0.95 per man-day. At this wage rate and with the assumption that 50 percent of the total labor requirement is hired and the remaining is provided by family labor, ₵10,450 in income would be the loss by casual laborers per 1000 acres harvested by combine. Thus, if the government goal of harvesting 35,000 acres by combine were achieved, the loss in income by casual workers would be ₵356,750 if 50 percent of the labor requirement were hired and ₵549,000 if 75 percent of the labor requirement were hired (Table 5.6). Given a 60-day harvesting period, 577,500 man-days (75 percent of the labor requirement potentially displaced by shifting to combine harvesting) would provide work for 9,625 workers working six hours per day for 60 days. If this labor were displaced, then the loss in income per worker over 60 days would be ₵57.

Table 5.5. Comparative Labor Requirements for Manual and Combine Harvesting and Estimated Labor Displacement for Combine Harvesting in Northern Ghana

Number of Acres	Labor Requirements by Harvest Method[1]				Estimated Labor Displacement
	Manual		Combine[2]		
	Man-Hours	Man-Days[3]	Man-Hours	Man-Days[3]	Man-Days[3]
1	142	23.7	10	1.7	22
1,000	142,000	23,700	10,000	1,700	22,000
35,000	4,970,000	829,500	35,000	59,500	770,000

[1]Based upon survey data; an average yield is assumed to be eight, 180-pound bags per acre.

[2]For bagging combined paddy.

[3]One man-day is defined as six field hours.

Table 5.6. Estimated Loss of Income to Casual Workers Resulting from a Shift From Manual to Combine Harvesting Under Three Assumptions Regarding the Proportion of Total Labor Requirement Hired

Number of Acres	Estimated Labor Displacement[1] (Man-Days)	Estimated Loss of Income[2]		
		Proportion of Total Labor Requirement Hired		
		50 Percent	75 Percent	100 Percent
1	22	¢10.45	¢15.70	¢20.90
1,000	22,000	10,450	15,700	20,900
35,000	770,000	365,750	549,500	731,500

[1]From Table 5.5 .

[2]Calculated under the assumption that the average wage rate is ¢0.95 per day which is the average wage rate in harvest activities among the five bottomland systems.

Gains to Producers

Since the Ministry of Agriculture's combine rate is heavily subsidized, farmers are encouraged to adopt combine harvesting because it costs substantially less than to hire labor. The Ministry charges ¢1.00 per bag for combine harvesting, as compared with an estimated economic cost of about ¢4.00 per bag. With a yield of eight bags per acre, the farmer is charged ¢8.00 for combine services and pays labor ¢0.80[6] for bagging combined paddy if 50 percent of the bagging requirement is hired. Thus, a farmer's total cost for combine harvesting is ¢8.80 per acre. If, on the other hand, the farmer harvests his crop manually and hires 50 percent of his labor requirement, his total cost for harvesting is ¢11.25[7] per acre. Thus, it costs the farmer 20 percent less to harvest with a combine. Moreover, if farmers hire 75 percent of their labor requirements, it costs 45 percent less to harvest by combine. Thus, a farmer not only reduces his harvesting costs, but he does not have to recruit and supervise as much labor if he harvests with a combine.

Who Benefits From the Current Combine Strategy?

The benefits of a major increase in combine harvesting would accrue to the relatively few--about 100 of the 6,100 rice producers--who are fortunate enough to be able to hire combines. These farmers are typically the larger, wealthier producers who receive a subsidy of about ¢3.00 for each bag that is combine harvested. On the other hand, the principal losers of subsidized combine harvesting are the displaced

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[6] Bagging combined paddy requires 1.7 man-days per acre. 1.7 X .50 X ¢0.95 = ¢0.80.

[7] The total labor requirement for manual harvesting is 23.7 man-days per acre. 23.7 X .50 X ¢0.95 = ¢11.25.

workers who lose about ₡0.95 per man-day, or between ₡30-90 during the harvesting period, depending on the number of days worked. Loss of income of this magnitude significantly reduces the welfare of the rural poor along with their capacity to provide adequate food, clothing, and shelter for their household. This loss in cash income also reduces the capacity of small farmers to purchase improved seed, fertilizer, and other inputs.

Effects of Charging Farmers the Economic Cost of Combine Services

If farmers were charged the estimated economic cost of combine harvesting (₡4.30 per bag), the cost to combine harvest an acre with a yield of eight bags would be ₡34.40 as opposed to ₡8.00 now charged. The total cost, including hired labor for 60 percent of the bagging requirements, would be ₡35.35. Comparing ₡35.35 per acre for combine harvesting with ₡13.45 for manual harvesting, the hand method would thus cost 62 percent less. If 100 percent of the labor required by both systems were hired, hand harvesting would cost about 38 percent less than combine harvesting (₡36.00 vs. ₡22.40).

At the present average wage rate, there is a shortage of labor for harvesting. This has been the situation in the region in recent years and was one of the reasons for introducing the combine harvester. With the introduction of the combine, wages have not been permitted to rise because increasing numbers of farmers have substituted subsidized combine harvesting for hired labor. However, if combine charges were to increase so that the cost of hired labor was competitive with combine charges, there would be an increase in the demand for labor, because manual harvesting would be cheaper than combine services and wages for labor would increase. While we do not have the data to estimate the elasticity of supply of labor for rice harvesting, wage increases would augment the supply of harvest labor, particularly labor migrating from other regions where there is seasonal unemployment.

Summary

In this chapter the employment and income distribution implications of alternative production systems were studied. The variation in labor requirements among production systems was analyzed, followed by an analysis of the composition of the labor supply in terms of (1) family and hired labor and (2) men, women, and children. The employment and income distribution implications of a major shift from manual to combine harvesting were also examined.

The average man-hours per acre for all field activities among the five bottomland systems ranged from a high of 220 man-hours for the 16.9-acre THS system to a low of 38 man-hours for the 119-acre tractor owner system. The amount of weeding and the method of harvesting were found to be principal determinants of the variation in labor utilization among all systems. With the exception of one system (System I), as farm size increased, man-hours per acre in weeding declined. With the exception of the most capital intensive system (System V), about 73 percent of the total labor were employed in harvest activities. Further, our analysis showed that the total labor utilization by the upland bullock system is three times greater per acre than the most labor intensive bottomland system. This is due to greater labor utilization in weeding and harvesting and the labor requirements associated with bullock plowing and hand harrowing.

Family labor was supplemented by hired labor for all six production systems. As acreage increased, the proportion of hired labor also increased from a low of 38 percent (System I) to a high of 75 percent (System V) of total labor requirements. Most hired labor was employed for cutting, followed by weeding and heaping activities.

There was considerable variation in the role of men, women, and children on rice farms. For all five bottomland systems the percentage of total man-hours supplied by men, women, and children was 57, 33, and 10 percent, respectively. Men performed most of the preharvest activities, particularly broadcasting of seed, and among harvest activities, men did most of the cutting and heaping. Threshing, winnowing, and bagging were predominantly the work of women. Our analysis showed that manual harvesting requires 142 man-hours per acre and combine harvesting 10 man-hours, under average yield conditions. Under the Ministry of Agriculture's subsidized combine service policy, farmers are encouraged to hire combine services as it costs between 20 to 50 percent less than it would to hire labor for manual harvesting. Nevertheless, for every 1,000 acres harvested by combine, 22,000 man-days of casual labor are potentially displaced, and if 50 percent of the labor requirements are hired and the remaining labor is provided by family labor, our analysis revealed that these casual workers could lose ₵10,450 in wages for every 1,000 acres harvested by combine.

CHAPTER VI

SUMMARY AND POLICY PRESCRIPTIONS FOR IMPROVING THE ECONOMIC PROFITABILITY OF RICE PRODUCTION IN THE NORTHERN REGION OF GHANA

Summary

Like most developing countries, Ghana has had to increasingly rely on food imports over the past decade to augment domestic production. In 1972 the National Redemption Council attempted to increase food production through its "Operation Feed Yourself" program by creating a national awareness of the importance of agriculture among Ghanaians and stressing self-reliance and self-sufficiency in food production. In particular, government has given high priority to increasing rice production. However, there is a lack of basic data on the costs and returns of present and alternative rice production systems. This study generates farm level data to estimate the costs and returns for six rice production systems in northern Ghana. In addition, the study analyzes the efficiency, output, employment, and income distribution implications of the six production systems.

In Chapter II the Northern Rice Production Industry was reviewed. The physical conditions in the region are adaptable to the production of rain-fed paddy. In 1971 there were an estimated 6,100 farmers producing rain-fed paddy, 50 percent of whom were producing rice on five acres or less. About 90 percent were producing paddy on 15 acres or less, and there were about 100 farmers with rice farms larger than 100 acres.

The Northern Region Rice Industry has been characterized by a rapid acreage expansion. The acreage of rice expanded from about 28,000 acres in 1968 to about 90,000 acres in 1974. During the same period average yields increased from about 800 to 1,200 pounds per acre. The major factors that have contributed to such a rapid increase in rice production in the Northern Region have been:

1. Easy access to free, unutilized bottomlands not requiring a great deal of clearing;

2. Increased imports of tractors and associated equipment in recent years for sale to private farmers and individuals desiring to engage in private custom plowing;

3. Subsidized selling prices of tractors and associated equipment with resulting low custom plowing charges and land preparation costs for tractor owners;

4. An increasing guaranteed floor price for paddy as established by the Government Rice Mills Unit;

5. Increased availability of subsidized improved seed and fertilizer;

6. Artificially high financial returns resulting from high input subsidies;

7. Prestige associated with land extension and large individual rice farms;

8. More recently, the introduction of subsidized combine harvesting services by the Ministry of Agriculture.

Except for mechanized land preparation, all field activities, including the application of seed and fertilizer, weed control, and harvesting, have been undertaken manually by the vast majority of rice farmers. Few combines were in operation in the region before 1973, although in 1973 the MOA imported and operated in the Northern Region 31 self-propelled combines, machines which were hired to farmers at a heavily subsidized rate. An analysis of the Ministry's combines did indicate that the service encountered organizational problems and heavy losses in its first year of operation.

With the rapid expansion of rice production, the demand for casual labor to work on rice farms has dramatically increased in recent years. However, a shortage of labor during the harvest has recently developed and, as a consequence, combine harvesting was introduced into the region.

The research methodology employed for this study was described in Chapter III. The Cost Route Survey Method was used to collect farm data by continuously interviewing a sample of farmers over the May 1973 to February 1974 period. During the 1973-74 crop season, 161 farmers were interviewed. The purpose of the field survey was to obtain farm level input/output data in order to estimate the relative financial costs and returns of the major rice production systems in Northern Ghana.

The sample size was determined by a fixed budget, which permitted the hiring of 15 field enumerators, and by the number of farmers that an enumerator could effectively interview. All enumerators participated in a 10-day training course prior to the survey. Enumerators interviewed farmers a minimum of twice a week over a 10 month period. To measure labor utilization, data were collected on an activity-by-activity basis, separately for family and hired labor. These data were recorded on the basis of the number of field hours and the type of labor (men, women, and children). For hired labor information was also collected on wage rates, total labor expenditures, and the estimated value of payments in kind. Total production was estimated by a physical count of the number of bags harvested by each farmer. To estimate farm size, each sample farm was measured after harvest by the triangular method.

Five major bottomland systems and one upland system were defined for analysis on the basis of power source used for land preparation and seed variety. Three of the bottomland systems were based upon farmers hiring private tractor-hire services (traditional, improved, and mixed seed varieties); two bottomland systems were based upon tractor owners (traditional and improved seed varieties); and one upland system was based upon farmers using traditional seed varieties and the bullock plow for land preparation.

In Chapter IV the private and economic costs and returns were estimated for each of the six major rice production systems. Financial rice enterprise budgets were constructed from survey data, and for each rice enterprise budget a net cash return to operating capital, family labor, and management was derived. The budget data were then used to derive financial returns to (1) family labor, (2) operating capital expenditures and (3) management, as well as costs of production. The returns to family labor among the five bottomland systems ranged from ₵252 for System I to ₵3347 for System V, while the return to operating capital varied from 15 percent of total operating expenditures (System VI) to 66 percent (System III). The five bottomland systems had a high return to management after opportunity costs were assigned to family labor and operating capital. However, for the upland system (System VI) there was a zero return to management, primarily due to the large input of family labor.

Among the five bottomland systems, there was a 28 percent variation in the financial costs of production. The 119-acre tractor owner system using improved seed (System V) had the lowest financial cost of production (¢104 per ton), whereas the upland bullock system had the highest cost of production (¢179 per ton).

Following a comparative financial analysis of the production systems, an economic analysis was undertaken. In order to evaluate the production systems from an economic point of view, unsubsidized costs of nonlabor inputs were estimated. The resulting economic costs of production among the bottomland systems were,on the average, 47 percent greater than the financial estimates, the variation depending upon the mix of capital items and the relative rates of subsidy among nonlabor resources.

Capital-labor ratios were computed and showed that the capital intensity of the two tractor owner systems was high, particularly in the case of the 119-acre system. The analysis revealed that the high C/L ratio was due to two complementary factors: as farm size increased, the use of mechanized harvesting increased and the labor utilization per acre decreased in harvesting and weeding.

