THE ECONOMICS OF RICE PRODUCTION IN THE INLAND-VALLEY SWAMPS OF SIERRA LEONE

BY

MANNAH FODAY KALLON
B.S., University of Illinois, 1970

THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Agricultural Economics
in the Graduate College of the
University of Illinois at Urbana-Champaign, 1971

Urbana, Illinois

PREFACE

A key problem in the development of West African agricultural economics is shortage of primary data at the farm level. This limitation has jeopardized the successful implementation of many well intentioned national plans. National plans can only be as reliable as the elements from which they are constructed. This principle applies to the value of plans of more modest proportions such as the Sierra Leone government's plan to increase rice production through an exhaustive development of the inland-valley swamps for rice cultivation.

To recommend improvements necessary to increase rice production and rural income, this study developed a farm plan for inland-valley swamps that was cognizant of both the level of technology and managerial ability in the country. The initial basis of the farm plan was the establishment of labor requirements for various farm operations in rice cultivation and the development of a labor flow statement as a guide to avoid labor bottlenecks that are characteristic of traditional tropical agriculture. Implements used in the farm plan were selected with the full realization that the society cannot currently afford the cash outlays for and the management of conventional farm tractors at the individual family-farm level. Suggestions of modest levels of mechanization that could be in the future development of a commercial farm business sector were however made.

The author wishes to express his sincere appreciation to Professor W. N. Thompson who acted as his academic advisor at both the undergraduate and graduate levels. During this period, the author has experienced special difficulties not typical of many students. Professor Thompson on all occasions willingly granted his time and counsel to encourage the author through difficult times.

Thanks are due to Professor Jean M. Due who has always been a personal friend and teacher. The author is also grateful to Professor Gerald L. Karr who not only assisted in the collection of data that formed the basis of this study, but who also supervised the writing of this thesis while Professor Thompson was on assignment in India. His deep and sincere interest in the economic development of Sierra Leone and in the author's writing of a problem solving thesis were a great inspiration at all times.

Finally the author extends his sincere thanks to the staff and volunteers of the United States Peace Corps who worked with the Sierra Leone rice farmers in the implementation of the 1968 Rice Farming Scheme.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CONVERSION FACTORS

1 Leone (Le 1.00)	= $1.20 (U.S.)
1 Acre	= 0.4046854 Hectares
1 Cwt. (Sa. Leone)	= 112.0 pounds
1 Cwt. (U.S.)	= 100 pounds
1 gallon (U.S. liquid)	= 3.785306 liters
1 meter	= 1.093613 yards
1 bag rice (clean)	= 168.0 pounds
1 bag rice (paddy)	= 120.0 pounds
1 bushel rice (clean)	= 84.0 pounds
1 bushel rice (paddy)	= 60.0 pounds

CHAPTER I

INTRODUCTION

The Problem

A land use approach to the principle of comparative advantage suggests that, under existing physical, biological and economic conditions, a nation can improve its economic well-being by allocating its land resources to those uses for which it comparatively has the greatest advantage.

In this regard, current knowledge of rice farming in Sierra Leone suggests a need to substitute the inland-valley swamps for the rainfed uplands for rice production. However, the individual farm household must realize increased returns for the additional efforts required in such a change in production systems. How can the available resources be organized to realize these increased returns?

General Research Hypothesis

The general research hypothesis of this study is that by using existing improved technology, increased net economic returns can be obtained from inland swamp rice cultivation. Such net returns to household labor and management are competitive to returns from traditional farming and selected nonagricultural opportunities.

Objectives of the Study

The purpose of this study is to provide an analysis of resources, technology and management used on individual rice farms in the inland-valley swamps of Sierra Leone. Specifically, the study will:

1. Review technical information that is pertinent to the proper management of rice farms for improved returns in the inland swamps.
2. Determine the kinds and quantities of resources, particularly labor, used on individual swamp rice farms for both development and cultivation.
3. Suggest needed adjustments that will improve the returns to household labor and management.

Justification of Study

Rice production is of extreme importance in the economy of Sierra Leone. Rice accounts for about 43 percent of the total annual per capita caloric intake in the country.[1] It is grown by about 86 percent of the farmers[2] on about 700 thousand acres of land.[3] Annual production of husk rice

---

[1] "Food Balances for 30 Countries in Africa and West Asia, 1959-61," ERS Foreign 119, Economic Research Service, United States Department of Agriculture, Washington, D.C., March, 1965, Table 28, p. 30.

[2] "Agricultural Statistical Survey of Sierra Leone, 1965-66," Central Statistics Office, Freetown, March, 1967, Table 23, p. 81.

[3] Ibid., Table J, p. 17.

is estimated to be 400 thousand metric tons,[4] 44 percent of which is from rainfed uplands[5] farmed under a system of shifting cultivation. Of the various rice growing systems in the country, the uplands produce the lowest yields of about 900 pounds of husk rice per acre. In contrast, the mangrove swamps, inland sedge swamps and deep flooding grasslands, which account for 10, 27 and 2 percent of total rice production respectively each produced yields of about 1600 pounds. The bolis or inland riverain grass covered swamps, accounted for 2 percent of rice production with yields of about 1200 pounds of husk rice per acre. The inland-valley swamps which accounted for 15 percent of total rice production produced the best yields of 1800 pounds per acre.[6] Field trials, using improved rice varieties in combination with water control and fertilizer application, have resulted in yields of over 300 pounds in the inland valley swamps.[7]

---

[4]"Rice in West Africa," U.S. Department of Agriculture, U.S. A.I.D., Washington, D.C., 1968.

[5]"Development of Inland Valley Swamps," Programme plan by the Division of Agriculture, Ministry of Agriculture and Natural Resources. Mimeo. February, 1970, p. 1.

[6]Ibid., Table 1, p. 1.

[7]Alan Hobby, "The Introduction of Intensive Swamp Rice Cultivation in the Eastern Province of Sierra Leone." Unpublished. Department of Agriculture, Ministry of Agriculture and Natural Resources, Kenema, Table 1, p. 15.

Swamp rice production is of major importance in the government's agricultural strategy to: (1) increase rice production to an extent that will at least halt the importation of 5 to 10 percent of total rice consumption in the country; (2) promote permanent cropping as a way of controlling erosion caused by shifting cultivation of the uplands and (3) develop a basis for a healthy rural economy. The scope of the strategy justifies the need of additional research to determine the profitability of swamp land development and cultivation.

In addition, the acreage of inland-valley swamps in Sierra Leone is estimated to be 738 thousand. Seventy-one percent is located in the Eastern Province, 15 percent in the Southern Province and 14 percent in the Northern Province.[8] The availability of the swamps in all regions of Sierra Leone makes it possible to involve local people in their development and cultivation which, if fully done, can meet the national rice consumption requirements. Yet only 13 percent of the total area of inland-valley swamps is currently under cultivation.[9]

---

[8] "Development of Inland-Valley Swamps," p. 2.

[9] Ibid., p. 2.

Inland swamps are convenient for the construction of simple and inexpensive systems of bunding for water management.[10] They represent the only rice growing system in the country that is not subjected to the vagaries of climate. Occasionally when early rains cause incomplete burning of upland farms, farmers resorted to inland swamps to grow rice for subsistence.

Field trials have also shown that, with proper management and improved technology, high yields can be obtained over long periods. These advantages of inland-valley swamps justify studies to determine costs and returns with respect to both development and rice cultivation.

Review of Literature

Because rice is generally considered an Asian diet cereal, foreigners, especially Europeans, were sufficiently impressed on initial exposure to Sierra Leone rice culture to make some observations. Roddan, for instance, was so impressed by the potential rice producing capacity of the country and the techniques of the local farmers that he made

---

[10]Bunds or terraces built from dirt and local material allow controlled flooding of swamps. The water is allowed into the swamp by sluices constructed at intervals in the bunds. A main drainage ditch affords rapid removal of flood waters caused by heavy rainfall.

a study of their methods of production.[11] One result of his study was the determination of an economical size of farm to be five acres. Roddan's observations were on the mangrove swamps of the Northern province, but his work was one of the earliest attempts to estimate a size of farm that would provide an economic compensation for the labor input he observed.

The importance of rice in Sierra Leone and the British colonial policy of establishing regional research centers were in part responsible for the establishment of the West African Rice Research Station at Rokupr (now Njala University College Rice Research Station) in the country in 1934. Since its inception, the station has accumulated a vast amount of basic knowledge on rice production in the country. Because of its location, close to the boli areas and mangrove swamps in the Northern Province, most of the earlier work related to rice production in these areas. Studies on other rice growing areas (e.g. inland swamps) showed that they had better potential for increasing rice production, especially when the costs of reclaiming mangrove swamps for extensive rice production were considered. The Rice Research Station as a consequence increased its research efforts on the inland swamps and other rice growing areas.

---

[11] G. M. Roddan, "The Cultivation of Swamp Rice in Sierra Leone," Tropical Agriculture, Vol. XIX:5, May, 1942.

The Department of Agriculture has used the results of such research in various rice producing schemes ranging from seed distribution to clearance schemes.[12] Some of these early schemes were on inland-valley swamps but records of their operation were misplaced and are not available for analysis.[13]

There is currently a renewed emphasis on the development of inland swamps. This has caused some staff members of the Research Station to release pertinent information from the Station's records as an extension guide to help farmers. One such release is Kargbo's "Guide Notes to Swamp Rice Cultivation."[14] The Notes provide advice on the techniques of site selection for a swamp rice farm, transplanting of rice, nursery practices, sowing dates for best yields, etc. The Notes recommend RH2, Faya and SR26 as the most suitable varieties for the inland valley swamps. Yields of 50 to 55 bushels of husk rice per acre for RH2, 30 to 35 bushels for Faya and 40 to 45 bushels for SR26 can be expected when water management and fertilizer are used.

---

[12] G. L. Karr, "The Use of Subsidies for the Promotion of Inland Swamp Development," Economic Trends, Bank of Sierra Leone, November-December, 1969, pp. 1-7.

[13] Hobby, p. 2.

[14] A. B. Kargbo, "Guide Notes to Swamp Rice Cultivation and Seed Multiplication Techniques in Sierra Leone." Unpublished mimeo. Rice Research Station, Rokupr, July, 1970.

In addition to basic plant breeding research, the Rice Research Station has conducted fertilizer trials, studies on cropping population and yields and studies of double cropping. The results of one double cropping trial indicated that a reduction of some 51 percent should be expected in the yields of a second crop.[15]

Other organizations, particularly the Food and Agricultural Organization (FAO) and the Peace Corps have made contributions to applied research on the inland swamps. The FAO in cooperation with the Ministry of Agriculture and Natural Resources (MANR) have conducted fertilizer trials all over the country. The results of the 1968 fertilizer trial showed that 30 pounds each of actual nitrogen and P_2O_5 per acre obtained an average increase in yield of over 700 pounds of husk rice per acre over control plots without fertilizer.[16] From such trials a rate of 25 to 45 pounds per acre each of nitrogen and P_2O_5 has emerged as the economic dose for swamp rice in the country.[17]

---

[15]"Annual Report of the West African Rice Research Station, 1963," Rokupr, 1965, Table 1, p. 12.

[16]"Fertilizer Newsletter," Ministry of Agriculture and Natural Resources and FAO Fertilizer Programme. Mimeo, March, 1969.

[17]Dr. W. Hill, "A Summary of Results of Fertilizer Work on Rice in Sierra Leone." Undated mimeo. Rice Research Station, Rokupr, p. 5.

Geldhaf,[18] an FAO land use expert, did a study of the practical improvements of inland swamps in the Eastern Province. This study was an engineering investigation of water management and gave some idea of the factors that affect bunding requirements. The length of bund required per acre of swamp was determined by the slope of the swamp. Geldhaf calculated the construction cost of one meter (1.09 yards) of bund to be two shillings (Le 0.20). He also suggested that the cost per hectare (2.47 acres) for the improvement of swamps depends on the slope and width of swamp and the water catchment area.

Another FAO land planning expert proposed two alternative systems of double cropping that can be used in the inland-valley swamps.[19] Different duration rice varieties were used to test the two systems in February, 1967, but the results of the tests are not available. His comparison of test plots revealed that a combination of improved varieties and proper water management that allowed a depth of at least 10 inches of water during the growth of the rice crop obtained yields "above 2000 pounds of sun dried rice."

---

[18] J. Geldhaf, "Practical Inland Swamp Improvements in the Eastern Province of Sierra Leone," African Soils, Vol. XII, January-April, 1965.

[19] J. Veenstra, "Land Use Planning--Some Notes Towards an Operational Programme for the Introduction of a Permanent Agricultural Land Use Pattern, Including Rice Farming in Sierra Leone," Unpublished Mimeo. FAO Office, Kenema, May, 1967.

The works cited above provide valuable insight into the problems and offer technical information on swamp rice production but do not provide answers regarding the profitability of swamp rice cultivation. The Diamond Corporation (DICOR) pilot scheme was initiated in 1966 to promote the development and cultivation of inland-valley swamps.[20] The scheme provided for subsidies of Le 14.00 per acre for farmers who were willing to use recommended technologies and practices on newly developed inland swamps. The records from farms participating in the scheme provided the best indication of the profitability of these swamps.

Average yields of 84 farms in the scheme was 30.8 bushels of husk rice per acre. Yields ranging from below eight bushels to over 50 bushels were reported. The highest frequency of yields was 25 to 33 bushels per acre.[21]

Records from the DICOR scheme emphasized the importance of water management. Average yields of 33 farms with bunding systems for water management were 36 bushels as compared to 31 bushels for a sample of 42 farms that lacked a water management system.[22] Todd also observed that water management encouraged even growth and better yields; facilitated the implementation of improved husbandry; reduced the weed

---

[20] Hobby.

[21] Ibid., p. 15.

[22] Ibid., p. 17.

problem and damage by the cutting grass.[23]

In the DICOR scheme the majority of participants had, in addition to their swamp rice farm, either a cocoa, coffee, upland rice farm or a combination of all three.[24] This situation resulted in labor bottlenecks at certain periods during the production year and for some tasks. Household labor was adequate for most of the production tasks but over 80 percent of the labor used for swamp development was hired.[25]

A more detailed study of labor use in Sierra Leone rice farming was recently completed by Njoku of the University of Illinois.[26] In that study, Njoku found that household labor was both the most important and reliable component of total labor force on both upland and partially mechanized rice farms. For selected operations like brushing, felling, and plowing, the hired labor ratio was sometimes over 60 depending on the size and location of farm.[27]

---

[23]Bill Todd, "Swamp Clearance and Water Control in the Eastern Province," Unpublished paper presented at the Conference of Agricultural Research and Development, Njala University College, Njala, May, 1967.

[24]Hobby, p. 20.

[25]Ibid., Table 7, p. 22.

[26]A. O. Njoku, "Labor Utilization in Traditional Agriculture: The Case of Sierra Leone Rice Farms." Unpublished Ph.D. dissertation, University of Illinois, Urbana, April, 1971.

[27]Ibid., p. 91. Hired labor ratio refers to the proportion of hired labor to total labor used.

The average cash wage rate for both the uplands and mechanical rice cultivation areas was Le 0.30 per day but the returns reported by Njoku for one workday of household labor was Le 0.20 on the uplands and Le 0.43 on the partially mechanized areas.[28]

If the inland-valley swamp system is going to be successfully substituted for traditional systems of production, the returns from this system should provide a net return that is higher than those obtained from any of the alternative systems.

Framework for Analysis

Method of Analysis

Various hypotheses have been developed about the behavior and objectives of the farmer in low income countries. Many of these assume subsistence to be the objective of farmers in these societies. Mellor's limited aspirations model," for instance, implies that subsistence is the objective at least in the early stages of economic development.[29]

Although the subsistence motive may still be important in food crop production, it is unlikely that farmers will

---

[28] Ibid., p. 158.

[29] J. W. Mellor, "The Use and Productivity of Farm Labor in the Early Stages of Economic Development," Journal of Farm Economics, Vol. 45:3, August, 1963, pp. 517-533.

willingly provide the additional labor required for swamp rice cultivation for purely subsistence purposes. The traditional preference for upland rice farming which involves less labor input and managerial attention suggests that subsistence requirements are more easily obtained from the uplands. The reluctance to cultivate the swamps until improved varieties demonstrated that additional yields would more than compensate for the additional labor input, suggests objectives other than subsistence. Moreover, the government plan is intended to increase rice production to an extent that will create a marketable surplus. Only operator decisions that will result in rice production that is above subsistence requirements will achieve this public objective.

Njoku attempted to determine the factors that influence the production decisions of the Sierra Leone farmer. The factors evaluated were: (1) income, (2) the farmer's debt obligations, (3) social status, (4) subsistence, and (5) tradition. The importance of these factors varied with the systems of rice farming. Hence, subsistence was the most important factor in traditional upland rice farming while income was the important factor in the mechanical rice cultivation areas.[30] On the basis of this evidence,

---

[30] Njoku, p. 135.

subsistence was rejected as an objective in swamp rice cultivation. Instead, returns to household labor and management were assumed to be the factor to be maximized.

Budgeting methods were used to determine returns to household labor and management. Basically, a budgeting process for a given period converges on two figures.[31] One is total revenue for the period or situation under consideration and the other is total expenses for the same period. The difference between the two figures is a net profit or loss depending on whether revenues are greater than or less than expenses. The condition can be represented by the following equation:

$$[Qy_1 Py_1 + \cdots + QynPyn] - [QX_1PX_1 + \cdots + QX_nPX_n] - FC = \pi$$

where

Q = Quantity

P = Price

π = Profit or loss

$Y_1 \cdots Y_n$ = Different products sold, consumed or added to inventory (in this study, rice)

$X_1 \cdots X_n$ = Inputs used in production process

FC = Fixed costs

To maximize π, the optimum amount of production is attained when:

---

[31] L. A. Bradford and G. L. Johnson, Farm Management Analysis, John Wiley and Sons Inc., July 1967, p. 328.

$$\frac{MVPX_1}{PX_1} = \frac{MVPX_2}{PX_2} = \text{---} \frac{MVPX_n}{PX_n} = 1$$

where

$MVPX_i$ = Marginal value product of input X_i

($i = 1,2,3,\text{---}n$)

PX_i = Price of input X_i

Under perfect competition and homogeneous products, this condition will be attained when resources are allocated in such a way that:

$$\frac{MPPX_1}{PX_1} = \frac{MPPX_2}{PX_2} = \text{---} \frac{MPPX_n}{PX_n}$$

where

$MPPX_i$ = Marginal Physical Products of input X_i

($i = 1,2,3,\text{---}n$)

PX_i = Price of input X_i

Labor expenses were the major component of the expenditure column of the farm plan of this study. It was therefore necessary to accurately determine the labor requirement and the hired labor costs in order to compute the returns to household labor and management. For the supply side, a fixed stock of household labor was assumed. Labor requirements for both swamp development and rice production were then matched with the household labor supply, and additional labor was hired when household labor was insufficient for the farm labor requirements.

Labor requirements for farm operations are not evenly distributed. There were peak labor periods which, in the case of Sierra Leone swamp rice farming, are in the months of May through July. Similarly, because of the tradition of division of labor by sex, and because of the school calendar which affects the labor contribution of school age children, the needed household labor was unevenly distributed over the year. To permit adjustments for these limitations to household labor use, a labor flow statement was developed to provide a guide of monthly labor requirements of an inland-valley swamp rice farm.

The other components of farm expenses included tools, and crop expenses. Required tools and their costs were determined by examining available farm records.

The revenue side of the budget was determined only by the value of rice produced. This depended on rice yields that were selected on the basis of information from research records and the price received by demonstration farmers for rice used for food.[32]

Sources of Data

The Peace Corps Rice Farming Scheme was initiated in early 1968 as an extension effort to encourage inland swamp

---

[32]Some farmers sell their rice production for seed rice which has a higher price, but since the greatest demand for rice is for food, the possibility of selling rice for seed was not considered in the farm plan.

development. From the beginning, detailed cost and returns data were recorded in order to determine and compare the profitability of upland and swampland rice cultivation in Sierra Leone. Of twenty-one inland swamp rice farms in the scheme, seven were in the Northern Province, twelve in the Southern Province and two in the Eastern Province.