The method of accounting used to evaluate the production systems altered the relative ranking of the system. When market prices were used to value resources (financial analysis), the large-scale, capital intensive system (System V) had the lowest cost of production (¢104 per ton). However, when economic prices were used, this sytem had the highest cost of production (¢193). This high cost system was characterized by the highest C/L ratio and the largest acreage, the greatest degree of combine harvesting, and the lowest average labor utilization per acre. In contrast, System III had the lowest economic cost of production (₡141) and was characterized by the highest yield and labor utilization per acre, the lowest C/L ratio, and the second smallest acreage among bottomland systems. The upland bullock system had the highest cost of production from both the financial and economic point of view.

Our analysis showed that rice farmers under present policies are receiving substantial income support through subsidized combine harvesting services, seed, fertilizer, and land preparation. The variation in income support from factor subsidies ranged from 26 percent of the net return to operating capital, family labor, and management (System VI) to 150 percent for the large-scale, capital intensive system (System V). The system with the lowest economic cost of production had the lowest proportion of its financial income derived from factor subsidies, whereas the system with the highest economic costs of production had the highest proportion of its income derived from subsidies.

The economic analysis further illustrated that all production systems, except the 16.9-acre THS system (System III), generated economic losses from the national point of view. Current policies are encouraging farmers to expand farm size, thereby using subsidized capital intensive and labor-saving production practices. The resulting artificially high incomes provide incentives for farmers to adopt production practices which are financially profitable but uneconomic from the national point of view.

Two contrasting production systems--small scale versus large scale--were analyzed in detail in order to identify more clearly the trade-offs among (1) capital requirements, (2) farm employment, (3) producer income, (4) output,and (5) economic profitability. One production system represented a small-scale, labor intensive approach to rice production and a second represented a large-scale, capital intensive approach to production. The analysis showed that, from a financial point of view, the returns to management were high for both systems and the costs of production were about equal were the lowest of all systems studied. However, from an economic point of view the small-scale approach to rice production had substantially lower capital requirements and costs of production than did the large-scale system. The small farm system was thus economically profitable, whereas the large-scale production approach generated substantial economic losses.

In Chapter V the employment and income distribution implications of alternative rice production systems were analyzed. The composition of the labor supply in terms of (1) family and hired labor and (2) men, women, and children was identified. Our analysis illustrated a wide variation in the average man-hours per acre among the bottomland production systems, from a high of 220 man-hours for the 16.9-acre tractor-hire system to a low of 38 man-hours for the 119-acre tractor owner system. The principal cause for such variation in employment among the production systems was the method of harvesting and the intensity of the weeding operation. We found that, with the exception of one system, as farm size increased, man-hours per acre in weeding declined. With the exception of the most capital intensive production system, about 73 percent of the labor were employed in harvest activities.

For all field activities among all production systems, family labor was supplemented with hired labor. Our analysis also showed that as the acreage of the system increased, the proportion of hired labor increased from a low of 38 percent (System I) to a high of 75 percent (System V) of total labor requirements. In general, the greatest proportion of hired labor was employed for cutting, followed by weeding and heaping activities. For all bottomland systems the average proportion of the total man-hours supplied by men, women, and children was 57, 33, and 10 percent, respectively. Among pre-harvest activities, men dominated all field activities, particularly the broadcasting of seed. With regards to harvest activities, cutting and heaping were mainly performed by men, while women dominated threshing, winnowing, and bagging.

The employment and income implications of a shift from hand harvesting to combine harvesting were also analyzed. We estimated that at current average yield levels manual harvesting requires 142 man-hours per acre, whereas combine harvesting requires 10 man-hours per acre for bagging. Our analysis showed that at current subsidized charges for combine services, farmers are encouraged to adopt combine services as it costs less to harvest with a combine than to hire labor. Our estimates also revealed that as combine harvesting expands, 22,000 man-days are potentially displaced per 1,000 acres harvested by combine. Thus, if, on the average, 60 percent of the total labor requirements for manual harvesting are hired, we estimate that casual workers would as a group experience a loss in income of about ₵12,700 per 1,000 acres harvested by combine.

Tentative Policy Recommendations to Improve the Performance of the Northern Region Rice Production Sector

This study provides planners in Ghana with some of the data required to identify the trade-offs among efficiency, output, employment, and income distribution for alternative rice production strategies. The survey data have permitted a detailed analysis of the farm-level trade-offs for six rice production systems. However, we do not have regional and macro-economic data to rigorously trace the direct and indirect implications of these alternative production systems for the Northern Region and the national economy. With this caveat, this dissertation will pose major policy issues facing Ghana and then conclude with tentative recommendations as to how to improve the performance of the rice industry in Northern Ghana.

Major Policy Issues

The present study indicates that the production strategies being pursued in the bottomlands of Northern Ghana are providing rice producers with high financial returns, but at a high cost to the Ghanaian economy. This study has also identified the key policy issues which Ghanaian policy makers should consider:

Capital Intensity. The current policies of subsidized land preparation and combine harvesting encourage farmers to (1) expand farm size, (2) tolerate low yields per acre, (3) use increasing amounts of imported capital, and (4) reduce labor inputs, especially in harvesting. However, with declining foreign exchange reserves and an anticipated foreign exchange gap in the years ahead, it is unlikely that the present capital intensive approach can be sustained. Thus, it will be necessary for planners to identify production strategies requiring less foreign exchange. One way to reduce the presently high capital-labor ratio in harvesting would be to identify national policies which could stimulate an internal migration of labor at harvest time to ease the present harvesting constraint and reduce the demand for combine harvesting.

Income Distribution and Employment. Capital input subsidies are providing large income transfers to about 100 large scale, capital intensive rice producers. Yet subsidized combine harvesting is displacing large numbers of casual workers, and the loss of income to these workers is substantial. To improve income distribution and employment in the northern rice production subsector, a major small farm rice production campaign should be designed and implemented as soon as possible.

Land Expansion. Although land expansion has been rapid among bottomland producers, there are a number of unfavorable medium and long term consequences of this strategy. The land extensive strategy is resulting in low average yields, increasing weed infestation, and declining soil fertility on farms with a low record of fertilizer use. As soil fertility declines on farms with a low record of fertilizer use, farm abandonment will likely increase. A less land extensive strategy could foster soil maintenance and increased yields and, thereby, reduce land expansion and the requirement for an increasing stock of tractors and associated equipment for land preparation.

Foreign Exchange Constraint and Factor Subsidy Burden. Our study has shown that the rates of subsidy on capital inputs (mechanized land preparation, combine harvesting, improved seed,and fertilizer) are very high. As increasing numbers of farmers adopt and/or increase their use of subsidized capital resources, there will be an increasing federal budgetary burden to finance subsidies and growing pressure on constrained foreign exchange reserves for the importation of equipment, spare parts, fuel, and fertilizer. Hence, one of the major challenges facing policy makers in the immediate future will be to identify means to reduce both foreign exchange requirements and input subsidies while at the same time providing farmers with incentives to increase rice production.

Recommended Policy Reorientation

Policy makers undoubtedly believe that there is a need for large-scale, capital intensive farms on the northern bottomlands because of their demonstrated ability to achieve dramatic short-run increases in output. Under the current focus, however, the small rice farmer has been neglected by the government's output strategies. This study illustrates that it is the small farm production campaign which would (1) be a lower cost approach, (2) generate more employment, (3) improve income distribution, and (4) require less foreign exchange and input subsidy support.

As a consequence, this author believes Ghanaian policy makers should give careful consideration to a major reorientation of the government's rice production strategy. He recommends that at the current time less emphasis be placed on achieving self-sufficiency by assisting only about 200 large-scale farms, and more emphasis be given to achieving increases in production by large numbers of small farms. A further recommendation proposes that government planners design and implement a small farm rice production campaign. While Ministry of Agriculture personnel are in a far better position to judge the desirable scope

of a small farmer campaign, this author would maintain that it is probable that the Ministry of Agriculture could include 500 farmers or 2,500 acres in the first year and expand to about 2,000 farmers or 10,000 acres over five years.

The following section will trace the output, employment, and income distribution implications of both small farmer and large farmer rice production strategies.

Small Vs. Large Farmer Production Strategies: Output, Employment, and Income Distribution Implications of a 35,000 Acre Rice Production Campaign

In this section we will analyze the employment and income distribution implications of two hypothetical production strategies.[1] In the analysis which follows we are assuming that a production campaign is focused on 35,000 acres of bottomland in Northern Ghana.

The input-output data used in the analysis is drawn from the rice enterprise budgets in Chapter IV.[2] The small farm system used tractor-hire services for land preparation, improved seed, above average fertilizer-use, and manual harvesting. The large farm system was composed of tractor owners who used improved seed, fertilizer, and combine harvesting.

Output, Employment, and Income Distribution Effects

If a rice production campaign were focused upon labor intensive, small farms, we estimate that about 24,500 tons of paddy would be

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[1] For a good example of this approach and the need for empirical farm level data, see Marsdan, 1969.

[2] See "Comparison Between Small Farm and Large Farm Rice Production Strategies" Chapter IV.

produced on 35,000 acres. If the campaign were focused upon large-scale, capital intensive farms, however, about 28,700 tons of paddy would be produced (Table 6.1). The large farm strategy would thus produce about 17 percent more total output; but, as our analysis in Chapter IV shows, the output by the capital intensive strategy would be produced at a high cost to society.

Table 6.1. Projected Output, Employment, and Income Impacts of a 35,000 Acre Rice Production Campaign in Northern Ghana: Small Farm Vs. Large Farm Strategies

Indicator	Units	Small Farm		Large Farm	
		Per Acre	35,000 Acres	Per Acre	35,000 Acres
Output	Bags	8.7[1]	304,500	10.2[2]	357,000
	Tons		24,470		28,688
Employment	Man-Days	30.6[1]	1,071,000	6.8[2]	238,000
	Man-Months		44,625		9,917
Net Farm Income	Cedis	60[1]	2,100,000	63[2]	2,205,000
Input Subsidies	Cedis	27[3]	945,000	81[3]	2,835,000

[1]Derived from Table 4.15. Man-hours are converted to man-days by assuming six man-hours per man-day. Man-days are converted to man-months by assuming 24 working days per man-month.

[2]Derived from Table 4.14.

[3]Derived from subtracting nonlabor financial expenditures (Rice Enterprise Budgets) from nonlabor economic costs (Table 4.17) and converting each to a per acre basis.

Aggregate employment would be markedly different for the two production strategies. The small farm strategy would generate employment of 1,071,000 man-days, whereas the large scale, capital intensive strategy would employ only 238,000 man-days, or realize 77 percent less aggregate employment.[3]

In terms of net farm income, <u>both</u> strategies would generate about equal aggregate income. However, under present policies, the large-scale, capital intensive system would require ¢2.8 million in government support to producers in the form of capital input subsidies. On the other hand, a small farm production campaign would require only ¢0.9 million, or about 66 percent less from the government budget.

<u>Income Distribution Implications</u>

Table 6.2 reveals the dramatic difference in the number of producers between small farm and large farm strategies. If the average size of the rice enterprise were four acres, then about 8,750 producers would be producing rice on 35,000 acres. If, on the other hand, the average farm size were 100 acres,then only 350 would be required to exhaust 35,000 acres.

If a small farm production campaign were pursued and the average farm size were four acres, then our estimates show that 8,750 rice producers would each receive about ¢240 of net income from the production of rice. If, on the other hand, a production campaign focused on one hundred acre farms, 350 farmers would each receive about ¢6,300 in net income. The latter approach concentrates high producer incomes among a few farmers and would greatly aggravate income distribution in Northern Ghana. Under a small farm campaign, given current subsidy policies on capital inputs, ¢945,000 in factor subsidies would be

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[3]As shown in Chapter IV,the primary reason for the difference in labor utilization between these two strategies is employment in harvesting and weeding.

Table 6.2. Producer Income Distribution Implications of a 35,000 Acre Rice Production Campaign in Northern Ghana: Small Farm Vs. Large Farm Approach

Small Farm				Large Farm			
Size of Farm (Acres)	No. of Farmers	Net Cash Income Per Farmer[1]	Gov't. Transfer Per Farmer[2]	Size of Farm (Acres)	No. of Farmers	Net Cash Income Per Farmer[1]	Gov't. Transfer Per Farmer[2]
		------------Cedis------------				------------Cedis------------	
2	17,500	120	54	100	350	6,300	8,100
4	8,750	240	108	200	175	12,600	16,200
6	5,833	360	162	300	117	18,846	24,231

[1]Derived by dividing aggregate net farm income (Table 6.1) by the number of farmers.

[2]Derived by dividing the value of the aggregate government transfer (Table 6.1) by the number of farmers.

required to support 8,750 four acre farmers in terms of subsidized factor prices. On the other hand, ¢2.8 million would be required to support 350, one hundred acre farmers under a large farm campaign. The government support would thus be ¢108 and ¢8,100 per producer under a small and large farm production campaign, respectively. The resulting distribution of government funds favors high income as opposed to low income members of society.