Peace Corps volunteers who served as demonstration farmers used improved varieties, fertilizers, water management and other improved practices recommended by the MANR and the Rice Research Station. The Sierra Leone farm record book was developed by the Department of Agricultural Economics, Njala University College to assist in the keeping of data on both costs and returns. These field records were one of the major sources of data for this study.

To complement the field data, additional information was sought from bulletins and reports of agricultural research workers. Reports of the MANR, Njala University College (NUC), the FAO and individual Peace Corps volunteers were particularly helpful as sources of information.

Source: This map was copied from Sierra Leone in Maps, published by University of London Press, Ltd., 1966.

Figure 1. Location of Sample Swamp Rice Farms in the 1968 Peace Corps Rice Farming Scheme, Sierra Leone

CHAPTER II

FACTORS AND TECHNIQUES RELEVANT TO SUCCESSFUL SWAMP RICE FARMING

Physical Factors and Environment

Climatic and environmental factors are important in crop growth and development. Sunlight is essential to the photosynthetic processes of plant development; fertile soils are required to supply essential nutrients and water is necessary for various metabolic processes.

Climate

Sierra Leone lies within the zone traversed seasonally by the intertropical front associated with the equatorial low pressure belt. As a result the climate is continuously warm with well defined wet and dry seasons. The mean daily temperatures vary between 78° and 84°F and the mean sunshine varies from a minimum of two hours in August to eight hours in January and February.[1]

Table 1 shows the annual rainfall distribution for ten stations in three regions in which inland-valley swamps are important. The well defined wet season (May to November) and dry season (December to April) can be observed in the

---

[1]Ralph Gerald Saylor, The Economic System of Sierra Leone (Durham, N.C.: Duke University Press, 1967), pp. 8-9.

Table 1. Rainfall Distribution as Reported by Selected Stations in Sierra Leone

	Prov	Years of Obser.	Months												D.S[a]	W.S[b]	Total	% W.S[c]
			J	F	M	A	M	J	J	A	S	O	N	D				
Daru	E	20	.46	1.3	4.2	5.8	9.9	11.2	11.2	14.5	16.1	13.1	8.1	2.5	14.3	84.1	98.4	85.4
Kenema	E	15	.73	1.3	3.8	5.8	8.7	12.7	14.9	21.5	16.9	12.2	6.6	1.8	13.4	93.5	106.9	87.4
Yengema	E	20	.45	1.1	4.0	5.9	8.6	12.5	12.3	15.5	16.8	12.1	7.1	1.9	13.4	84.7	98.1	86.3
Bo	S	20	.57	.96	3.0	5.1	9.4	13.3	19.1	22.3	19.5	14.7	7.4	2.1	11.7	105.7	117.4	90.0
Njala	S	20	.54	.66	3.1	5.0	9.3	13.3	17.5	20.0	16.4	13.8	7.2	1.9	11.2	97.5	108.7	89.6
Sumbuya	S	10	.77	1.6	2.4	3.7	7.6	14.5	19.7	19.4	21.1	13.4	7.9	2.2	10.7	103.6	114.3	90.6
Makeni	N	20	.36	.34	1.7	3.9	8.8	15.2	19.2	24.2	22.3	17.0	7.7	1.1	7.4	114.4	121.8	93.9
Kambia	N	20	.16	.14	.81	2.4	7.8	13.6	24.6	28.0	18.2	13.0	5.5	1.0	4.5	110.7	115.2	96.0
Batkanu	N	20	.26	.19	1.2	2.9	7.9	14.6	17.5	18.0	16.2	15.3	6.9	0.9	5.5	96.4	101.9	94.6
Port Loko	N	16	.15	.40	1.1	3.3	7.2	13.8	21.5	26.1	15.7	14.5	6.2	1.4	6.4	105.0	111.4	94.2

Source: S. Gregory, "Rainfall over Sierra Leone," Department of Geography, University of Liverpool, Research Paper No. 2, Table 1, p. 17, 1965.

[a]Dry Season (December to April).

[b]Wet Season (May to November).

[c]Percent of Annual Rainfall in Wet Season.

table. The last column of Table 1 shows the percentage of annual rainfall in the wet season.

Because rain is one source of water for crop growth, the poor distribution makes water management critical in swamp rice production especially in areas where the swamps are relatively dry and where double cropping is contemplated.

The existence of the two seasons with their respective characteristics also influences the economic activities in the country. In the agricultural sector, the cropping calendar is determined more by the rainfall than by any other factor.[2] It is for instance, important to finish brushing early in the year to allow the plant material to dry well and assure complete burning before the wet season begins in April.

The prevalence of unpaved roads in the country also subjects the marketing of agricultural products to the influence of the weather. The heavy rains of the wet season damage roads and render some producing areas inaccessible by road.

Vegetation

Inland-valley swamps are found around ill defined streams and valleys throughout the country. The common vegetation of the swamps are grasses, raffia palms, and a

---

[2] K. Little, "The Mende Rice Farm and Its Cost." Zaire, Vol. 5:3, March, 1951.

few native oil palms.

The density of vegetation is not homogeneous and this factor may affect labor requirements for brushing, felling and stumping in different swamps.

Soils

Rice is a plant suitable for waterlogged soils. Typical soils for lowland or paddy rice are heavy, preferably with a hard pan at a depth slightly below the root depth.[3] These conditions are economical as well as ecologically desirable since percolation results in loss of water and nutrients. They also encourage flooding and anaerobic conditions which favor the accumulation of ammonium salts that are preferred by rice as a source of nitrogen.[4]

A detailed analysis of one sample of inland-valley swamp soil from a pit near Segbwema in the Eastern Province showed that the parent material was alluvium over residium from quartz rich granite bedrock.[5] The soil was grayish brown to dark grayish brown. It had loose and structureless loamy sand to a depth of 21 inches and was of poor drainage.

---

[3]"Tropical Soils in Relation to Tropical Crops," Imperial Bureau of Soil Science and Technical Communication No. 34, pp. 11-19.

[4]Ibid., pp. 11-19.

[5]R. T. Odell and J. C. Dijkerman, Properties, Classification and Use of Tropical Soils with Special Reference to Those in Sierra Leone (Njala: Njala University College, 1967), p. 121.

This condition approximates the typical qualities that prevent percolation and facilitates waterlogging.

The soil sample was acid with a P.H. = 4.5 in the top 11 inch layer and P.H. = 5.0 at depths below 21 inches. Since deep plowing is not practiced because of the simple tools used in Sierra Leone, this soil sample seems to be a little acid for rice which "thrives on alkaline soils, the desirable conditions being neutral or slightly acidic."[6]

The top 11 inch layer of the sample was about 94 percent sand, 4 percent silt and only 2 percent clay while at depths of 21 to 33 inches, the sand content was 67 percent and silt and clay contents were higher at 15 and 18 percent, respectively.[7] This quality of soil is much less than the following mechanical limits considered to be desirable for first class rice soil: humus 3 to 7 percent; clay 25 to 65 percent; fine silt 20 to 60 percent; silt 10 to 25 percent and sand 2 to 10 percent.[8]

Soil structure is, however, not critical when rice is grown under flooded conditions. Experiments in Java showed little correlation between rice yields and composition of soil solid phase. Parent material and age of soil were found

---

[6]"Tropical Soils in Relation to Tropical Crops," pp. 11-19.

[7]R. T. Odell and J. C. Dijkerman, p. 121.

[8]"Tropical Soils in Relation to Tropical Crops," pp. 11-19.

to be more important.[9] Younger soils from tephritic materials produced the highest yields while older soils of limestone origin produced the lowest yields. These observations further emphasize the need for water management that will permit flooding to partially compensate for the inferior soil quality.

Cultural Practices

Rice culture in Sierra Leone is more extensive on the rainfed uplands than in the swamps. In those cases when inland-valley swamps are cultivated, they are adjuncts to the upland rice farm as a source of subsistence. Cultural practices suitable to the uplands are transferred to the swamps where they are unsuitable. As a result, farmers have failed to fully exploit the productive potentials of inland-valley swamps. This, in part, explains the skepticism of farmers with regards to the profitability of the swamps.

Various swamp rice demonstration schemes have been implemented over the years to demonstrate the profitability of swamp rice farming, using improved technology and management. This section will therefore consider only those recommended improved techniques that are essential to profitable rice production in the swamps.

---

[9] Rice Production Manual. University of Phillipines, College of Agriculture/International Rice Research Institute, undated, p. 44.

Use of Fertilizer

Inland-valley swamps vary in fertility, but in general, they are deficient in many plant nutrients. To correct deficiencies and maintain a satisfactory level of production over long periods, farmers have been urged to use animal manure and compost. Experiments in many parts of tropical Africa have shown that when applied in heavy doses, such treatments help maintain soil fertility.[10]

In the case of Sierra Leone, where rice farmers are traditionally not herdsmen, the use of animal manure may be difficult to implement in rice farming areas. Therefore, in place of farm manure, extension staff have advocated the use of chemical fertilizers. Fertilizers not only provide a dramatic demonstration of the yield advantages of improved technology, but also increase the production of crop residue that add organic matter to the soil.

Experiments have shown that the soils of inland-valley swamps respond well to phosphate and ammonium fertilizers. A treatment of 30 pounds P_2O_5 per acre produced an average per acre rice yield increase of 27 percent over a control plot without fertilizer. Addition of 30 pounds of nitrogen

---

[10]H. L. Richardson, "Use of Fertilizer," The Soil Resources of Africa. A Symposium of the African Studies Association of the United Kingdom. Cambridge University Press, 1968, pp. 137-153.

and 30 pounds of P_2O_5 resulted in a yield increase of 42 percent over the control plot.[11] Table 2 shows the response of inland-valley swamp rice to various levels of fertilizer application.