Employment Implications for Casual Workers

The potential income received by casual workers depends in part on the degree to which family labor is supplemented by hired labor. If, under a small farm campaign, farmers on the average hired 50 percent of their labor requirement, then about ¢535,500 would be paid to hired laborers. If large-scale, capital intensive producers hired 90 percent of their labor requirement, then only ¢214,200, or 40 percent less would be paid to casual laborers. Thus, a small farm production campaign would generate more employment and income for casual workers (Table 6.3).

Summary

Aggregate employment would be markedly different depending on whether a small farm or a large farm, capital intensive strategy is pursued by Ghana in the future. We estimate that a small farm production strategy would generate one million man-days of employment, whereas a large-scale, capital intensive strategy would employ only 240,000 man-days, or 77 percent less labor. In terms of net farm income, both strategies would generate about the same net farm income in the aggregate. A small farm strategy would generate an estimated

Table 6.3. Income Distribution Implications of a 35,000 Acre Rice Production Campaign for Casual Workers in Northern Ghana: Small Farm Vs. Large Farm Approach

Proportion of the Labor Requirement Hired (Percent)	Income Paid to Casual Workers[1]	
	Small Farm	Large Farm
30	¢321,300	¢ 71,400
50	535,500	119,000
70	749,700	166,600
90	963,900	214,200

[1]Derived by multiplying man-days from Table 6.1 by the appropriate proportion of the labor requirement hired and multiplying the resulting sum by ¢0.95 per man-day.

¢240 in net income for 8,750 small farmers, whereas a large farm strategy would concentrate very high producer incomes (over ¢12,000) among only 200-400 rice producers.

With the government's present subsidy policies, a large farm strategy would require an estimated ¢2.8 million to subsidize factor prices, whereas a small farm strategy would require only ¢0.9 million. The employment of casual workers would be dramatically different under the two production strategies, and the amounts of aggregate income paid to casual workers would be more than double under a small farm production campaign.

Recommended Components of a Small Farm Production Campaign

Policy changes are identified for the evaluation of Ghanaian policy makers. For each, a tentative policy action is recommended for the consideration of government decision makers who determine national agricultural policy and planners involved in the rice development program.

1. Reorienting the Extension Service to Focus on Improving the Production Practices of Small Farmers.

In the Northern Region the focus of the Extension Service has been almost exclusively on large scale, capital intensive rice producers. The proposed policy reorientation will require extension officers to focus upon the production problems of small farmers which will, in turn, demand the retraining of extension personnel in order for them to be effective change agents among the new target group. Since small farmers are also engaged in the production of other crops such as maize, sorghum, groundnuts, and yams, the training program should not be exclusively centered on the production problems and recommended cultural practices of rice. Extension officers will have to be equally effective change agents for other crops in order to gain the confidence of farmers and in order to assist with multiple enterprise production problems.

Extension officers should be trained in methods for establishing effective demonstration plots to show farmers how to use improved cultural practices and what the tangible benefits of improved production techniques can be. The training program should also teach extension officers the need and benefits of (1) retarding land extension, (2) increasing yields per acre, (3) maintaining soil fertility, and (4) relying on manual methods of harvesting. Our analysis shows that most farmers are not following recommended production practices; hence, there is a great potential for increasing rice production by encouraging the farmers to apply recommended rates of seed and fertilizer, to undertake timely field activities, to intensify labor use in weeding and manual harvesting, to shorten the harvesting duration, and to plant a combination of traditional and improved seeds, thereby minimizing shattering problems. Extension officers should also be trained to assist farmers to obtain improved seed, fertilizer, hired labor, and credit to purchase improved inputs.

2. Identify and Promote Small-Scale Paddy Threshers.

To remove some of the drudgery associated with manual harvesting and to shorten the duration of the harvesting period, the MOA should embark on a search for proven, low-cost hand threshers. The International Institutes, such as IITA and IRI, as well as aid donors could be asked to assist with the identification and provision of appropriate small-scale threshers for trial purposes. The MOA in collaboration with the Ghanaian Society of Agricultural Engineers should undertake on-farm performance trials to evaluate the relative effectiveness and durability of a range of hand threshers. Farmers, and particularly women, should be involved in these trials to identify the machine(s) they prefer. When one to two effective low-cost threshers are identified, the MOA should import about 50-100 hand threshers to be sold to farmers. If sales and performance then prove to be good, larger quantities should be imported or, preferably, manufactured locally.

3. Foster an Internal Migration of Seasonal Labor to the Northern Region.

To encourage an internal migration of unemployed and underemployed labor to the Northern Region to harvest rice during October through December, each September the government should launch a major propaganda campaign to inform the public of the employment opportunities on northern rice farms during the harvesting season. The government should also consider establishing low-cost labor stations where workers seeking farm employment can congregate and farmers can recruit contract labor.

Encouraging internal migration as a source of supply of labor for harvesting should be the immediate priority. However, it is likely that weeding requirements will become increasinly critical as the harvesting constraint is minimized. Therefore, the MOA should determine to what extent migratory labor will be required and, if necessary, launch a propaganda campaign to encourage labor migration to the bottomlands to engage in weeding activities.

4. Encourage A Combination of Seed Varieties to Ease the Harvesting Constraint.

To help ease the harvesting constraint, the Extension Service should encourage farmers to plant part of their farms to short maturing improved varieties and part to longer maturing traditional seed varieties. If the shorter maturing, higher yielding improved seed varieties are harvested first, followed by the longer maturing traditional varieties, the harvesting period can be prolonged and the potential shattering losses minimized. The proportion of the farm planted to improved varieties will depend upon farm size and the supply of labor individual farmers can realistically expect to engage during the harvesting operation.

Longer maturing varieties would significantly ease the shattering losses and thereby reduce a critical seasonal harvesting bottleneck. Moreover, a shift to longer maturing varieties would complement hand harvesting methods and reduce the potential benefits of early combine harvesting. Other desirable seed characteristics should be incorporated as a selection criteria for the screening trials. These would include (1) resistance to blast, (2) resistance to shattering, and (3) yield response to low application rates of fertilizer.

Given current and anticipated world fertilizer prices, it would be highly advantageous to identify medium yielding paddy varieties which do not require high fertilizer application rates in order to achieve desirable yield levels. There is an important economic trade-off between (1) yield and (2) fertilizer requirement which, given Ghana's foreign exchange position, probably should be weighted more heavily toward medium yield varieties requiring less fertilizer.

5. Proposed Seed Sales Policy.

Improved seed varieties are multiplied and sold to farmers by the Seed Multiplication Unit of the MOA. Farmers purchase seed with cash or with credit vouchers from lending institutions and are not required to purchase fertilizer when they purchase improved seed. In order to foster increased yields per acre, it is recommended that improved rice seed be sold to farmers only under a condition that they present evidence (sales receipt) that they have purchased the appropriate complement of fertilizer. If farmers were required to purchase recommended quantities of fertilizer, this would encourage them to shift away from a land extensive approach to a yield intensive production system.

6. Seed Selection Trials

The Crops and Soils Research Institute at its Northern Region Nyanpala Station should undertake screening trials to identify high yielding seed varieties which are longer maturing than the 115-day improved varieties presently being promoted. Varieties with about 130-day maturity would be more appropriate for the Northern Region ecological zone. The West African Rice Development Association (WARDA) and IITA at Ibadan should be encouraged to suggest and supply appropriate seed stock for the screening trials.

7. Expanded Soil Testing Program.

The MOA has a soil sampling program whereby farmers and Extension Officers can bring to the Regional Headquarters soil samples for testing pH, organic matter, and nutrient content for the purpose of determining appropriate cultural practices. Given problems of declining soil fertility and weed infestation on some farms and the reports of rice farm abandonment, we recommended that this program be greatly expanded. A systematic soil sampling campaign should be undertaken, taking care to obtain, in addition to soil samples, a history of cultural practices (mechanization practices, seed varieties, fertilizer use) and estimated yields for each sample farm.

It is recommended that about 200-300 rice farms drawn from major bottomland areas throughout the region be established as an ongoing rice land soil testing sample. The soils of these sample farms should be tested annually over five years. Each year data should be obtained about cultural practices and paddy yield. From this program the MOA can objectively determine what is happening to soil fertility and the relative nutrient status of bottomland rice soils over time. The analysis will be useful in evaluating current recommended cultural practices, particularly fertilizer recommendations.

8. Weed Control Techniques.

The present study has identified problems of (1) weed infestation, (2) late or prolonged weeding activities, and (3) low labor utilization in weeding on large farms. At the present time the MOA recommends two to three mechanical harrowings and manual weeding to control weeds. The MOA has undertaken aerial spraying on a pilot basis to determine if the technique is effective for weed control on large farms. For the majority of farmers, however, this control technique is not a practical solution.

As a short term policy objective, we encourage a migration of labor to assist with weeding activities. In the longer term we believe that simple, low-cost intermediate technology will be required. To this end we recommend field trials to identify low-cost hand sprayers which can be locally manufactured. In collaboration with these trials, low-cost, effective, easy to use, and safe chemicals need to be identified.

9. Reorient Credit Eligibility Requirements and Substantially Increase the Stock Funds for Production Loans to Small to Medium Sized Farms.

In order to focus a production campaign on small rice farms, the credit eligibility policies of the Agricultural Development Bank (ADB) should be changed. Credit priority should be given to rice farmers with less than 10 acres, and farmers with more than 50 acres should be excluded from eligibility for ADB loans.[4] Larger farmers should be required to use other commercial lending institutions.

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[4]Present lending policies of the ADB favor rice farmers with above 50 acres. Among rice farmers receiving credit, the majority are tractor owners.

To support the proposed production strategies, the ADB should establish two types of lending policies for rice farmers. One group of farmers would be provided with credit for land preparation, seed and fertilizer, and hired labor. No farmer would receive credit for combine harvesting. The current policy of providing credit in kind for seed and fertilizer should be continued. Further, credit policies should be designed in such a manner that a high proportion of the production loans are used for the purchase of improved seed and fertilizer (at recommended rates) and the contracting of hired labor for manual harvesting and weeding.

The second group of farmers would receive seasonal credit only for the purpose of hiring labor for harvesting. It is envisioned that as much as 25 percent of the farm loans should be in this latter category, thus providing added support to a labor intensive harvesting strategy.

10. Improvement in the Input Distribution and Product Marketing Systems.

The present plan to establish a network of small, rural, low-cost input supply depots in major production centers in the north should be expanded to improve the distribution of improved seed and fertilizer to small farmers.[5] In addition to supplying production inputs, it is recommended that these depots be used at harvest time as paddy buying centers of the Rice Mills Unit of the MOA.

It is further recommended that "supply depots/buying centers" be

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[5] The Ghanaian-German Agricultural Development Project [for the] Northern and Upper Regions has conceived of this plan and is presently financing a small network of rural input supply depots in the Northern and Upper Regions.

used as an institutional arrangement to provide credit to farmers as a means to increase the adoption of improved seed and fertilizer. Farmers with less than 10 acres who meet minimum standards[6] should be supplied in May and June with appropriate quantities of improved seed and fertilizer from the rural supply depots. Farmers would not be required to pay for these inputs at the time of delivery, but rather would receive the inputs as credit-in-kind to be repaid at harvest time. Farmers receiving such credit would then repay their loansby delivering to the supply depot at harvest time the equivalent value of paddy, the value being determined by the going market price. The paddy would be turned over to the Rice Mills Unit, and the Mill would pay the Ministry of Agriculture for the paddy received.

Recommended Policy Changes for Large-Scale Rice Production

Several of the above policy recommendations for a small farm production campaign are equally appropriate for the large-scale farms. The three policy recommendations which follow are proposed to reduce the economic losses[7] resulting from large-scale rice production.

1. Retard the Expansion of Combine Harvesting.

Over the next two crop seasons, the MOA should increase its custom rates from the present charge of ₵1.00 per bag to the estimated

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[6]It is envisioned that District Extension Committees on the recommendation of local extension officers would screen and certify farmers who are eligible for credit. During certification the quantity of seed and fertilizer to be provided as credit-in-kind would be stipulated.

[7]Economic losses from the national point of view. Input subsidies are reduced to zero and output is valued at the economic import parity price. See Chapter IV for the procedure adopted to calculate economic costs and benefits.

economic cost of ¢4.00 per bag. This policy change would have several desirable spin-offs. Private combine owners engaged in custom harvesting would follow the lead of the MOA and increase their contract charges so that the average cost of combine harvesting would be above the cost of manual methods of harvesting, thus making labor competitive with the combine. This would retard future labor displacement and increase the demand for casual labor in harvesting. Given the shortage of casual workers in the bottomland areas, wage rates would increase. Expanded employment opportunities coupled with increased wage rates would then stimulate the migration of unemployed and underemployed labor to the Northern Region to seek work during the harvesting period.

The Ministry should discontinue its combine harvesting services after the present combines have deteriorated. In addition, the government should discontinue importing combines and import only the required stock of spare parts to maintain the present privately owned machines. It is the author's opinion that combines should be used only on the large rice farms over 50 acres. Caution should be exercised so as not to create an excess capacity of combine harvesting services because of the major labor displacement that would be realized as documented by our analysis. Farms of less than 50 acres should be required to harvest manually with the assistance of small-scale paddy threshers.