From the results of such trials, the MANR has recommended the use of one hundredweight each of single super-phosphate and sulfate of ammonia per acre of swamp rice.[12] The Chinese Agricultural Mission recommended about twice this amount of P_2O_5 and nitrogen in addition to potassium chloride.[13]

Table 2. Response of Inland-Valley Swamp Rice to Nitrogen and P_2O_5. (yield per acre)

		N P_2O_5 K	N P_2O_5 K	N P_2O_5 K
Province	Sample	0 - 0 - 0	0 - 30 - 0	30 - 30 - 0
		(Average Yield in Pounds)		
Northern	18	1,083	1,356	1,591
Southern	14	1,969	2,638	2,883
Eastern	43	1,863	2,289	2,573
Western	8	1,493	2,028	2,241
Sa. Leone	83	1,676	2,120	2,381

Source: "Fertilizer Newsletter." Mimeo. Ministry of Agriculture and Natural Resources/FAO Fertilizer Programme, March, 1969, Appendix 1, Table V.

---

[11] "Fertilizer Newsletter," p. 2.

[12] These quantities of fertilizer contain approximately 18 percent of actual P_2O_5 and 20.5 percent actual nitrogen, respectively.

[13] "Release by S. L. Chinese Agricultural Mission." Unpublished Mimeo. Chinese Agricultural Mission, 1969, p. 5.

A proper method of applying fertilizer under Sierra Leone conditions is to broadcast in a split application. The first treatment should be applied after puddling and immediately before transplanting the rice. The final application should be at tillering, about 6 to 8 weeks after the rice has been transplanted. On both occasions, the swamp should be clean weeded, if this is found to be necessary, and the fertilizer should be worked well into the soil.

Water Management

Water is the most important single factor in rice production.[14] It is such a dominant factor that the composition of the soil's solid phase is of minor significance except insofar as it affects the water regime.[15] A water management system that can take advantage of both the high rainfall and streams in inland-valley swamps can have a positive effect on rice production in the country.

In many parts of Sierra Leone, the intensity of rainfall can reach four inches an hour.[16] Because of the dense vegetation, permeability and good absorption capacity, Geldhaf used a rate of an inch of rain per hour,[17] or 27

---

[14] Rice Production Manual, p. 47.

[15] "Imperial Bureau of Soil Science," pp. 11-19.

[16] Geldhaf, p. 83.

[17] Ibid., p. 83.

thousand gallons of water per acre per hour in his calculations. This volume of water determines the dimensions of a drainage system that can evacuate a specific catchment area for efficient water management. For a catchment area of 40 acres, Geldhaf calculated that a maximum width of sluice of about 10 feet together with a depth of 16 inches of water can allow a rate of water flow of about 1119 gallons per hour.[18] For the same depth of water, a larger width of sluice will be required for the same efficiency in controlling water in a larger catchment area.

A basic principle of water management under Sierra Leone conditions is that it should be as simple as possible, of low cost and use local materials. "This reduces the number of qualified staff required and permits the improvement of the biggest area for a given sum."[19] This is why bunds built of dirt and local materials are recommended as the key element in water management in the inland-valley swamps.

In the construction of a bunding system, the swamp should be surveyed to determine its slope. Contour lines should be pegged running perpendicular to the downstream flow of the stream around which the swamp is formed. Bunds should then be constructed along the contour lines. A bund of 47

---

[18] Ibid., p. 84.

[19] Ibid.

inches width at the base, 30 inches height and 16 inches width at the top should provide an efficient water management system.[20]

The size of paddies (bunded plots) must be small enough to permit easy evacuation and refilling of water to a uniform height. The Chinese Agricultural team recommend paddies of a quarter of an acre in size; but most farms in the Peace Corps rice farming scheme exceeded this size limit. The common size of paddy was one half to three quarters of an acre.

Other advantages of bunding include: (1) even distribution of water over the swamp which permits puddling in a way that will release soil nutrients and make them available to the rice crop; (2) the deposition of silt which helps maintain soil fertility; and (3) the draining of water facilitates fertilizer application, weeding if necessary and harvesting.[21]

Seed Preparation

Testing seeds for viability will give an estimate of the amount of seed needed for planting and save time and expenses that may be incurred by planting seeds that will not germinate.[22]

---

[20] Ibid., p. 86.

[21] Hobby, p. 17.

[22] Rice Production Manual, p. 78.

This is particularly important because most farmers in Sierra Leone do not plant pure seed rice.

In 1968, the Rice Research Station distributed about 1500 bushels of seed rice for both upland and swamp rice cultivation.[23] Of this, only 175 bushels was the RH2 variety recommended to give the best yields in the inland-valley swamps. The Chinese also distribute seed rice to farmers participating in their intensive rice cropping program.

Seed rice from these sources is viable but accounts for an insignificant proportion of the total seed rice needs of the inland swamp. At the recommended seed rate of one bushel per acre, the 13 percent of the total acreage under cultivation in inland-valley swamps currently would require roughly 96 thousand bushels of seed rice every year. The overwhelming proportion of this need is met by seed rice obtained from other farmers or from the farmer's own crop. Seed rice from the latter sources should be tested for both purity and viability as one way of reducing production costs.

Purity refers to seeds that are free of any excessive amount of chaff, weed seeds and other seed varieties. It can be assured by rogueing of the growing crop and through handling precautions.[24] Rogues are seeds that were left in

---

[23]G. L. Karr and M. Hanson. "Evaluation of the 1968 Small Packet Rice Seed Distribution Scheme." Unpublished Mimeo. Njala University College, August, 1968, p. 6.

[24]Kargbo, p. 7.

the field in the previous harvest and grow with the new crop. They can be eliminated by consistent planting of the same variety on the same plot every year. Where double cropping is practiced, this may be an impossible practice since the first crop may be RH2 and the second crop, a shorter duration variety.

In this case, the field should be carefully inspected for plants that flower conspicuously early or late and those that are conspicuously shorter or taller than the general population. Such plants are rogues and must be completely removed.

The practice of rogueing can result in considerable labor input which can be avoided by careful handling of the harvested crop. The frequent handling of the crop at various stages of harvesting and seed processing facilitates the risk of mixing varieties. To avoid or minimize this risk, various varieties should not be threshed side by side. Labels should also be used on both the inside and outside of containers in which seed rice is stored.[25]

Viability of seeds refers to their ability of normal development under normal conditions. A rice seed must not exceed 14 percent moisture content if it is to remain viable for a long period of time. More important, it should have a minimum germination of 80 percent.[26]

---

[25] Ibid., p. 8.

[26] Rice Production Manual, p. 75.

The germination of seed rice can be determined by randomly selecting a sample of 100 seeds from the bulk supply. The sample is spread thinly and half covered with water in a dish. It is possible to count the number of germinated seeds after five days.[27] If germination is less than 80 percent but above 60 percent, more seeds should be sown in the nursery to compensate for the poor germination.[28] Seed rice with less than 60 percent germination may be either too old or intensely dormant and should not be sown.

If dormancy is suspected in seed rice, it can be broken by simple heat treatment. Continuous heat at 120°F should be applied for a few days depending on the intensity of dormancy. Firewood or a kerosene lamp can be used as sources of heat. The seed should be protected from flames or higher temperatures. By this process four to five 25 pound bags of seed rice can be treated using a 44 gallon drum as a heating chamber.[29]

A final treatment is the dipping of seed rice in a solution of two six ounce canfuls of salt in eight gallons of water. This separates the heavier viable seeds from the non-viable seeds which float. The heavier seeds should

---

[27] "Improving Rice Yields in Sierra Leone," Unpublished Mimeo. Rice Research Station, Njala University College, undated, p. 11.

[28] Rice Production Manual, p. 79.

[29] Ibid., p. 85.

then be rinsed in fresh water and soaked in water for 24 hours, after which they are incubated for 36 to 48 hours. This treatment induces rapid and uniform growth in the nursery.[30]

Nursery Preparation

Two types of nursery, the wet and dry types are in use in Sierra Leone. A wet nursery is generally situated along the borders of a swamp or in a moist valley area, whilst a dry nursery is generally situated in the adjacent uplands.

The nursery should be properly brushed, cleared and plowed to a depth of 6 inches.[31] The soil should be puddled to a fine tilth and raised beds if desired should be about 1 to 1 1/2 yards in width and as long as convenient with drainage canals.[32] Such a width permits an individual to work across the beds without stepping into them.

About 350 square yards of nusery space should provide the quantity of seedlings that can plant an acre of swamp.[33] If the nursery is too wet, pre-germinating the seeds in water may be necessary. The pre-germinated seeds should

---

[30] Ibid., p. 85.

[31] Kargbo, p. 3.

[32] Rice Production Manual, p. 85.

[33] Kargbo, p. 3.

be mixed with 10 pounds of sand to facilitate separation for planting in nursery.

If fertilizer is necessary,[34] the recommended dosage of 40 pounds of single superphosphate should be hoed in with the seed. An additional 15 to 20 pounds of sulfate of ammonia may be necessary between 7 and 10 days after sowing. The seeds in the nursery should be covered with palm leaves to protect them from birds and other pests.

Estimates of the optimum time rice seed should spend in the nursery vary between 20 to 35 days depending on the seed variety. For most varieties recommended for inland-valley swamps, a period of 21 days in the nursery is considered to be optimum. Seed and nursery preparation should be scheduled to permit transplanting after the selected optimum nursery period.

Transplanting

Transplanting of rice evolved in Asia as an adjustment to the peculiarities of the rainfall distribution.[35] Asian farmers learned through experience that during the dry season, they could plow heavy soils more easily when they were

---

[34]Nurseries with fertile soil may not need a fertilizer dressing.

[35]Richard Bradfield, "Farming Systems in Africa, Management of Crops, Soil and Water: Mechanization," Agricultural Research Priorities for Economic Development in Africa. Abidjan Conference organized by the U.S. Academy of Sciences/National Research Council, Vol. III, April, 1968, p. 267.

saturated with water. Transplanting was the best way to plant seeds in a system based on puddled soils.