2. Increase the Cost of Land Preparation by Imposing a Tariff on Imported Tractors and Associated Equipment.

In order to retard land expansion, the cost of land preparation must be increased. This can be achieved by placing a tariff on imported tractors and associated equipment. It is thus recommended that the government place a tariff of about 50 percent on imported tractors and associated equipment. The increased tariff, which should be phased over two to three years, will increase the cost of land preparation among tractor owners and force private contractors to increase their custom rates. This higher cost of land preparation will then discourage extensive production methods and encourage yield increasing techniques. We believe that farmers will be encouraged to increase yields per acre to maintain their present returns from rice production. Given the yield response to fertilizer on field trials, increased yields of 30-50 percent are within reach of farmers applying fertilizer at recommended rates and undertaking other recommended cultural practices.

3. Inventory Tractors and Associated Equipment to Determine if Tractor Imports Should be Temporarily Suspended.

In addition to a tariff on imported machinery and equipment, the MOA should immediately take an inventory of the number of tractors operating in the region and identify the approximate acreage that can be mechanically prepared with the present stock of tractors and associated contract services. The purpose of such an inventory should be to determine whether tractor imports should be temporarily suspended and to ascertain the estimated import requirements of associated equipment and spare parts. A temporary shortage of plowing services would assist with increasing contract charges,thereby discouraging farmers from expanding farm size. There would be an additional benefit in that tractor owners would be encouraged to increase the income earning utilization of their machinery.

4. Create Land Values by Imposing a Land Tax.

In order to discourage farmers from expanding farm size too fast, the government should consider the merits of imposing a land tax on bottomland rice producers. This imposition, in collaboration with the tariff on imported machinery, would discourage land expansion.

Free access to bottomland is a major contributing cause of land expansion. The current cost of land, which is embodied only in the cost of clearing, does not reflect the economic value of land. A land tax would increase the cost of land and thereby create land values. The added cost of land would then retard extensive land use, and farmers would be encouraged to increase their yield in order to pay for the tax and to maintain their farm income.

To obtain the desired results from a land tax, the tax should be imposed on a per acre basis. The result would be that large farmers would have a greater tax bill than small farmers. Policy makers might consider a graduated tax whereby farms of less than 10 acres pay a tax at a low rate, farms of between 10 and 50 acres pay a higher rate, and farms of above 50 acres pay the highest rate. Such a graduated tax would thus place a higher tax burden on large farmers who utilize a greater quantity of the limited stock of bottomlands. It is estimated that the <u>average</u> tax rate to be effective should be equal to the financial value of one-half bag of paddy per acre. At the current guaranteed floor price this would amount to an average tax rate of ¢6.00 per acre.

APPENDICES

APPENDIX A

ADDITIONAL INFORMATION ABOUT TRACTOR OWNERS, FARMERS HIRING PRIVATE TRACTOR SERVICES, AND BULLOCK FARMERS

APPENDIX A

ADDITIONAL INFORMATION ABOUT TRACTOR OWNERS, FARMERS HIRING PRIVATE TRACTOR SERVICES, AND BULLOCK FARMERS

Introduction

The objective of this appendix is to provide the reader with additional information about tractor owners, farmers hiring tractor services for land preparation, and bullock farmers.

Tractor Owners

Introduction

There were 33 farms in the sample classified as farms where the source of power for initial land preparation was obtained from tractor ownership.[1] Of these farms, 30 tractor owners operated 33 farms; the information which follows relates to 25 of these tractor owners.[2]

Occupational Background[3]

Most tractor owners, in addition to producing rice, were undertaking private contract plowing and harrowing for other rice farmers. A relatively large proportion of the tractor owners (60-80 percent)

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[1]Improved seed was used by 19 farmers, traditional seed by 10, and a combination of improved and traditional seed was used by four farmers.

[2]Since rice owners were out of the region at the time of the survey form upon which this data is based was administered, it was not possible to obtain the information from them.

[3]This section is based upon informal interviews during the course of the survey because it was found during pre-testing that it was not possible to secure these data through a formal questionnaire.

had occupations other than rice farming and private contract work. Most of these were retail and wholesale traders, professionals (e.g., businessmen, lawyers, and doctors), and civil servants. Many tractor owners believed that they could pay for their equipment within two years by producing rice on their own farm and undertaking custom-hire work for other farmers.

Number of Years Producing Rice and Farm Size

The 25 tractor owners had been producing rice for an average of about six years. These farmers had been tractor owners from one to five years which implies that they relied upon tractor hire services for initial land preparation before purchasing their own tractors.

The range in farm size among the tractor owners ranged from eight to 469 acres, and the average farm size was 107 acres. The author indirectly estimated that the tractor owners were undertaking the equivalent of 200 acres of contract plowing.

Acreage Expansion

Over the 1971-74 crop seasons, 20 tractor owners reported that they expanded their farm size by an average of 104 percent. Over the 1972-74 production seasons, 25 tractor owners expanded their acreage by 76 percent.[4]

Farm Abandonment

In 1973-74 the 25 tractor owners had been producing paddy on the farm for 3.7 years, and they had been rice farmers for 6.4 years. Six

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[4]These estimates are based on the farmers estimates rather than field measurements over time.

of the 25 farmers had previously abandoned a farm upon which they had operated, on the average, for four years. The reasons given for abandoning the farms were as follows: two complained that their farm had developed too many weeds; three indicated that they were unable to expand their farms because of too many trees to be removed; one farmer complained of a loss of soil fertility.

Use of Improved Practices

Table A.1 reports the use of selected improved practices among the 25 tractor owners. During the survey year 64 percent of the tractor owners were using improved seed. The percentage using compound fertilizer, ammonium sulfate, and combine harvesting was, respectively, 80, 36, and 52 percent. The rate of adoption of combine harvesting and compound fertilizer was greatest among the five improved practices. During the 1971-72 production season 11 farmers were using compound fertilizer, and three farmers hired combine harvesters. However, by the survey year 20 tractor owners were using compound fertilizer and 13 were hiring combine harvesters.

Labor Recruiting Practices

Since many farmers complain of difficulty in recuriting labor to work on their farms, we asked the tractor owners from where they recruited their labor and how difficult it was to obtain labor to work on their farms. Tamale, the regional capital, is an important source of farm labor for tractor owners; however, villages surrounding rice farms are also important sources of labor.

Table A.1. Use of Selected Improved Practices Among 25 Sample Tractor Owners

Improved Practice	Number of Observations[1]	Number of Tractor Owners Using Improved Practices				
		1971/72		1972/73	1973/74	
		No.	%	No.	No.	%
Improved Seed	15	13	48	14	16	64
Compound Fertilizer	18	11	44	19	20	80
Ammonium Sulfate	7	7	28	12	9	36
Tractor Plowing	24	21	84	25	25	100
Combine Harvesting	13	3	12	5	13	52

[1]Data were not obtained from one tractor owner regarding his first year of using improved practices. In addition, one farmer could not recall when he started using compound fertilizer.

Source of Funds for Rice Farming

Farmers were willing to reveal their source of funds for rice farming but not the absolute amount of funds withdrawn from savings and other business enterprises, or borrowed in the form of credit. In 1973-74 10 of the tractor owners obtained their funds from their own savings, 11 from savings and bank credit, and four from bank credit only.

Crops Produced in Addition to Rice

Of the 25 tractor owners, 14 produced crops in addition to rice. Of those producing other crops, the average acreage in other crops was 11 acres. The major crops produced were maize and sorghum followed by yams and millet.

Farmers Hiring Tractor Services for Initial Land Preparation

Introduction

There were 83 sample farms where private tractor services were hired for initial land preparation. The information which follows relates to 79 farmers.[5]

Number of Years Producing Rice and Farm Size

The number of years these farmers had been producing rice varied from one year (three farmers) to 17 years. The average number of years the 79 farmers had been producing rice was about four years, or about two years less than the tractor owners. The variation in farm size among the 79 farmers ranged from 2.8 acres to 74.0 acres, and the average farm size was 18.3 acres; the average farm size among sample tractor owners was 107 acres.

Acreage Expansion

Over the 1971-74 crop seasons, the last being the survey year, 53 farmers, on the average, expanded their farm size by 148 percent. Over the past two crop seasons 41 farmers expanded their farm size, on the average, by 137 percent, 24 farmers had no change in farm size, and nine farmers reduced their farm size by 42 percent.

Farm Abandonment

The mean number of years that these farmers had been producing rice on the farms they were operating during the survey year was three years. Twenty-six of the 79 farmers (or 33 percent) indicated that

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[5] One farmer had three farms in the sample, and we were unable to interview two farmers after harvest with the questionnaire upon which these data are based.

they had abandoned a rice farm since they started producing rice. Among the respondents, the variation in the number of years they produced rice on the farm before abandoning it ranged from one to five years; the average number of years of producing rice before abandonment was 3.2 years. The main reasons given for abandonment, in order of frequency, were as follows: declining fertility; increasing weed problems; too much water; farms too small for extending; and farms too far from the village.

Adoption of Improved Practices

During 1973-74, 66 percent of the sample farmers using tractor hire services were using improved seed and 71 percent were using compound fertilizer. The rate of adoption for five improved practices over three years was greatest for compound fertilizer followed by improved seed. The use of ammonium sulfate and combine harvesting was relatively unimportant among these farmers.

Labor Recruiting Practices

The most important source of hired labor for this group of rice farmers is their own village and surrounding villages. Only 11 of the 74 responding farmers, or 15 percent, obtained at least part of their labor requirements from Tamale, the regional capital. Fifty-two percent of the tractor owners described earlier obtained at least part of their labor from the regional capital.

Source of Funds for Rice Farming

For the crop season surveyed, 59 (75 percent) of the farmers in this category obtained their funds from savings, 14 (18 percent) obtained credit from a lending institution, three financed their costs from personal savings and bank credit, one farmer obtained a loan for part of his costs from a trader, and two farmers did not respond.

Table A.2. Use of Selected Improved Practices Among 79 Farmers Using Tractor Hire Services for Initial Land Preparation

Improved Practice	Number of Observations	No. of Farmers Using Improved Practice				
		1971/72[1]		1972/73[2]	1973/74	
		No.	%	No.	No.	%
Improved Seed	53	21	37	39	53	66
Compound Fertilizer	57	15	26	24	57	71
Ammonium Sulfate	19	8	14	11	19	24
Tractor Plowing	79	54	95	76	79	100
Combine Harvesting	8	1	2	2	11	14

[1]Based upon the response of 53 out of 57 farmers who were producing rice in 1971-72; thus, the percentage is computed on the basis of 57 farmers.

[2]Seventy-six of the 79 farmers were producing rice in 1972-73; thus, the percentage is computed on the basis of 76 farmers.

Crops Produced in Addition to Rice

Fifty-five of the 79 farmers (70 percent) said that they produced other crops in addition to rice. We found that a greater proportion of the farmers with small rice farms produced other crops than did farmers with large rice farms. Eighty-eight percent of the farmers with rice farms less than five acres in size produced other crops, and only 52 percent of the farmers with rice farms over 25 acres produced other crops (Table A.3).

Table A.3. The Relative Importance of Rice and Other Crops Among 79 Sample Rice Farmers Hiring Tractor Services for Initial Land Preparation During the 1973-74 Crop Season

Acres of Rice: Range	Acres of Rice: Average	Number of Farmers	Farmers Producing Other Crops: No.	Farmers Producing Other Crops: %	Average Acres of Other Crops: Declared[1]	Average Acres of Other Crops: Adjusted[2]
Less than 5.0	3.8	17	15	88	9.2	6.3
5.0-15.0	10.0	29	21	72	8.7	6.0
15.1-25.0	17.9	10	7	70	13.9	9.6
25.0-	39.8	23	12	52	15.8	10.9

[1] As declared by farmers.

[2] On the average, this sample of rice farmers over-declared their rice farms acreage by 31 percent. The declared acreage of other crops is assumed to be equally over-declared.

The other crops produced by these farmers were maize, sorghum, millet, groundnuts, yams, cassava, and beans. Of these crops, 46 of the farmers produced maize, 41 yams, 39 sorghum, 33 millet, and 21 groundnuts. Only three farmers reported producing cassava and two beans.

Smallholders Using the Bullock Plow for Initial Land Preparation

Introduction

There were 14 sample farms where farmers were using traditional seed and a bullock plow for initial land preparation. Since two of the sample farmers operated two rice farms, the information which follows relates to 12 farmers.

Number of Years Producing Rice

The number of years bullock farmers had been producing rice varied from four years to 22 years, and the average number of years was about 9 years. Among these farmers, farm size varied from 0.3 to 4.6 acres, and the average size of the rice farm was 1.1 acres.

Acreage Expansion

Over the last three crop seasons, the last being the survey year, the 12 bullock farmers, on the average, only expanded the size of their rice farms by one percent. Of the 12 farmers, four reduced their farm size, on the average, by 38 percent; five farmers had no change in farm size, and three farmers expanded their rice farms, on the average, by 54 percent.