Several demonstration farms, however, questioned the need for transplanting, especially when it has high labor requirements at a time when the labor demands of the farm are at a peak. Some obvious advantages of transplanting include: (1) affords the young plant a head start over weeds in well-prepared swamps, (2) permits the rearing of healthy seedlings in the sursery, (3) allows for easy weeding and other operations especially if straight row planting is used and (4) permits optimum plant spacing.[36]

Improper spacing can result in a reduction of 25 to 30 percent of potential yield,[37] but proper spacing standards are hard to establish. They depend on (1) the rice variety, (2) the fertilization practices and general fertility of the soil and (3) the growing season.[38]

Heavy tillering, tall growing, leafy and lodging susceptible varieties should have a wider spacing of about 12 x 12 to 14 x 14 inches. Rice on fertile soil or with heavy fertilizer application are likely to be tall growing and leafy and should have a similar wide spacing. The Rice

---

[36] Rice Production Manual, p. 97.

[37] Ibid., p. 97.

[38] Ibid., p. 95.

Research Station's recommendations for Sierra Leone swamps is 6 x 6 to 8 x 8 inches spacing.[39] Dry season rice plants which are likely to be less leafy should have this smaller spacing.

The seedlings should be carefully pulled off from the nursery and tied in small bundles. If the plants are tall and leafy, some of the foliage should be cut off to minimize transpiration after transplanting. The roots should not be cut as this will reduce the ability of the seedlings to establish themselves in the new environment and also their nutrient intake ability.

---

[39]Kargbo, p. 4.

CHAPTER III

DEMAND AND SUPPLY OF LABOR ON A SWAMP RICE FARM

Labor Requirements

An essential part of a farm plan designed to establish the profitability of swamp farming in Sierra Leone relates to obtaining estimates of labor requirements. It is necessary to determine the amount of labor required in each month, especially in peak labor periods.

A determination of monthly labor requirements makes it possible to fit the selected intensive cropping system into the existing activity calendar and avoid conflicts with other established enterprises. In a low income economy, where a class of landless laborers is lacking and where funds are not readily available to pay for hired labor, a farm plan must be developed with critical attention directed to the quantity and the distribution of the labor inputs.[1]

Table 3 shows a profile of actual labor inputs for swamp rice farms in the Peace Corps rice farming scheme. The tasks were separated into development and operational phases. Development tasks were performed only once for a given swamp and their cost represent the investment

---

[1]D. W. Norman, "Labor Input of Farmers: "A Case Study of the North Central State of Nigeria," The Nigeria Journal of Economics and Social Studies, Vol. 2:1, 1969, pp. 3-14.

Table 3. Labor Requirements of Swamp Rice Farms by Task. (In Workdays)[a]

Task	No. of Farms Reporting	Range of Labor Use	Average Labor Use	Adjusted Labor Requirement Per Acre
DEVELOPMENT				
Brushing	21	6.80- 75.26	23.55	16
Felling	2	2.20- 10.20	6.20	3
Clearing & Burning	7	2.37- 17.25	10.67	8
Stumping & Leveling	12	3.95-174.50	46.12	25
Bunding & Sluice Gates	16	9.50-180.67	39.22	42
TOTAL				94
OPERATIONAL				
Brushing	5	4.00- 16.54	9.69	5
Nursery Work	15	0.26- 24.35	8.78	2
Plowing	20	2.80-110.26	40.50	25
Puddling	10	14.89- 56.66	30.80	15
Fertilizer Application	0	--- ---	---	0.5
Transplanting	18	8.00-140.78	50.52	18
Fencing	6	1.82- 27.60	10.68	10
Weeding	6	11.16- 37.60	24.60	12
Bund Repairs	8	2.86- 32.60	12.00	1
Pest Scaring	12	2.89- 31.67	5.00	20
Harvesting & Seed Processing	14	2.19-103.94	33.94	25
TOTAL				133.5

[a]Workdays assume an adult was working with hand tools over time periods varying according to the type of task being performed.

that increases the value of the swamp. Operational tasks were performed in the actual production process and their costs incurred with each crop.

The table also shows one of the difficulties encountered in this study, (a wide range of labor was used by different farms in performing similar tasks). It was hence necessary to make adjusted estimates of the labor requirements for various tasks. In making such estimates, factors such as the quality of the farm records, difficulty of performance and the nature of the tasks were important.

For the most part, the adjusted estimates were below the actual average labor inputs of demonstration farms. The downward adjustment was influenced by the following factors: 1) the labor hired was generally inexperienced for specific operations and evidence in the records suggested that labor efficiency improved as the workers acquired experience; 2) some farm tasks were spread over a period of many months and the record keepers were unable to make any detailed assessments of actual time spent on such tasks; and 3) the laborers used for some tasks (e.g. harvesting) were contracted for cheaper wages than would be paid if they were hired on an individual basis. The economies inherent in the contract arrangement created a tendency to hire more people through a contract than were needed for the task. There were also, in a few instances, difficulties in the supervision of a large number of workers.

Development

The adjusted estimate of labor required for the development of one acre of inland-valley swamp was 94 workdays. Seventy percent of this requirement is for bunding[2] and stumping.[3]

Bunding Labor Requirements: The adjusted estimate of 42 workdays for bunding is slightly above the average actual labor input of 16 farms reporting this task. The average bund length for the 16 farms was 205 yards. The estimated labor requirement of 42 workdays therefore suggested over five yards[4] of bund construction in a workday. This is consistent with Geldhaf's calculation that a "labourer can build four meters (4.4 yards) of bund a day."[5] Another estimate of sixteen yards of bund per workday seemed to be too high even when the narrower dimension of the suggested bunds were taken into consideration.[6] The MANR estimate that bunding, digging drains and construction of sluice gates for

---

[2]Bunding includes digging waterways as necessary and the construction sluice gates.

[3]Stumping includes leveling and removal of stumps from field.

[4]The average length of bund per farm was 205 yards. This length of a bund was constructed in an average of 39 workdays (205 divided by 39 = 5.25 yds./workday).

[5]Geldhaf, p. 86.

[6]Todd, p. 7. Todd recommended bunds of 24 inches width at the base; 20 inches height and "somewhat narrower at the top." Farm records commonly reported bund dimensions of 36 inches at the base; 36 inches in height and 24 inches width at the top.

an acre of swamp can be completed in 29 workdays is, on the basis of the farm records low.

Geldhaf suggested that the bund requirement is determined by the slope of swamps.[7] He calculated that a one percent sloped swamp required 60 meters of bund per hectre (26.55 yards per acre) and indicated a linear relationship between bund requirements and the slope of swamp. Although the slope factor provides a rule of thumb for estimating bunding requirements, Geldhaf's suggested requirements failed to recognize the effect of the size of paddy on bund length and hence bunding labor requirements. The quarter of an acre paddy recommended by the Chinese Agricultural Mission to be the most efficient in terms of both water management and leveling of the field requires more bunds and more labor input than Geldhaf allowed.

Stumping Labor Requirement. Stumping was one of the tasks that was spread out over a period of months. Because of this some field records on stumping are not as detailed as might be desired. Also the extreme maximum of 175 workdays substantially raised the average actual labor input to 46 workdays. Five of 12 farms actually used between 16 and 25 workdays for the task. Three other farms used less than ten workdays per acre. An alternative to the stumping task involved spreading it over two years. This was done

---

[7]Geldhaf, p. 86.

on some farms because the task was difficult and interferred with the timeliness of other operations. The labor requirement for complete stumping was established at 25 workdays per acre which is the average of the farms that stumped for less than 30 workdays. This requirement will vary in different swamps, depending on the density and size of vegetation.

Brushing Labor Requirement: Brushing is one of those tasks for which a clear cut definition is lacking. Although many farms reported labor input for brushing, the concept of the task was often different between farms. Some included felling as a part of brushing and others referred to "brushing and land preparation" which included many activities like felling and clearing.

The average labor used for brushing was 24 workdays per acre. Two farms brushed for over 40 workdays; four others in between 25 and 40 workdays but the highest frequency was nine farms that brushed between 7 and 19 workdays per acre. The average labor input of these nine farms was 14 workdays per acre which was selected as the adjusted estimate of the labor requirement for brushing the farm site.

Nursery Labor Requirement: The development work for the nursery was in all cases aggregated with production nursery work. The nursery area was generally small, often less than a quarter of an acre. It was estimated that this area can be brushed, cleared or burnt in two workdays.

The total labor requirement for development brushing is 16 workdays per acre. A similar estimate by the MANR was 10 workdays. This estimate did not however include the development of the nursery area.

Felling, Clearning & Burning: There were not enough data on felling, clearing and burning to make an empirical estimate of the labor requirements for these tasks. Only two farms provided data on felling labor. Their average labor input was six workdays. One of the farms felled trees in almost five times as much workdays as the other farm; this created an upward bias in their average labor input. The downward adjustment was made in recognition that some inland swamps do not use any labor for felling. Three workdays was hence established as the labor requirement for felling one acre of swamp.

Because of a lack of enough data on clearing and burning, the MANR estimate of eight workdays per acre was accepted as the labor requirement for this task.

Operational

The difficulties encountered in the estimation of labor input in tropical agriculture are much more serious in the production tasks than in swamp development tasks. The difference is due to the fact that swamp development as used here (stumping, bunding, etc.) are new methods that were recently introduced and work habits and task definitions are fairly uniform. On the other hand, production tasks have

been performed by farmers since the introduction of rice culture in the country. As a result, work habits and task definitions have evolved to suit individuals and their specific environment. As a consequence, more subjective decisions are required in estimating labor inputs for rice production activities.

The production of rice on one acre of swamp was estimated to require 133.5 workdays. Adjustments for specific tasks were required in the total labor requirement as farm size increased.

Plowing Labor Requirement: Plowing accounts for almost 20 percent of total operational labor requirements. It is one of the tasks for which an ambiguity of definition exists. Different farmers plowing at different depths cannot be said to be actually performing the same task. The nature of the swamp (i.e. how wet or dry) also adds another variable. A third variable in plowing labor requirements refers to the range of hand tools used by demonstration farms in the 1968 rice farming scheme. Some farms used shovels to plow much deeper but at a slower rate than farms who plowed with hand hoes.

The 20 farms that reported labor input for plowing recorded work ranging from 3 to 110 workdays per acre. Thirteen of them completed plowing in less than 40 workdays per acre. The average labor used by these 13 farms was 24 workdays. One record keeper, after detailed observation

determined that 1700 square feet of swamp could be plowed in one workday. This measurement converted to about 25 workdays per acre which was consistent with labor inputs of the thirteen farms that plowed for less than 40 workdays. The measured labor requirement was therefore a key element in the selection of the labor requirement for plowing.