Farm Abandonment

The mean number of years the sample bullock farmers had been producing rice on their farms was about eight years. Only one of the bullock farmers indicated that he had abandoned a rice farm since he started producing rice. Unlike the bottomland rice producers, abandonment of upland rice farms does not occur often among upland bullock farmers. We are puzzled by the comparative results on farm abandonment between this subsample of farmers and the bottomland farmers reported in previous sections. Is it that traditional seed varieties with little or no fertilizer are better suited to upland soils than improved varieties on bottomland soils with declining soil fertility?

Use of Improved Practices

All bullock farmers were using traditional seed during the survey year. The variation in the number of years farmers had used the bullock plow for initial land preparation ranged from one to 16 years, and the average number of years was nine. Five of the 12 farmers had used bullocks for, on the average, 2.6 years longer than they had been rice farmers (i.e., they used bullocks for land preparation of other crops before they started producing rice). Five of the bullock farmers, on the average, started using the bullock 4.6 years after they had been producing rice, and one farmer started using a bullock team the same year he started producing rice.

Labor Recruiting Practices

Bullock farmers operating on relatively small acreages, like bottomland rice farmers, hired labor for field activities. Nine of the 12 bullock farmers hired labor, three of which recruited labor from their own village, three from their own village and surrounding villages, and three from surrounding villages only.

Source of Funds for Rice Farming

During the survey year, nine of the 12 bullock farmers obtained their funds for rice farming from their own savings, two obtained credit from the Agricultural Development Bank, which was arranged by a local church mission for the purchase of a bullock team and plow, and one farmer obtained credit from a local trader.

Crops Produced in Addition to Rice

The twelve sample bullock farmers all produced crops in addition to rice, and the total acreage of other crops was greater than the acreage of rice. Among the other crops produced, eight farmers produced groundnuts; five a mixture of sorghum and millet; six millet in pure stand and five sorghum in pure stand, two a mixture of sorghum and beans. Other crops produced though less important among the sample farmers were a mixture of sorghum and beans, maize in pure stand, yams, and a mixture of groundnuts and beans.

APPENDIX B

SELECTED ATTRIBUTES OF SAMPLE FARMS FOR SIX RICE PRODUCTION SYSTEMS IN NORTHERN GHANA, 1973-74

Table B.1. Selected Attributes of Sample Farms for Six Rice Production Systems in Northern Ghana, 1973-74

Production System and Farm Attributes	Units	Range		Mean	Standard Deviation
		Minimum	Maximum		
System I THS - Traditional Seed (28 farms)					
Farm Size	Acres	3.2	74.0	12.8	14.8
No. of Years Farmer has Produced Rice	Years	2.0	17.0	4.6	
No. of Years Rice Produced on Present Farm	Years	1.0	5.0	2.5	1.1
Yield Per Acre	180 lb. Bags	0.4	15.9	5.2	3.6
Date of Plowing	Week/Month	3/April	1/August	3/June	
Date of 1st Harrowing (24 farms)	Week/Month	1/May	2/August	2/July	
Planting Date	Week/Month	3/May	2/August	2/July	2.8 Wks.
Seeding Rate	Lbs. Per Acre	26	170	72	37
Application Rate of Nitrogen	Lbs. Per Acre	0.0	37.3	9.1	11.3
Beginning Date of 1st Weeding (21 Farms)	Week/Month	1/July	1/October	3/August	4.3 Wks.
Ending Date of 1st Weeding	Week/Month	2/August	4/October	1/September	4.1 Wks.
2nd Weeding	Two Farmers Only				
Beginning Date of Harvesting	Week/Month	4/October	3/December	3/November	1.9 Wks.
Ending Date of Harvesting	Week/Month	1/December	2/February	1/January	2.8 Wks.
Paddy Growth Period	Weeks Days	15.0 105	25.0 175	19.7 138	1.9 Wks.

Table B.1. Continued

Production System and Farm Attributes	Units	Range		Mean	Standard Deviation
		Minimum	Maximum		
System II					
THS - Improved Seed (44 Farms)					
Farm Size	Acres	2.7	65.9	21.2	17.0
No. of Years Farmer Has Produced Rice	Years	1.0	17.0	4.5	
No. of Years Rice Produced on Present Farm	Years	1.0	9.0	2.9	1.6
Yield Per Acre	180 Lb. Bags	1.1	22.4	6.2	4.9
Date of Plowing	Week/Month	3/May	4/July	2/June	3.0 Wks.
Date of 1st Harrowing (43 Farms)	Week/Month	4/May	2/August	4/June	2.8 Wks.
Date of 2nd Harrowing (19 Farms)	Week/Month	1/June	2/August	1/July	3.1 Wks.
Date of 3rd Harrowing (2 Farms)					
Planting Date	Week/Month	1/June	2/August	2/July	2.3 Wks.
Seeding Rate	Lbs. Per Acre	33	208	76	34
Application Rate of Nitrogen	Lbs. Per Acre	0.0	85.9	27.0	21.8
Beginning Date of 1st Weeding (40 Farms)	Week/Month	2/July	4/October	2/August	3.6 Wks.
Ending Date of 1st Weeding	Week/Month	3/July	1/November	4/August	3.2 Wks.

Table B.1. Continued

Production System and Farm Attributes	Units	Range		Mean	Standard Deviation
		Minimum	Maximum		
Beginning Date of 2nd Weeding (14 Farms)	Week/Month	2/August	1/October	1/September	1.9 Wks.
Ending Date of 2nd Weeding	Week/Month		1/October	3/September	1.1 Wks.
Beginning Date of Harvesting	Week/Month	3/October	2/February	2/November	3.0 Wks.
Ending Date of Harvesting	Week/Month	1/November	1/March	4/December	2.6 Wks.
Paddy Growth Period	Weeks	15.0	33.0	18.9	3.3
	Days	105	231	132	
System III					
THS - Mixed Seed (11 Farms)					
Farm Size	Acres	3.1	48.9	16.9	12.7
No. of Years Farmer Has Produced Rice	Years	2.0	10.0	5.3	
No. of Years Rice Produced on Present Farm	Year	1.0	9.0	4.4	2.3
Yield Per Acre	180 Lb. Bags	1.2	19.0	8.3	5.4
Date of Plowing	Week/Month	2/May	4/July	2/June	
Date of 1st Harrowing (10 Farms)	Week/July	3/June	1/August	2/July	
Planting Date	Week/Month	3/June	1/August	2/July	2.1 Wks.
Seeding Rate	Lbs. Per Acre	44	205	88	46
Application Rate of Nitrogen	Lbs. Per Acre	0.0	75.9	23.9	25.7

Table B.1. Continued

Production System and Farm Attributes	Units	Range		Mean	Standard Deviation
		Minimum	Maximum		
Beginning Date of 1st Weeding (11 Farms)	Week/Month	2/July	4/October	3/August	
Ending Date of 1st Weeding	Week/Month	4/July	1/November	2/September	
Beginning Date of 2nd Weeding (11 Farms)	Week/Month	2/August	2/September	1/September	
Ending Date of 2nd Weeding	Week/Month	2/September	3/September	3/September	
Beginning Date of Harvesting	Week/Month	1/November	2/December	3/November	2.2 Wks.
Ending Date of Harvesting	Week/Month	4/November	3/February	2/January	3.3 Wks.
Paddy Growth Period	Weeks Days			19.2 134	1.5
System IV					
TO - Traditional Seed (10 Farms)					
Farm Size	Acres	7.9	176.8	41.6	53.
No. of Years Farmer Has Produced Rice	Years	2.0	10.0	5.0	
No. of Years Rice Produced on Present Farm	Years	2.0	5.0	3.3	1.3
Yield Per Acre	180 Lb. Bags	1.9	14.7	6.5	4.1
Date of Plowing	Week/Month	1/April	4/July	2/June	
Date of 1st Harrowing (10 Farms)	Week/Month	2/May	4/July	1/July	2.0 Wks.

Table B.1. Continued

Production System and Farm Attributes	Units	Range		Mean	Standard Deviation
		Minimum	Maximum		
Date of 2nd Harrowing (8 Farms)	Week/Month	2/June	1/August	3/July	1.8 Wks.
Date of 3rd Harrowing (1 Farm Only)					
Planting Date	Week/Month	4/June	2/August	3/July	1.9
Seeding Rate	Lbs. Per Acre	39	160	83	42
Application Rate of Nitrogen	Lbs. Per Acre	0.0	33.6	19.0	10.1
Beginning Date of 1st Weeding (6 Farms)	Week/Month	2/July	3/September	1/August	2.8 Wks.
Ending Date of 1st Weeding	Week/Month	1/August	4/October	2/September	3.9 Wks.
Beginning Date of Harvesting	Week/Month	4/October	4/December	3/November	2.5 Wks.
Ending Date of Harvesting	Week/Month	1/December	1/February	2/January	3.5 Wks.
Paddy Growth Period	Weeks Days			19.0 132	
System V					
TO - Improved Seed (19 Farms)					
Farm Size	Acres	3.2	467.7	119.3	140.2
No. of Years Farmer Has Produced Rice	Years	2.0	8.0	3.5	
No. of Years Rice Produced on Present Farm	Years	2.0	6.0	3.3	1.3

Table B.1. Continued

Production System and Farm Attributes	Units	Range		Mean	Standard Deviation
		Minimum	Maximum		
Yield Per Acre	180 Lb. Bags	2.1	14.4	7.1	3.6
Date of Plowing	Week/Month	3/May	4/June	1/June	2.3 Wks.
Date of Lst Harrowing (19 Farms)	Week/Month	3/May	1/August	4/June	
Date of 2nd Harrowing (13 Farms	Week/Month	2/June	1/August	4/June	
Date of 3rd Harrowing (1 Farm Only)	Week/Month				
Planting Date	Week/Month	2/June	1/August	1/July	2.2 Wks.
Seeding Rate	Lbs. Per Acre	37	133	83	24
Application Rate of Nitrogen	Lbs. Per Acre	0.0	96.2	33.8	28.9
Beginning Date of 1st Weeding (12 Farms)	Week/Month	3/July	2/September	1/August	
Ending Date of 1st Weeding	Week/Month	1/August	4/October	4/August	
Beginning Date of 2nd Weeding (4 Farms)	Week/Month	2/August	1/September	3/August	
Ending Date of 2nd Weeding	Week/Month	1/September	1/October	3/September	
Beginning Date of Harvesting	Week/Month	3/October	1/January	2/November	2.8 Wks.
Ending Date of Harvesting	Week/Month	2/November	3/February	1/January	3.8 Wks.
Paddy Growth Period	Weeks Days			19.9 139	3.1 Wks.

Table B.1. Continued

Production System and Farm Attributes	Units	Range		Mean	Standard Deviation
		Minimum	Maximum		
System VI					
BO - Traditional Seed (14 Farms)					
Farm Size	Acres	0.3	4.6	1.1	1.1
No. of Years Farmer Has Produced Rice	Years	2	22	9.4	
No. of Years Rice Produced on Present Farm	Years	3.0	17.0	7.9	4.3
Yield Per Acre	180 Lb. Bags	4.0	13.5	7.5	2.7
Date of Plowing	Week/Month	1/June	2/July	3/June	1.4 Wks.
Hand Harrowing (5 Farms)	Week/Month	2/June	3/July	4/June	2.1 Wks.
Planting Date	Week/Month	2/June	3/July	1/July	2.3 Wks.
Seeding Rate	Lbs. Per Acre	27	300	92	83
Application Rate of Nitrogen	Lbs. Per Acre	0.0	56.0	14.0	18.0
Beginning Date of 1st Weeding (12 Farms)	Week/Month	4/June	4/August	2/July	4.5 Wks.
Ending Date of 1st Weeding	Week/Month	1/July	3/September	4/July	6.2 Wks.
Beginning Date of 2nd Weeding	Week/Month	4/July	3/October	4/August	3.7 Wks.
Ending Date of 2nd Weeding	Week/Month	2/August	3/October	1/September	3.3 Wks.
Beginning Date of 3rd Weeding	Week/Month	4/August	4/October	3/September	
Ending Date of 3rd Weeding	Week/Month	4/August	1/November	4/September	

Table B.1. Continued

Production System and Farm Attributes	Units	Range		Mean	Standard Deviation
		Minimum	Maximum		
Beginning Date of Harvesting	Week/Month	2/October	2/December	1/November	2.4 Wks.
Ending Date of Harvesting	Week/Month	3/October	4/January	3/December	3.3 Wks.
Paddy Growth Period	Weeks	15.0	26.0	19.6	2.8
	Days			137	

APPENDIX C

CALCULATION OF LAND PREPARATION COSTS FOR TRACTOR OWNERS

Table C.1. Tractor and Equipment Performance Assumptions for Northern Ghana Tractor Owners

Operation	Implement	Acres Per Hour[1]	Acres/ Day[2]	Acres[3]	Days Per Year	Annual Tractor Hours
Plowing	3-disc plow	0.75	9.0	250	28	336
1st Harrowing	12-14 disc harrow	1.00	12.0	250	21	252
2nd Harrowing	" " "	1.50	18.0	250	14	168
					63	756
Trailer Work					90	450
Total Working Tractor Hours Per Annum						1206
Plus: Miscellaneous Running Time at 10 Percent						181
Total Tractor Hours Per Annum						1387 (1400)

[1]Conservative estimates reflecting the field conditions and standard of machinery operation in the study area.