Puddling Labor Requirement: The combination, in some field records, of plowing and puddling labor use also affected the labor records of puddling. In other cases, where there was a delay in transplanting, it was necessary to repuddle, a practice that inflated the labor input for the task. Some records also included in puddling data, part of the labor input for transplanting, which was done almost simultaneously with puddling. Considering normal conditions, 15 workdays per acre were allocated to this final land preparation task.

Transplanting Labor Requirements: Spacing affects the rate of transplanting and consequently the labor requirement for the task. On one farm where the recommended spacing of 6 x 6 to 8 x 8 inches was used, 2000 square feet of swamp was transplanted in one workday or one acre of swamp in 22 workdays. This figure included the transportation of the seedlings from the nursery which was on a nearby upland area. If the nursery can be closely situated to the farm or in some portion of the farm as suggested in the farm plan of this study, the labor used in transporting the seedlings can be reduced.

Because of this reorganization, the measured 22 workdays was discounted to 18 workdays per acre which was selected as the labor requirement for transplanting. In further support of this selection was the experience of one farmer that farmed two different swamps. Although his puddling and transplanting labor data were combined, his records showed the effect of experience on farm labor input. The first swamp was puddled and transplanted at a rate of 48 workdays per acre but after the experience of the first swamp, the efficiency of his workers improved and similar work on the second swamp was completed at a rate of 22 workdays per acre.

Fencing Labor Requirement: Fencing and harvesting were commonly handled by contract labor on the demonstration farms. Fences around Sierra Leone rice farms were constructed from materials cut from the surrounding bush. Such fences provide adequate protection from rodents, but because of the type of materials used, they dry out and rot after each crop. New fences are hence required every production season.

An average of 212 yards of fencing per acre was constructed on six swamps reporting detailed data. The average labor input for this length of fence was 11 workdays or 19 yards of fence per workday. Four of six farms fenced one acre of swamp in 5 to 14 workdays, at an average labor input of 9 workdays. Ten workdays was therefore established as the labor requirement for fencing an acre of swamp. This requirement included the labor required for cutting and

transporting materials used in the constructing of the fence.

The economies in fencing labor requirements can be explained by visualizing an ideal basic unit as a square acre. A swamp of this size and shape will need four units of fence each of which can be constructed in 2.5 workdays. When the size of swamp is doubled, six units of fence are needed. Doubling the size of fence has not doubled the fencing requirements. Three acres of fence by similar reasoning will require eight units of fence; the same is required for a four acre swamp. From these relationships, the units required by all even acreages of swamp larger than three acres can be obtained from the equation:

$$YE = 4 + X$$

where; YE = units of fence required by even acreage of swamp

x = even acreage of swamp, ($X > 3$ acres)

A four acre farm will hence need $4 + 4 = 8$ units of fence and a 6 acre swamp will need $4 + 6 = 10$ units of fence. Fencing requirements for odd acres larger than one acre can be obtained from the equation:

$$YO = a + 2$$

where: YO = units of fence required by odd acreage of swamp

a = units of fence required by preceeding even acreage of swamp.

As an illustration, a two acre farm (even acreage preceeding three acres) requires 6 units of fence. A three acre farm will therefore require $6 + 2 = 8$ units of fence.

Such economies in labor use were important as the farm size was increased as an adjustment to increase returns to household labor and management.

Harvesting Labor Requirement: Harvesting labor requirements should be influenced by the yield of rice crop. There were not however, enough data on harvesting labor input to satisfactorily establish the relationship between the labor requirements for harvesting and rice yields. Figure 2 shows the relationship of workdays of labor used for harvesting rice in the 1968 rice farming scheme with the yields of rice. The graph suggests a positive relationship between rice yields and harvesting labor requirements.

The labor requirement for a yield of 40 bushels, according to the graph was about 29 workdays. An actual stop watch observation in the mechanical rice farming area showed that 36.5 bushels of Indo-China Blanc were harvested in 245 minutes, 26 minutes of which was used for resting. The yield per manhour of harvesting labor was 0.152 bushels.[8] If an eight hour workday is assumed, 1.2 bushels was harvested per workday and 40 bushels of rice would be harvested in 33 workdays, which is consistent with the results of Figure 2.

---

[8]Victor A. Whittaker, "The Economies of Mechanical Cultivation of Rice Lands in Sierra Leone," Unpublished Ph.D. Dissertation, University of Illinois, April, 1971, Footnote p. 26. Harvesting was done by hand.

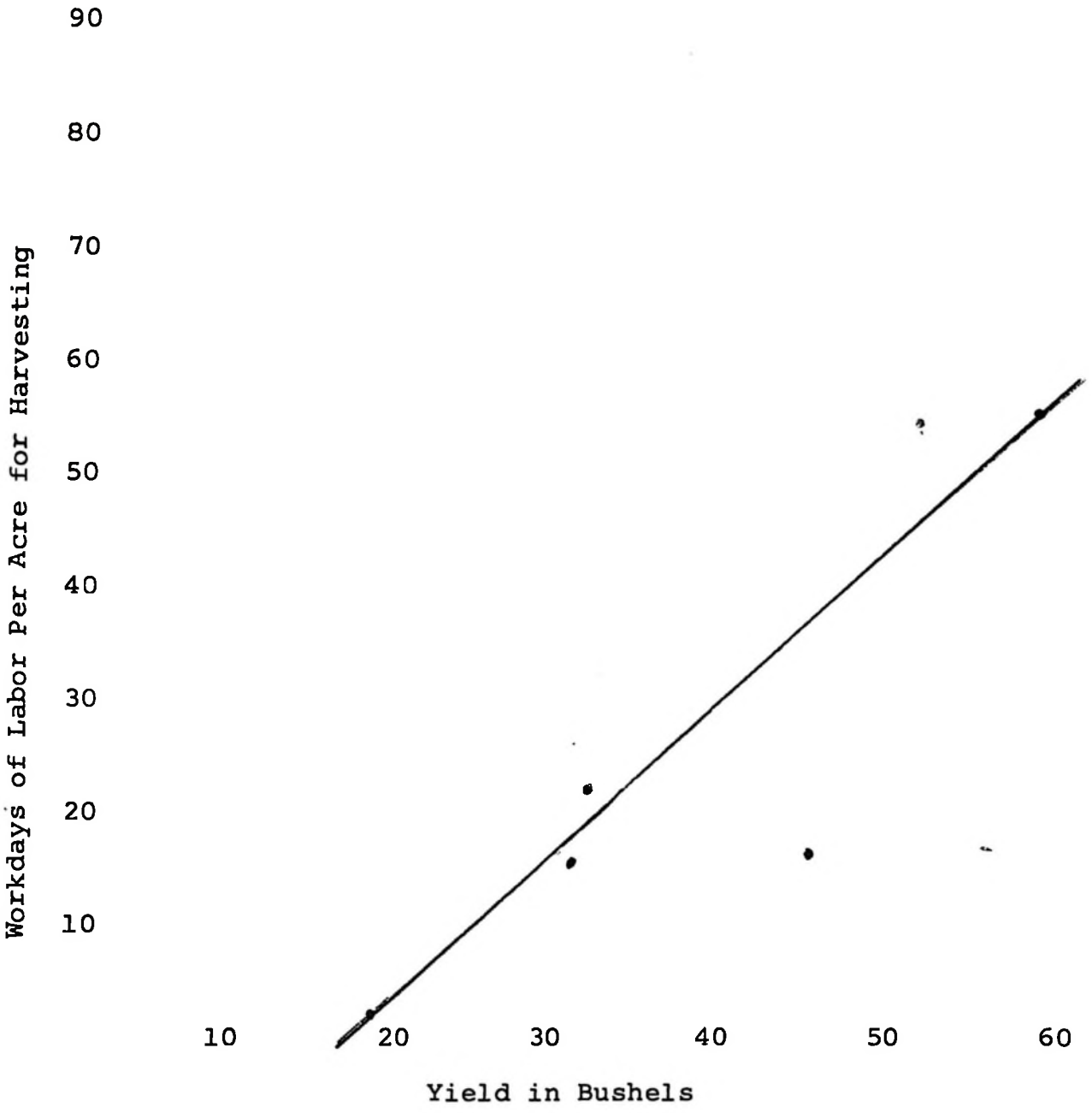

Figure 2. Labor Input for Harvesting and Yield on Inland-Valley Swamp Farms in Sierra Leone, 1968

Indo-China Blanc is however a variety susceptible to serious lodging. This characteristic means that the straws were lifted before the rice was harvested. The harvesting of Indo-China Blanc consequently requires much more time than the harvesting of non-lodging varieties of rice used in the inland-valley swamp. The harvesting labor requirement determined by the graph of Figure 2 was reduced to 25 workdays which is selected as the labor required to harvest and process 40 bushels of non-lodging RH2. This labor requirement means that 1.6 bushels of rice can be havested in a workday.

Second Brushing Labor Requirement: Since the available records are for the first year of farm production, production activities immediately followed the development phase, and there was no need for a second brushing. In subsequent years of rice production however, there may be a need to brush or burn the straws of the previous crop before the production of the second crop can begin. Also, in the tropics and especially in the wet swamps, grasses and sedges can grow between crops. The farm plan should therefore include a provision for labor to brush these grasses and straws.

The average actual labor of five farms that reported second brushing was about 10 workdays. Everyone of the five farms included some development brushing labor input in this second brushing data. Fifty percent of the actual average or five workdays was therefore selected as the labor required for a second brushing of one acre of swamp.

Weeding Labor Requirement: The average labor input of six farms for weeding one acre of swamp was 24 workdays. The bunds on one of these farms, where weeding was completed in 38 workdays, broke in the heavy rains and this might have aggravated the weed problem. Two other farms were weeded in 20 and 23 workdays per acre, respectively. The average for the other three farms that reported labor used for brushing was 12 workdays per acre, which was established as the labor requirement for weeding an acre of swamp.

Weeding labor requirements are determined by the density of weeds, which under efficient water management should be minimum. Effective water management should theoretically eliminate the need for weeding, but the experience of the intensive cropping demonstration by the Chinese indicates that some weeding is necessary even with water management.

Pest Scaring Labor Requirements: Labor requirements for pest scaring are prone to be overestimated since the task is done over a longer period of time than any other task in rice farming. Pest scaring begins at the time the rice flowers and continues until harvest. Pests are scared away from dawn till dusk. It is however not a full-time task and is done between other farm and household chores. This in part accounted for the poor records on pest scaring.

The difficult part of the task is the construction of elevated huts from which a person can look over the entire field to see where birds may be flocking. Strings along

which empty cans, half filled with pebbles connect the hut and areas of the farm. When birds flock into a section of the farm, a boy in the hut pulls the string connecting that portion of the farm. The noise made by the cans temporarily frightens away the birds. More stubborn pests like monkeys are frightened away by slings made from the raffia fibre.

The job is primarily conducted by children whose labor cannot be considered to be on par with that of adults. The two records that reported over 30 workdays for pest scaring simply counted the number of days in which the task was done and made productivity adjustments for the labor of children that conducted the task.[9] The average labor input of 12 farms for pest scaring was five workdays per acre. Considering the long period over which the task is done, this average was very low even after adjustments for child labor were made. Moreover, six of the twelve farms reported less than six workdays and two of these six reported less than two workdays per acre. These extremely low figures reduced the average. The average of five workdays was increased to 20 workdays to establish the labor requirement for pest scaring.

Since the task is generally conducted from one location, it was assumed that modest increases in the size of farm would not affect the established labor requirement.

---

[9]The labor of a child was assumed to be 50 percent as productive as that of an adult.

Labor Requirement for Bund Repairs: Bund repairs may not be required if strong bunds are constructed. The heavy rains of August however destroyed weak bunds. One farm that reported bunding repairs labor input of 33 workdays included some actual bunding in the figure. Two others repaired bunds for 17 and 18 workdays per acre, respectively. The highest frequency of labor input for bund repairs was five farms that made repairs in less than ten workdays per acre. Because a major assumption of this study was the construction of strong bunds for water management, the established labor requirement for bund repairs was only a precautionary allowance for checking bunds and sluices. The average of five workdays for the five farms was therefore reduced to a requirement of one workday for checking the bunds and sluices on one acre of swamp.

Labor Requirement for Fertilizer: None of the records reported data on labor use in fertilizer application. This was probably because the task did not require much labor input and was consequently overlooked. Fertilizer use is however, essential to the success of this farm plan. The labor plan should therefore provide labor for fertilizer application.

Dr. G. L. Karr, who observed and on some occasions supervised fertilizer application, noted that fertilizer

was sometimes applied on entire farms in a few hours.[10] It is however preferred to make a generous estimate to avoid labor bottlenecks in the farming operation. Half a workday was established as the labor required to apply fertilizer on one acre of swamp.

Labor Supply and Distribution

Labor Supply

Njoku defines four sources of labor in Sierra Leone rice farming. These are: communal labor, gang labor, hired labor and household labor.[11] Labor from these sources is compensated in several ways including reciprocal service and cash payments with or without meals.

Established standards for obtaining labor from communal and gang sources are quite arbitrary and highly localized. Individual farmers should consider using labor from these sources as they often result in a reduction of total farm labor costs and in the provision of needed labor at critical periods in the farm operation. However, because of their subjective arrangement of compensation, they are not used as sources of labor in the farm plan.

---

[10] G. L. Karr, Assistant Professor of Agricultural Economics, University of Illinois was on assignment in Sierra Leone and assisted with the Peace Corps Rice Farming demonstration scheme.

[11] Njoku, pp. 74-76.

The two sources of labor important in this analysis were hired labor and household labor. Hired labor is becoming increasingly important in Sierra Leone rice farming.[12] It is compensated by the payment of daily cash wages, with or without meals. The cost of meals is also highly variable and for this reason, it was preferred to establish wage rates which did not include meals. A farmer who wishes to provide meals as part of the payment for hired labor should reduce the wage rates used in the next chapter accordingly.

Hired labor may be in the form of task labor[13] in which cash labor is paid in accordance with work actually completed. Many farms in the 1968 rice farming scheme used this labor arrangement to reduce their labor costs. However, the cost of contract labor was arbitrary and depended largely on the esteem of the farmer in his community. For this reason, this aspect of hired labor was not included in the labor plan although individual farmers are urged to consider using it as a means of reducing labor costs.

Household labor refers to the labor provided by members of the farm household. It is compensated by the net returns to household labor and management from the farm operations. The amount of household labor depends on:[14]

---

[12] Ibid., p. 75.

[13] Task labor refers to labor contracted to perform a particular task.

[14] Norman, pp. 3-14.

1. The number of members of the household who can work the farm.

2. Length of time each household member is prepared to work on the farm.

3. Age, sex and social traditions that regulate work habits.

4. Nutrition and health of household members working the farm.

5. Climatic conditions that affect an individual's performance at work.

Household labor is generally more reliable than other sources of labor for rice farming and also has the flexibility in that household members can work overtime on some non-workdays. The amount of available household labor was an effective constraint on the practicability of the farm plan developed for a typical rice farm.

Household Labor Inventory

The inventory of household labor used in the farm plan is shown in Table 4. The household membership was assumed to be seven. In a sample of 63 farm households in one area of Sierra Leone, the average size of household was eight people.[15] The detailed composition of this average household was not reported and could not therefore be used for comparative purposes. The composition of the household in Table 4, however, affects the quantity of available household labor for swamp rice farming.

---

[15]Njoku, Table 29, p. 111. Based on a 1969 household survey of urban areas in the country, the projected size of household for the three Provinces where inland-swamps are important were as follows: Eastern Province, 5.9; Southern Province, 6.4; and Northern Province, 6.6

Table 4. Labor Inventory for a Typical Sierra Leone Farm Household.

Household Membership	Available Workdays/Year
Adult Males (2)	600
Adult Females (2)	300
Teenage Son (Secondary School Age)	50
Two Younger Children (Elementary School Age)	50
Total Household Labor (Workdays)	1000

For each member of the household, there is an opportunity cost involved in the use of their labor for swamp rice farming. Alternative employment opportunities for the two male adults include non-farm work as domestic servants or as laborers. They may grow cash crops such as coffee or cocoa, and other food crops. They may dig for diamonds if they are in a mining area.

Such alternative opportunities are determined by the location of the farmer's village. Employment in a large town is virtually prohibitive if the town is at such a distance that it might almost require complete migration and relocation. For most areas in the Northern Province, coffee and cocoa are not feasible alternatives.

Alternative opportunities for the two female adults include petty trading, vegetable gardening, gara dyeing[16] or full-time housework. For the children, the choice is

[16] Gara is a local dye used for cloth which has become a national dress in the country. Gara dyeing requires some schooling in the trade.

between leisure and swamp rice farming in the periods when schools are not in session. Upland rice farming is an alternative occupation for the entire household.

The returns from successful development and rice production in an inland-valley swamp should be in excess of the expected returns from anyone of the alternative employment possibilities.

The total available labor of the entire household was estimated to be 1000 workdays. In making the estimate, 52 workdays were subtracted from the year in recognition of the fact that Fridays are not workdays in much of rural Sierra Leone. A 13 day adjustment was also made for days that are taken off for traditional obligations or leisure. This left 300 workdays for which all adult males were assumed to be available. This estimate is slightly above the number of workdays actually observed in the Zaria Province of Northern Nigeria.[17] An adult male was observed to work 1200 hours per year which consisted of 230 working days, or slightly more than five hours of work per day. The difference between the two estimates can be explained by noting that the Nigerian observation was made on upland or traditional subsistence farming. The swamp cultivation system selected to substitute for traditional farming demands basic

---

[17]Norman, pp. 3-14.

adjustments in work habits. Investments in swamp development can only be justified if farmers are willing to provide the additional labor required to successfully produce rice in the inland-valley swamps.

Each of the two adult females was assumed to be available for 150 workdays in the year. Their labor contribution to the farm enterprise is less than that of the male adults because in addition to farm work, they were assumed to be responsible for child care and household work. In the traditional African context, household work may, in addition to cooking, include vegetable gardening and other tasks that can take many days of the year.

The three children are available for 100 days of work in the year. Their availability for farm work is determined by the school calendar.

Distribution of Household Labor

Table 5 shows the distribution of household labor. The labor of the four adults was assumed to be evenly distributed throughout the year. This assumption did not however mean that all available labor was actually used in every month. The tradition of the division of labor by sex and the nature of some tasks imposed limitations on the quantity of available household labor used in certain months.

These limitations are more pronounced in the development phase where tasks, due to their difficult nature are beyond the physical abilities of women. Consequently, during the

Table 5. Distribution of Available Household Labor by Month and Membership. (In Workdays)

Household Member	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
First Adult Male	25	25	25	25	25	25	25	25	25	25	25	25	300
Second Adult Male	25	25	25	25	25	25	25	25	25	25	25	25	300
Adult Females	25	25	25	25	25	25	25	25	25	25	25	25	300
Older Son						20	20	5				5	50
Younger Children						20	20	5				5	50
Total	75	75	75	75	75	115	115	85	75	75	75	85	1000

development months, only the available adult male labor was used.

In the production phase of farm operations, all the available household labor was used although there was also some division of labor by sex. Fencing, for instance, was done exclusively by men. A recent study revealed that under intensive cropping and mechanization, there seemed to be a breakdown in the division of labor. Tasks like weeding, harvesting, etc., traditionally exclusive to women were performed by both sexes.[18]

The distribution of the children's labor was determined by the school calendar. Their labor was only available during the summer and Christmas vacations.

---

[18] Njoku, Table 38, p. 129.

Labor Use on a Typical Swamp Rice Farm

Results of the 1965-66 Agricultural Statistical Survey showed the average size of farm in Sierra Leone to be about four acres.[19] This size of farm was assumed to be typical for inland-valley swamp rice farms. Table 6 shows both the labor flow and requirement for the development and rice production on a four acre inland-valley swamp rice farm.