[2]Assumes a 12 hour work day of two shifts with two drivers.

[3]Estimated acreage that a 65 hp wheel tractor can operate given the agricultural calendar in the study area.

Table C.2. Estimated Financial Owning and Operating Costs of a Tractor and Associated Equipment in Northern Ghana During the 1973-74 Crop Season: The Case with Subsidies[1]

A. ESTIMATED OWNING AND OPERATING COSTS PER HOUR OF A 65 H.P. WHEEL TRACTOR[2]

1. Owning Costs

Assumption: Anticipated life = 7000 hours (1400 hrs./yr. x 5 yrs.)

a. Purchase Price of a Tractor Purchased in Tamale, Northern Region

1. Purchase price	¢ 7250
2. Plus, interest at 6%[3]	1088
3. Price plus interest	8338
4. Plus, cost of repairs at 100% of initial cost	7250
5. Plus, interest on repairs at 6% (¢7250 x 0.06)	435
6. Cost of tractor, plus repairs over life of the tractor[4]	¢16023

b. Owning Cost per Hour $\frac{¢16,023}{7000 \text{ hours}}$ = ¢2.29

c. Annual Owning Cost $\frac{¢16,023}{5 \text{ years}}$ = ¢3,205

2. Operating Costs

Assumptions: Tractor works 12 hrs./day;
Tractor operates 1400 hrs. per annum;
Average fuel consumption = 1.5 gal./hr.

a. Fuel:[5] Average consumption rate = 1.5 gallons/hr.

1. Pump price = ¢0.50 per gallon
2. Annual Fuel requirements (1.5 gal. x ¢0.50 x 1400 hrs.) = ¢1050.00

b. Engine oil: 14 oil changes at 1 1/2 gallons per change

1. Price per gallon = ¢2.50
2. Annual requirement (1.5 gal. x 14 x ¢2.50) = ¢52.50

c. Grease: 24 lbs. for tractor and equipment

1. Price = ¢0.40 per lb.
2. Annual requirement (24 lbs. x ¢0.40) = ¢9.60

d. Wages for two tractor drivers

1. At ¢45.00 per month (¢45 x 2 x 12 mos.) = ¢1080.00

e. Total Operating Costs Per Annum = ¢2192.10

f. Annual Operating Costs Per Hour: $\frac{¢2192}{1400 \text{ hours}}$ = ¢1.57 per hour

3. Summary of Owning and Operating Costs:

a. Owning Costs Per Hour: ¢2.29

b. Operating Costs Per Hour: ¢1.57

Total ¢3.86

B. ESTIMATED OWNING COST OF A PLOW AND HARROW[6] ASSUMPTIONS: ANTICIPATED LIFE = 4000 HRS. PURCHASE PRICE = ¢1225

1. Owning Costs:

a. Purchase Price in Tamale	¢1225
b. Plus, Interest at 6%	184
c. Total Cost Without Repairs	1409
d. Plus, Repairs at 100% of Initial Costs	1225
e. Interest on Reparis at 6% (¢184 x .06)	74
f. Total Costs	2708

g. Owning Cost Per Hour $\frac{¢2708}{4000 \text{ hours}}$ = ¢0.68 per hour

h. Annual Owning Costs - Plow $\frac{¢2708}{12 \text{ years}}$ = ¢226

i. Annual Owning Cost - Harrow $\frac{¢2708}{10 \text{ years}}$ = ¢271

C. ESTIMATED OWNING COSTS PER HOUR FOR A TRAILER: ASSUMPTION: ANTICIPATED LIFE = 4000 HOURS

1. Owning Costs

a. Purchase Price in Tamale	¢2000
b. Plus Interest at 6%	300
c. Total Cost Excluding Repairs	2300
d. Plus Repairs at 50% of Initial Costs	1000
e. Interest on Repairs at 6% (¢1000 x .06)	60
f. Total Cost	¢3360

g. Owning Cost Per Hour $\frac{¢3360}{4000 \text{ hours}}$ = ¢0.84

Table C.2. Continued

D. OWNING AND OPERATING COSTS OF UNDERTAKING FIELD ACTIVITIES

1. Tractor Owning Costs Associated with Field Activities

Activity	Total Hours[7]	Owning Costs Per Hour	Adjustment Factor[8]	Adjusted Owning Costs Per Hour	Total Owning Costs Per Annum
Plowing	336	¢2.29	1.60	¢3.67	¢1233
1st Harrowing	252	2.29	1.20	2.75	693
2nd Harrowing	168	2.29	1.00	2.29	385
Sub-Total	756				2311
Other	631	2.29	0.62	1.42	894
Total	1400				3205

2. Owning and Operating Costs of Undertaking Field Activities

Activity	Tractor		Owning Costs of Implements	Total Cost Per Hour	Acres Per Hour[9]	Costs Per Acre[10]
	Owning Costs	Operating Costs				
Plowing	¢3.67	¢1.57	¢0.84	¢6.08	0.75	¢8.10
1st Harrowing	2.75	1.57	0.84	5.16	1.00	5.16
2nd Harrowing	2.29	1.57	0.84	4.70	1.50	3.13

E. OWNING AND OPERATING COSTS ASSOCIATED WITH TRAILER WORK AND MISCELLANEOUS RUNNING

1. Trailer Work
   a. Tractor
      1. Owning Costs ¢1.42[11]
      2. Operating Costs 1.57
      3. Total Costs ¢2.99
   b. Trailer
      1. Owning Costs 0.84
   c. Total owning and operating costs ¢3.83
2. Miscellaneous Running[12]
   a. Tractor
      1. Owning Costs ¢1.42
      2. Operating Costs 1.57
      3. Total Costs ¢2.99

[1]The cedi equivalent of the c.i.f. price of capital imports is artificially low since at the official exchange rate the Ghanaian Cedi is 35 percent overvalued. The official exchange rate is GH¢1.15 = US$1.00.

[2]Based on two manufacturer models, Ford 4000 and Massey Ferguson Model 165 diesel tractors, the technical coefficients and the spare parts and maintenance requirements are based upon a report prepared by G. M. Wylie (1972), an F.A.O. Agricultural Engineer who has worked in Ghana several years and was stationed in Northern Ghana during 1972-74.

[3]The estimated private opportunity cost of a capital for owners of capital in Ghana. This figure is 6 percent of the undepreciated value of the asset over its five year life.

[4]A zero salvage value is assumed after 7000 hours.

[5]During the 1973-74 production season it was estimated that the National Redemption Council was subsidizing petroleum products by about 20 percent. It is assumed that 70 percent of the retail price of petroleum products is import content.

[6]Based upon a report by Wylie (1972), the anticipated life of both the plow and harrow is 4000 hours. The average retail price of a 3-disc mounted plow and a 12-disc mounted harrow are equal. Thus, the above calculations are for either item of equipment. No operating costs are assumed to be associated with the plow and harrow. Repairs are treated as an owning cost.

[7]Based on Appendix C, Table C.1. "Tractor and Equipment Performance Assumptions for Northern Ghana Tractor Owners."

[8]Adjustment factor is a relative estimate of the rate of wear and tear or user cost associated with the different tractor operations. An adjustment of 1.50 for plowing means there is an estimated 50 percent greater wear and tear on the tractor associated with plowing compared to 2nd harrowing. The adjustment factor for nonfield (Other) is treated as a residual; it was determined by subtracting the total annual owning costs for field work (¢2311) from the total annual owning costs (¢3205) and then calculating the adjusted owning costs per hour required for 631 hours to equal ¢894.

[9]Based upon report prepared by Wylie (1972).

[10]Total cost per hour divided by acres per hour.

[11]See adjusted owning costs per hour in Part D, above.

[12]The use of a tractor as a standard four-wheel vehicle, generally in nondirectly productive use.

Table C.3. Estimated Economic Owning and Operating Costs of a Tractor and Associated Equipment in Northern Ghana During the 1973-74 Crop Season: The Case Without Subsidies[1]

A. ESTIMATED OWNING AND OPERATING COSTS PER HOUR OF A 65 H.P. WHEEL TRACTOR[2]

1. Owning Costs

Assumption: Anticipated Life = 7000 hours (1400 hrs./yr. x 5 yrs.)

a. Real Cost Price of a Tractor Purchased in Tamale, Northern Region

1.	Purchase price	₵7250
2.	Plus, 35 percent of c.i.f. price (₵5075.00 x 0.35)[3]	1776
3.	Purchase Price without overvalued currency	₵9026
4.	Plus, interest at 15%[4]	3385
5.	Real cost price excluding repairs	12411
6.	Plus, cost of repairs at 100% of initial costs	9026
7.	Plus, interest on repairs at 15% (₵9026 x 0.15) =	1354
8.	Real cost price of a tractor plus repairs over the life of a tractor[5]	₵22791

b. Owning Cost Per hour $\frac{₵22791}{7000 \text{ hr.}} = ₵3.25$

c. Annual Owning Costs $\frac{₵22,791}{5 \text{ years}} = ₵4558$

2. Operating Costs

Assumptions: Tractor works 12 hrs/day;
Tractor operates 1400 hrs. per annum;
Average fuel consumption = 1.5 gal./hr.

a. Fuel:[6] Average Consumption Rate = 1.5 gallons/hr.

1. Pump price = ₵0.50 per gallon
2. Pump price, plus subsidy = ₵0.50 x 1.20 = ₵0.60
3. 35% of the estimated c.i.f. price (₵0.35 x 0.35 = ₵0.12)
4. Real cost of fuel without subsidy and overvalued exchange rate (₵0.60 + ₵0.12 = ₵0.72/gallon)
5. Annual fuel requirements (1.5 gal. x ₵0.72 x 1400 hrs.) = ₵1512.00

b. Engine Oil: 14 Oil Changes at 1 1/2 Gallons Per Change

1. Price = ₵2.50 per gallon
2. Price, plus subsidy (₵2.50 x 1.20 = ₵3.00)
3. 35% of estimated c.i.f. price (₵1.75 x 0.35 = ₵0.61)
4. Real cost without subsidy and overvalued exchange rate (₵3.00 + ₵0.61 = ₵3.61/gallon)
5. Annual oil requirements (1.5 gal. x 14 x ₵3.61) = 75.81

c. Grease: 24 Lbs. for Tractor and Equipment

1. Price = ₵0.40 per lb.
2. 35% of estimated c.i.f. price (₵0.28 x 0.35 = ₵0.10)
3. Real cost without overvalued exchange rate (₵0.40 + ₵0.10 = ₵0.50)
4. Annual requirements (24 lbs. x ₵0.50) = ₵12.00

d. Wages for Two Tractor Drivers

1. At ₵45 per month (₵45 x 2 x 12 mos.) = ₵1080.00

e. Total Operating Costs Per Annum = ₵2679.81

f. Annual Operating Costs Per Hour

$\frac{₵2680}{1400 \text{ hours}} = ₵1.91$ per hour

3. Summary of Owning and Operating Costs

a.	Owning Costs Per Hour	₵3.25
b.	Operating Costs Per Hour	1.91
	Total	₵5.16

B. ESTIMATED OWNING COSTS OF A PLOW AND HARROW[7] ASSUMPTIONS: ANTICIPATED LIFE = 4000 HOURS
PURCHASE PRICE = ₵1225

1. Owning Costs

a. Real Cost Price of Plow Purchased in Tamale, Northern Region

1.	Purchase Price in Tamale	₵1225
2.	Plus, 35% of c.i.f. (₵858 x 0.35)	300
3.	Purchase price without overvalued currency	1525
4.	Plus, interest at 15%[8]	572
5.	Plus repairs at 100% of initial costs	1525
6.	Plus interest on repairs at 15 percent (₵1525 x 0.15) =	229
7.	Total costs	₵3851

b. Owning Costs Per Hour $\frac{₵3851}{4000 \text{ hrs.}} = ₵0.96$

Table C.3. Continued

C. ESTIMATED OWNING COSTS PER HOUR OF A TRAILER ASSUMPTION: ANTICIPATED LIFE = 4000 HOURS

1. Owning Costs

a. Real Cost Price of a Trailer Purchased in Tamale, Northern Region

1.	Purchase price	¢2000
2.	Plus 35% of c.i.f. (¢1400 x 0.35)	490
3.	Purchase price without overvalued currency	2490
4.	Plus interest at 15%[9]	934
5.	Real cost price without repairs	3424
6.	Plus repairs at 50% of initial costs	1245
7.	Plus interest on repairs at 15% (¢1245 x 0.15)	187
8.	Total cost	¢4856

b. Owning Cost Per Hour $\frac{¢4856}{4000 \text{ hrs.}} = ¢1.21$

D. OWNING AND OPERATING COSTS OF UNDERTAKING FIELD ACTIVITIES

1. Tractor Owning Costs Associated with Field Activities

Activity	Total Hours[10]	Owning Cost Per Hour	Adjustment Factor[11]	Adjusted Owning Costs Per Hour	Total Owning Costs Per Annum
Plowing	336	¢3.25	1.60	¢5.20	¢1747
1st Harrowing	252	3.25	1.20	3.90	983
2nd Harrowing	168	3.25	1.00	3.25	546
Sub-Total	756				3276
Other	631	3.25	0.62	2.03	1282
Total	1400				4558

2. Owning and Operating Costs of Undertaking Field Activities

Activity	Tractor		Owning Costs of Implements	Total Cost Per Hour	Acres Per Hour[12]	Costs Per Acre[13]
	Owning Costs	Operating Costs				
Plowing	¢5.20	¢1.91	¢0.96	¢8.07	0.75	¢10.76
1st Harrowing	3.90	1.91	0.96	6.77	1.00	6.77
2nd Harrowing	3.25	1.91	0.96	6.12	1.50	4.08

E. OWNING AND OPERATING COSTS ASSOCIATED WITH TRAILER WORK AND MISCELLANEOUS RUNNING

1. Trailer Work
   a. Tractor
      1. Owning Costs ¢2.03[14]
      2. Operating Costs 1.91 ¢3.94
   b. Trailer
      1. Owning Costs 1.21
   c. Total Owning and Operating Costs ¢5.15
2. Miscellaneous Running[15]
   a. Tractor
      1. Owning Costs ¢2.03
      2. Operating 1.91 ¢3.94

[1] The official foreign exchange rate in Ghana is GH¢1.15 = US$1.00. It is estimated by the I.M.F. that the local currency is overvalued by 35 percent; the accepted shadow rate of exchange is US$1.00 = GH¢1.15 = US$1.00. The import component of the purchase price of a tractor and associated equipment is increased by 35 percent to reduce to zero the implicit subsidy of the overvalued exchange rate. The explicit subsidy on petroleum products has also been reduced to zero in the calculation of the operating costs.

[2] Based on two manufacturer models, Ford 4000 and Massey Ferguson 165 diesel tractors. The technical coefficients and the spare parts and maintenance requirements are based upon a report prepared by G.M. Wylie (1972), an F.A.O. agricultural engineer who has worked in Ghana several years and was stationed in Northern Ghana during 1972-74.

[3] Based upon discussions with representatives of the two major farm machinery dealers in Ghana, it is assumed that the retail price of tractors, associated equipment and spare parts is composed of a 70 percent import content.

[4] The social opportunity cost of capital in Ghana is estimated to be 15 percent by the Ministry of Economic Finance and Planning. The figure is 15 percent of the undepreciated value of the asset over its five year life.

[5] A zero salvage value is assumed after 7000 hours.

[6] During the 1973-74 production season it was estimated that the National Redemption Council was subsidizing petroleum products by about 20 percent. It is assumed that 70 percent of the retail price of petroleum products is import content.

[7] Based upon a report by Wylie (1972), the anticipated life of both the plow and harrow is 4000 hours. The average retail price of a 3-disc mounted plow and a 12-disc mounted harrow are equal. Thus, the above calculations are for either item of equipment. No operating costs are assumed to be associated with the plow and harrow. Repairs are treated as an owning cost.

[8] The social opportunity cost of capital in Ghana is estimated to be 15 percent by the Ministry of Economic Finance and Planning. The figure is 15 percent of the undepreciated value of the asset over its five year life.

[9] The figure is 15 percent of the undepreciated value of the asset over its five year life.

[10] Based on Appendix C, Table C.1, "Tractor and Equipment Performance Assumptions for Northern Ghana Tractor Owners."

[11] Adjustment factor is a relative estimate of the rate of wear and tear of user cost associated with the different tractor operations. An adjustment of 1.50 for plowing means there is an estimated 50 percent greater wear and tear on the tractor associated with plowing compared to 2nd harrowing. The adjustment factor for nonfield work (Other) is treated as a residual; it was determined by subtracting the total annual owning costs for field work (¢3276) from the total annual owning costs (¢4558) and then calculating the adjusted owning costs per hour required for 631 hours to equal ¢1282.

[12] Based upon report prepared by Wylie (1972).

[13] Total cost per hour divided by acres per hour.

[14] See adjusted owning costs per hour in Part D, above.

[15] The use of a tractor as a standard four-wheel vehicle, generally in nondirectly productive use.

APPENDIX D

CALCULATION OF LAND PREPARATION COSTS FOR BULLOCK OWNERS

Table D.1. Estimated Financial Cost Per Acre for Bullock Plowing in Northern Ghana, Based Upon Survey Data, 1973

I. Owning Cost of a Bullock Team[1]	
A. Purchase Price of two, three year old West African shorthorns	¢270.
B. Plus, opportunity cost at 10.5 percent[2]	156.
	426.
C. Less salvage value after four years at 170 percent of initial purchase price[3]	473.
D. Total owning cost	-¢ 47.
E. Annual gain from owning team: -¢47 ÷ 4 years. =	-¢ 11.75
F. Allocation of gain to rice enterprise:[4] -¢11.75 x 0.14 =	-¢ 1.65
II. Equipment	
A. Bullock Plow	
1. Purchase Price	¢ 70.00
2. Plus, opportunity cost at 10.5 percent[5]	74.00
3. Plus, maintenance at 50 percent of initial cost	35.00
4. Total Owning cost	¢179.00
5. Annual Owning cost: ¢179 ÷ 20 yrs. =	¢ 8.95
6. Allocation to rice enterprise: ¢8.95 x 0.51[6] =	¢ 4.56
B. Yolk, Harness, Chains, Nose Ring	
1. Purchase Price	¢ 22.00
2. Plus, opportunity cost at 15 percent[7]	4.95
3. Total purchase cost	¢ 26.95
4. Annual owning cost: ¢26.95 ÷ 3 yrs. =	¢ 8.98
5. Allocation to rice enterprise: ¢8.98 x 0.14 =	¢ 1.26
III. Total Cost of Bullock Plowing	
A. Annual cost of plowing 1.1 acres of rice land	
1. Bullock Team	-¢ 1.65
2. Plow	4.56
3. Yolk, etc.	1.26
4. Supplemental Feed[8]	1.70
	¢ 5.87
B. Cost Per Acre: ¢5.87 ÷ 1.1 acres =	¢ 5.34

[1] Based upon the 14 bullock farmers for whom the average rice enterprise budget in Chapter IV is computed. The mean total farm acreage of the 14 farmers was 7.7 acres, of which 1.1 acres was rice and 6.6 acres were other crops.

[2] Assumes on the average, that half the undepreciated value of the team is held as equity with an opportunity cost of 14 percent and half is in the form of bank credit at an interest rate of six percent. The undepreciated value of the team increases with time, and its net salvage value is 175 percent of its net acquisition value at the end of its four year useful life. It is assumed that at the end of four years the team is sold for meat.

[3] It is common experience in Ghana and other West African countries that bullocks appreciate over 3 to 5 years of use by 170 percent of the initial purchase price.

[4] Since 14 percent of the acres (1.1 of 7.7 acres) are rice, 14 percent of the gain is allocated to the rice enterprise.

[5] Assumes that half the undepreciated value of the plow is held as equity with an opportunity cost of 15 percent and half is in the form of bank credit at an interest rate of six percent. Assumed salvage value is zero.

[6] Farmers purchase a bullock frame which has a plow attachment and a ridger attachment. The frame is ¢40.00 and the plow attachment is ¢30.00. Fourteen percent of the cost of the frame (1.1 of 7.7 acres) is assigned to the rice enterprise, plus the total cost of the plow attachment (¢40 x 0.14 = ¢5.60; ¢5.60 = ¢30 = ¢35.60; ¢35.60 ÷ ¢70.00 = 0.51). Fifty-one percent of total owning cost is assigned to the rice enterprise.

[7] Assumes that these items are purchased with cash reserves which have an opportunity cost of 15 percent. Salvage value after threes is zero.

[8] Upland soils are light, sandy soils. Farmers, on the average, plow 1 acre per 6 hour day. Supplemental feeding is practiced only during the days in which bullocks are plowing (rice) or ridging (other crops). On the average, farmers feed food stuffs valued at ¢1.55 per working day (sorghum, maize, plus, in some cases, purchased sorghum mash from local beer making). Supplemental feeding for 1.1 acres costs ¢1.70 (¢1.55 x 1.1 days).

Table D.2. Estimated Economic Costs Per Acre for Bullock Plowing in Northern Ghana

I.	Economic Owning Cost of a Bullock Team[1]			
	A.	Purchase price of two, three year old West African shorthorns		¢270.
	B.	Plus, opportunity cost at 15 percent		223.
	C.	Less salvage value after four years at 170 percent of initial purchase price		473.
	D.	Total Owning Cost		¢ 20.
	E.	Annual owning cost: ¢20 ÷ 4 yrs. =		¢ 5.00
	F.	Allocation of gain to rice enterprise: ¢5.00 x 0.14 =		¢ 0.70
II.	Equipment			
	A.	Bullock Plow		
		1.	Purchase Price	¢ 70.00
		2.	Plus, 35 percent of c.i.f. price: ¢56 x 0.35 =	19.60
		3.	Purchase price without overvalued currency	89.60
		4.	Plus, opportunity cost at 15 percent	134.40
				224.00
		5.	Plus, maintenance at 50 percent of initial cost	35.00
		6.	Total economic owning cost	¢259.00
		7.	Annual owning cost: ¢259 ÷ 20 yrs. =	¢ 12.95
		8.	Allocation to rice enterprise: ¢12.95 x 0.51 =	¢ 6.60
	B.	Yolk, Harness, Chains, Nose Ring		
		1.	Annual owning cost	¢ 8.98
		2.	Allocation to rice enterprise	¢ 1.26
III.	Total Economic Cost of Bullock Plowing			
	A.	Annual Cost of Plowing 1.1 Acres of Rice Land		
		1.	Bullock Team	¢ 0.70
		2.	Plow	6.60
		3.	Yolk, etc.	1.26
		4.	Supplemental Feed	1.70
				¢ 10.26
	B.	Economic Cost Per Acre: ¢10.26 ÷ 1.1 =		¢ 9.33

[1]For the procedures used to calculate the owning cost of a bullock team, see companion table, Appendix D, Table D.1.

APPENDIX E

ESTIMATED ECONOMICS OWNING AND OPERATING COSTS

OF TWENTY-FOUR SELF-PROPELLED COMBINES

Table E.1. Estimated Economic Owning and Operating Costs of Twenty-Four Self-Propelled Combines Operated by the Ministry of Agriculture in Northern Ghana, 1973-74: When Import Prices are Converted at the Shadow Rate of Exchange[1]

A. INVESTMENT COST OF TWENTY-FOUR COMBINES

Machine Manufacturer/ Model	Number of Units	Unit c.i.f. Price	Total Import Costs	
			Official Exchange Rate	Shadow Exchange Rate
Gloria-C12	13	¢17,215	¢223,795	¢302,123
MF-400	6	21,800	130,800	176,580
MF-520	5	27,400	137,000	182,250
	24		¢491,595	¢660,953

B. TOTAL OWNING COSTS

Machine	Number of Units	Purchase Price	Plus Interest at 15%[2]	Plus, Repairs at 40% of Initial Cost	Plus, Interest on Repairs at 15%	Real Cost of Combines Plus Repairs
Gloria-C12	13	¢302,123	¢181,274	¢120,849	¢18,127	¢ 622,373
MF-400	6	176,580	105,948	70,632	10,595	363,755
MF-520	5	182,250	109,350	72,900	10,935	375,435
	24	¢660,953	¢396,572	¢264,381	¢39,657	¢1,361,563

C. ANNUAL OWNING COSTS ASSUMPTIONS: Anticipated machine life is 8 years
No Salvage Value

Machine	Number of Units	Total Owning Costs	Annual Owning Costs
Gloria-C12	13	¢ 622,373	¢ 77,797
MF-400	6	363,755	45,469
MF-520	5	375,435	46,929
Total	24	¢1,361,563	¢170,195

D. OPERATING COSTS FOR THE 1973-74 HARVEST SEASON

Expenditure Item	Machines			
	Thirteen Gloria	Six MF-400	Five MF-520	Total Expenditure
1. Fuel[3]	¢ 1,532	¢5,322	¢1,044	¢ 3,898
2. Lubricants	698	94	145	937
3. Operators' Salaries	10,633	3,825	3,431	17,889
4. Operator Travel and Transport	744	273	295	1,342
Total	¢13,637	¢5,514	¢4,915	¢24,066

E. TOTAL ANNUAL OWNING AND OPERATING COSTS

Machine		Owning Costs	Operating Costs	Total Annual Costs
Type	No.			
Gloria	13	¢ 77,797	¢13,637	¢ 91,434
MF-400	6	45,469	5,514	50,983
MF-520	5	46,929	4,915	51,844
Total	24	¢170,195	¢24,066	¢194,261

F. NET OPERATING POSITION

Machine		Total Costs	Gross Revenue	Net Return
Type	No.			
Gloria	13	¢ 91,434	¢12,937	¢ -78,497
MF-400	6	50,983	12,721	-38,262
MF-520	5	51,844	10,844	-41,000
Total	24	¢194,261	¢36,510	¢-157,751

Table E.1. Continued

G. AVERAGE HARVESTING COSTS PER BAG DURING 1973-74 CROP SEASON

Machine		Costs Per Bag		
	Total Bags	Fixed	Variable	Total
Gloria	14,439	₵ 5.39	₵0.94	₵6.33
MF-400	15,461	2.94	0.36	3.30
MF-520	11,415	4.11	0.43	4.54
Weighted Average Cost Per Bag	41,315	₵12.44	₵1.73	₵4.70

H. ADJUSTED COSTS[4]

Machine	Adjusted Bags[5]	Adjusted Total Costs[6]	Adjusted Cost Per Bag
Gloria	₵18,049	₵ 94,843	
MF-400	19,326	52,362	
MF-520	14,269	53,073	
	₵51,644	₵200,278	₵3.88

I. AVERAGE LOSS PER BAG HARVESTED

1. Average Total Cost Per Bag	₵3.88
2. Average Charge	0.90
3. Average loss per bag	₵2.98
4. Average rate of subsidy	77 Percent

J. BREAK-EVEN CHARGES FOR COMBINE HARVESTING

1. Bags Harvested[7]

a. Complete combine harvesting	41,315
b. Combine as stationary thresher	10,329
c. Total bags	51,644

2. Estimated Break-Even Charges[8]

Method of Harvesting	Bags Harvested	Charge Per Bag	Total Revenue
Complete Combine Harvesting	41,315	₵4.20	₵173,523
Combine Used As A Stationary Thresher	10,329	2.55	26,399
			₵199,862

3. Current Rates of Subsidy

Method of Harvesting	Current Charge	Actual Cost	Rate of Subsidy (Percent)
Complete Combine Harvesting	₵1.00	₵4.20	76
Combine Used As A Stationary Thresher	0.60	2.55	76

[1] Shadow Rate of Exchange is GH₵1.55 = US$1.00. This table is based upon Winch, 1974.

[2] Figures are calculated by taking 15 percent of the undepreciated value of the asset over the assumed life of the asset (8 years).

[3] The cost of fuel and lubricants is increased by the extent of the implicit and explicit subsidies. Given a 20 percent explicit subsidy on petroleum products and a 35 implicit subsidy, due to the overvalued exchange rate, on 70 percent of the retail price (import content), the total subsidies on these products is 44 percent.

[4] The above costs require an adjustment to be made for the following reasons. The above costs are based upon the first year of operation of the combines, and many of the combines were not in the region at the beginning of the harvesting season. Owing to first-year organizational problems, inexperienced operators, and excessive down-time because of inadequate maintenance and service support, the combines operated at only 25 percent of rated capacity.

It is assumed that some of these problems will be partially corrected, and, as a result, that annual utilization of the machines will be increased. It is assumed that the average increase in annual utilization in terms of bags harvested over the remaining life of the machines will be 25 percent. Part of the increase will come from anticipated increasing average farm yields, and part will come from an increase in the number of days the machines are operated as a result of improved organization (deployment) and experience. The following are the adjusted figures for annual bags harvested and total costs.

[5] Actual bags harvested are increased by 25 percent.

[6] The operating costs in Part E above are increased by 25 percent. Thus, ₵170,195 + ₵30,083 = ₵200,273; where ₵30,083 or total operating costs = ₵24,066 x 1.25.

[7] Assumes that 80 percent of the total bags harvested annually are done by complete combine harvesting and 20 percent by combines used as stationary threshers.

[8] Assumption: The relative charge per bag for hiring a combine as a stationary thresher is 60 percent of the charge per bag for complete combine harvesting. The sum of the total revenue from each harvesting method should equal total owning and operating costs of the 24 combines as estimated above.

APPENDIX F

ESTIMATED LAND CLEARING COSTS PER ACRE ON BOTTOMLAND RICE FARMS

Table F.1. Estimated Land Clearing Costs Per Acre on Bottomland Rice Farms in Northern Ghana, 1973

I. Machine and Labor Method[1]	
A. Financial Costs Per Acre	
1. Machine Costs	
a. Average contract charge[2]	¢15.95
2. Labor Costs at 13.4 Man-hours Per Acre	
a. Family labor[3]	
5.0 man-hours @ ¢0.32 = ¢1.60	
b. Hired labor	
8.4 man-hours @ ¢0.32 = ¢2.69	
c. Total labor costs	4.29
3. Total Costs	¢20.24
4. Plus, Opportunity Cost at 15% of the Undepreciated Balance Over Five Years[4]	7.59
5. Total Costs Including Opportunity Costs	¢27.83
6. Average Annual Cost Per Acre	
¢27.83 ÷ 5 Yrs. =	¢ 5.55
B. Economic Costs Per Acre	
1. Machine Costs	
a. Financial contract charge = ¢15.95	
b. Adjustment[5]	
¢15.95 x 0.80 x 0.35 = 4.47	
c. Estimated economic contract charge =	¢20.40
2. Labor Costs	4.29
3. Total Costs	24.69
4. Plus, interest at 15 Percent	9.26
5. Total Costs Plus Interest	¢33.95
6. Average Annual Cost Per Acre	
¢33.95 ÷ 5 Yrs. =	¢ 6.80
II. Hand Labor Method[6]	
A. Costs Per Acre at 30.8 Man-hours Per Acre	
B. Family Labor	
9.5 Man-Hours @ ¢0.12 = ¢1.14	
C. Hir Labor	
21. Man-Hours @ 0.12 = 2.56	
D. Total Labor Costs	¢ 3.70
E. Plus, Interest at 15 Percent	1.39
F. Total Costs, Plus Interest	¢ 5.09
G. Average Annual Cost Per Acre	
¢5.09 ÷ 5 Yrs. =	¢ 1.00

[1] Based upon survey data from 9 farms using a combination of machine and labor methods of land clearing during 1973.

[2] Average contract charge per acre after adjusting for an assumed 30 percent over-declaration of acreage. The machines used were medium-size bulldozers with conventional blades of various manufacturers and models owned by the Ministry of Agriculture.

[3] The opportunity cost of family labor is assumed to be equal to the wage rate paid to casual workers for land clearing activities.

[4] Assuming straight line depreciation with a salvage value of zero at the end of year five.

[5] It is estimated that 80 percent of the contract charge is import content. The import content of the financial charge is increased by 35 percent to reduce to zero the implicit subsidy of the over-valued exchange rate.

[6] Based upon 1973 survey data from 37 farms using only hand methods of land clearing. Financial and economic costs are the same since all costs are measured using opportunity costs.

APPENDIX G

ESTIMATED COST OF ONE BAG OF IMPROVED RICE SEED SOLD BY SEED MULTIPLICATION UNIT, MINISTRY OF AGRICULTURE, NORTHERN REGION, GHANA AND THE RATE SUBSIDY, 1973-74

Table G.1. Estimated Cost of One Bag of Improved Rice Seed Sold by Seed Multiplication Unit, Ministry of Agriculture, Northern Region, Ghana and the Rate Subsidy, 1973-74

A. Cost of One 160 lb. Bag of Improved Seed[1]	
1. Purchase Price (180 lb. Bag)[2]	₵17.40
2. Cost of Mechanical Cleaning and Treating	2.20
3. Cost of Bagging and Handling	0.55
4. Overhead Charges	0.45
5. Total Costs for One Bag[3]	₵20.60
B. Rate of Subsidy	
1. Total Cost of One Bag	₵20.60
2. Less Selling Price	12.00
3. Subsidy	₵ 8.60
4. Rate of Subsidy: 42.0 Percent	

[1]Cost data were obtained from records of the Seed Multiplication Unit of the Ministry of Agriculture, Northern Region.

[2]The Seed Multiplication Unit purchases seed from Registered Seed Growers, whom it supervises.

[3]During the process of cleaning and treating and natural drying, the volume and weight of 180 lbs. of seed is reduced to 160 lbs. Seed is stored and sold in 160 lb. bags.

APPENDIX H

CALCULATION OF FERTILIZER COST PER TON AND RATES OF GOVERNMENT SUBSIDY AT OFFICIAL AND SHADOW FOREIGN EXCHANGE RATES

Table H.1. Calculation of Fertilizer Cost Per Ton and Rate of Government Subsidy at Official and Shadow Foreign Exchange Rates, 1973-74

Per Ton:	15-15-15		Ammonium Sulfate	
	Official Exchange Rate[1]	Shadow Exchange Rate[2]	Official Exchange Rate	Shadow Exchange Rate
	¢/Ton			
1. c.i.f., Port of Tema	195.00	263.25	110.00	148.50
2. Port and Clearance Charges	2.90	2.90	2.90	2.90
3. Bank Charges	0.30	0.30	0.30	0.30
4. Transport to Tamale	36.00	46.08[3]	36.00	46.08
5. Total Cost	234.20	312.53	149.20	197.78
6. Sales Price	56.00	56.00	40.00	40.00
7. Government Subsidy	178.20	256.53	109.20	157.78
8. Percent Subsidy	76	82	73	80
Per 1 cwt. bag:				
Total Cost	11.71	15.63	7.46	9.89
Sales Price	2.80	2.80	2.00	2.00
Subsidy	8.91	12.83	5.46	7.89

[1] GH¢1.15 = US$1.00

[2] GH¢1.55 = US$1.00

[3] It is assumed that the foreign exchange component of the transport is 80%. Thus, transport costs are increased by (¢36.00 x 0.80 = 28.80; 28.80 x .35 = 10.08; 36.00 + 10.08 = 46.08).

APPENDIX I

ESTIMATION OF THE IMPORT PARITY PRICE FOR RICE MILLED BY THE RICE MILLS UNIT AT TAMALE, NORTHERN GHANA

APPENDIX I

ESTIMATION OF THE IMPORT PARITY PRICE FOR RICE MILLED BY THE RICE MILLS UNIT AT TAMALE, NORTHERN GHANA

The average 1973 Ghanaian c.i.f. price for milled rice was ₵329. or $287 per metric ton.[1] The 1973 price f.o.b. Bangkok for 25 percent broken milled rice was $200 per metric ton. The average expected price between 1973 and 1980 f.o.b. Bangkok in 1973 prices is $196.[2] Given the relationship between the 1973 Ghana c.i.f. price and the f.o.b. Bangkok price and the projected f.o.b. price for 1980, we assume no change in the average Ghana c.i.f. price for imported rice in real terms.

I. Estimation of Import Parity

A. Milling Rates for the Tamale Rice Mills Unit

The average milling rate for the Rice Mills Unit is 55 percent. The output of milled rice in terms of grades is as follows:[3]

Grade	Milling Rate	Estimated Import Parity Value As a Percentage of 25 Percent Broken
25% Broken	30 Percent	100
40% Broken	15 Percent	75
100% Broken	10 Percent	50
Milling Loss	45 Percent	0
	100 Percent	

[1] Personal communication from IBRD county representative.

[2] Rice price projection developed in 1973 by the IBRD and used in a project document.

[3] From Goodwin, 1975.

The weighted average import parity value of one tone of domestic milled rice is therefore:

$$[(30/50 \times 1.00) + (15/55 \times .75) + (10/55 \times .50)] \times \$287. = \$241.$$

B. Adjustment for Processing and Internal Transport

1. Internal Transport

Assumption: Fifty percent of the Tamale milled rice is transported and sold in Accra in competition with imported rice and must be reduced by transport costs to get import parity. The other 50 percent goes to distribution centers, on the average, equidistant between Tamale and Accra and has equal parity with imported rice. Therefore, the import parity price of Tamale rice marketed in Accra is equal to the import parity price less half the cost of transportation.

The estimated economic transport cost in Ghana for a seven ton truck is $0.15 per ton mile.[4] Thus, the transport cost from Tamale to Accra is $0.15 x 410 miles + $62.00

2. Domestic Milling Cost

The estimated cost of milling one ton of rice at the Tamale Rice Mills is $44.00 per ton.[5]

3. Total Domestic Costs

Total domestic costs are, therefore, 50 percent of the internal transport costs from Tamale to Accra, plus total milling costs, or $44.00 + $31.00 = $75.00.

C. Net Foreign Exchange Value Per Ton of Domestically Milled Rice

The net foreign exchange value or net economic value per ton of domestically milled rice is, therefore, the ex-mill import parity price,

[4] From Goodwin, 1975.

[5] Ibid.

less estimated processing and transport costs, or

$241.00 - $75.00 = $166.00

D. Domestic Parity Value Per Ton of Rice in Local Currency

1. At the official Exchange Rate

(US $1.00 = GH ¢1.15)

$166.00 x 1.15 = ¢191. per ton

2. At the shadow Rate of Exchange

(US $1.00 = GH ¢1.55)

$166.00 x 1.55 = ¢257. per ton

E. Domestic Economic Parity Value Per Ton of Paddy

At the milling rate of 55 percent, it requires 1.8 tons of paddy to obtain one ton of milled rice. Therefore, the domestic economic parity value of one ton of paddy is:

¢257. ÷ 1.8 = ¢143. per ton or ¢11.50 per 180 lb. bag.

In the economic analysis the import parity price or economic value of paddy is therefore assumed to be ¢12.00 per 180 lb. bag.

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