A basic principle in determining the labor flow of Table 6 was to schedule labor requirements for various tasks in accordance with their sequence in the development and production processes. Tasks were also assigned to months in a way that permitted the completion of those tasks for which timeliness was critical. Hence, brushing and burning were completed before plowing started and the seed was sown in the nursery at a time that permitted a June/July transplanting. All assignments for the completion of tasks were done on the basis of the cropping calendar. Adjustments were also made to accommodate economies of size in the labor requirements of tasks for which these economies were claimed.

According to Table 6, a single cropping system on a four acre farm used about 65 percent of available household labor. This suggested multiple cropping, crop rotation or an increase in the size of farm that would improve the efficiency of household labor use.

---

[19] "Agricultural Statistical Survey of Sierra Leone," p. 7.

Table 6. Days of Labor Flow for a Four Acre Swamp Rice Farm Under a System of Single Cropping.

DEVELOPMENT TASKS	MONTHS J	F	M	A	M	J	J	A	S	O	N	D	Total
Brushing	50	6			2								58
Felling		12											12
Clearing and Burning		10	22										32
Stumping and Leveling		32	68										100
Bunding and Sluice Gates				168									168
TOTAL DEVELOPMENT	50	60	90	168	2	0	0	0	0	0	0	0	370
PRODUCTION TASKS													
Brushing or Burning					20								20
Nursery Work				2	6								8
Plowing					45	55							100
Puddling						25	35						60
Fertilizer Application						1	1						2
Transplanting						32	40						72
Fencing							15	5					20
Weeding								48					48
Bund Repairs								4					4
Pest Scaring									4	6	6	4	20
Harvesting & Seed Processing											50	50	100
TOTAL PROD. LABOR REQUIREMENT	0	0	0	2	71	113	91	57	4	6	56	54	454
TOTAL DEVL. & PROD. LABOR REQ.	50	60	90	170	73	113	91	57	4	6	56	54	824
HOUSEHOLD LABOR USED	50	50	50	50	73	113	91	57	4	6	56	54	654
HIRED LABOR USED	0	10	40	120	0	0	0	0	0	0	0	0	170
AVAILABLE HOUSEHOLD LABOR	75	75	75	75	75	115	115	85	75	75	75	85	1000

CHAPTER IV

COSTS AND RETURNS OF RICE PRODUCTION IN INLAND-VALLEY SWAMPS

Costs

Wage Rates

In this study, a range of wage rates was evaluated in the determination of rates that accurately measure labor costs. These wage rates shown in the first column of Table 7 were selected on the basis of: 1) the nature of the tasks for which they were paid; 2) the skill required in performing each task; 3) the period in which the task was performed; and 4) the wage rates paid by demonstration farmers.

Wages paid for development tasks were generally higher than those paid for production tasks because development tasks were generally more difficult and depended entirely on the male labor force. Stumping and bunding commanded higher wage rates than other development tasks. Stumping was the most difficult of the swamp development tasks while bunding required the most skill.

Production tasks performed in peak labor periods of May through July were also assigned higher wage rates. One study suggested such higher wage rates for tasks performed in peak labor months.[1] At this time potential hired workers may be

---

[1]Norman, pp. 3-14.

Table 7. Hired Labor Costs for a Four Acre Farm With a Single Rice Crop, Sierra Leone.

DEVELOPMENT TASKS	Wage Rates (Leones)	Total Labor --In Workdays--	HHL[a]	HL[b]	HLC[c] (Leones)
Brushing	Le .60	58	52	6	Le 3.60
Felling	.60	12	8	4	2.40
Clearing and Burning	.60	32	10	22	13.20
Stumping and Leveling	.65	100	82	18	11.70
Bunding, Digging Water Ways and Sluice Gates	.65	168	50	118	76.70
TOTAL		370	202	168	107.60
PRODUCTION TASKS					
Brushing or Burning	Le .65	20	20	0	Le 0
Nursery Work	.65	8	6	2	1.30
Plowing	.65	100	100	0	
Puddling	.65	60	60	0	
Fertilizer Application	.65	2	2	0	
Transplanting	.65	72	72	0	
Fencing	.65	20	20	0	
Weeding	.40	48	48	0	
Bund Repairs	.50	4	4	0	
Pest Scaring	.40	20	20	0	
Harvesting, Thrashing, Winnowing	.50	100	100	0	
TOTAL		454	452	2	1.30
TOTAL DEV. AND PROD.		824	654	170	108.90

[a]Refers to Household Labor.

[b]Refers to Hired Labor.

[c]Refers to Hired Labor Cost.

working on their own farms. Higher rates were, under these circumstances, necessary to provide incentives that would attract hired labor.

The selected wage rates were below the rates paid by institutions and the MANR for agricultural workers in Sierra Leone. This latter rate was 73 cents until late 1969 when it was raised to 85 cents per day.[2] Several demonstration farms paid institutional or minimum wage rates for most of the tasks requiring hired labor, but included, when possible, contract labor to reduce cash labor costs. Some farms were successful in offering lower but acceptable rates which they considered to be fair compensation for the work done. Farms in the diamond mining areas paid higher rates than farms in non-mining areas. Those farms in the area of the Tonkolili-Kono road construction project paid rates that were competitive with rates paid by the construction company for hired labor.

Most of the selected wage rates were about twice the average cash wage rate Njoku observed on mechanical and upland cultivation areas.[3] The average rate in these areas was 30 cents per day plus meals. When the cost of meals was added to this rate, the average wage rate increased to

---

[2]Njoku, p. 157 (Sierra Leone cents). The official minimum wage for agricultural workers in the rural areas in 1968 was 60 cents per day.

[3]Ibid., p. 157.

50 cents per day which was still below most of the wage rates selected in Table 7. The selection of rates presented in Table 7 was deliberately liberal and was intended to prevent an overestimation of the profitability of inland swamps.

Cash Development Costs

Labor

The first part of Table 7 shows development cash labor costs. Table 7 was used with Table 6 of Chapter III to determine cash costs of hired labor. Since women did not participate in the development work, their labor was not relevant in the final computation of development costs of hired labor.

Using the labor flow of Chapter III and the selected wage rates, the relevant household labor for each month was allocated to the tasks performed in that month according to the various wage rates. For instance, in March, when clearing and most of stumping were completed, the relevant household labor for the month was of priority allocated to stumping which commanded a higer wage rate. By such internal adjustments, hired labor cost was reduced.

About 45 percent of the required 370 workdays for swamp development was hired at a cost of LE 107.60. Seventy-one percent of this cost was for bunding.

Tools and Equipment

Tools used in Sierra Leone swamp rice farming are simple and inexpensive. The quantity of tools was determined by the number of adults in the household rather than by the size of farm. Hired workers generally furnished their own tools. This was possible because such tools were used for a wide variety of agricultural and non-agricultural purposes. In much of the rural communities every adult, especially men are likely to own a set of such equipment. The quantity and costs of tools and equipment needed by the household are shown in Table 8.

Computation of the proportion of tool costs charged to development was necessary for an accurate determination of development costs. It was possible to determine this proportion when tasks for which various tools were used were identified.

Of the tools shown in Table 8, axes were used exclusively in swamp development. Their cost was therefore a development cost. Likewise, the costs of hoes and harvesting knives were charged to rice production where they were used exclusively. The tools that required a division of costs were matchets and shovels which were used in both swamp development and rice production activities.

The major uses of matchets were in brushing, felling, clearing and fencing, which accounted for 142 workdays of swamp farm labor use. Seventy-two percent of this labor

Table 8. Initial Tool Costs for a Household of Four Adults, Sierra Leone.

Tools		Initial Costs	
Matchets	(4)	Le	1.84
Large Hoes	(4)		1.60
Small Hoes	(4)		1.20
Harvesting Knives	(4)		0.80
Shovels	(4)		4.00
Axes	(4)		2.00
Total		Le	11.44

use was in development; this proportion of matchet costs was therefore charged to development.

Shovels were mainly used in stumping, bunding (bund repairs) and plowing which accounted for 372 workdays, 72 percent of which was for development. By similar logic, this proportion of shovel cost was charged to development. The above allocation afforded the development charges for tools shown in Table 9.

Table 9. Swamp Development Tool Cost for Four Acre Farm, Sierra Leone.

Item			Cost
Matchet Costs (72 percent)	=	Le	1.32
Shovel Costs (72 percent)	=		2.88
Axe Costs (100 percent)	=		2.00
Total		Le	6.20

Because of the intensity of use, all tools used in swamp development were completely depreciated in the development year. Other tools were depreciated over a period of two years or two crops. Field experiences with these tools suggested this useful lifetime.

Government Subsidies

Because of the importance of swamp development in the Governments agricultural policy, a subsidy of Le 30.00 per acre was offered in 1970 to all farmers developing new acres of swamp land. The payment scheme was initiated to encourage the use of improved practices and continuous cropping on inland-valley swamps. The permissible range of acreage per farm family for which subsidies could be paid was a minimum of two to a maximum of twenty acres.

The subsidy was paid in both cash and crop supplies and was allocated in a way that assured the use of improved technology essential to the success of the swamp development program. The recommended allocation per acre was Le 10.00 for seed and crop supplies; Le 2.00 for tools and Le 18.00 for labor. The actual implementation of the program demanded a need for some adjustments in this allocation. The Principal Agricultural Officer in Bo, Southern Province recommended an increase in the payment for tools to Le 6.00 and a reduction of the seed and crop payment to Le 6.00 per acre. Government payments were deducted from the total development costs.

Total Cash Development Costs

Hired labor accounts for about 95 percent of the total cash development costs shown in Table 10. The only other component of this cost was the tool costs.

Table 10. Total Cash Outlay for Developing a Four Acre Swamp Rice Farm, Sierra Leone.

Item		Cost
Hired Labor	Le	107.60
Tools		6.20
Total	Le	113.80
Minus Government Subsidies (Le 30.00/acre)		120.00
AVAILABLE FOR OTHER EXPENSES	Le	6.20

Government payments could be treated as income in the income statement, but it was preferred to use the payments to completely write-off the development costs in the first year of farm operation. This was done because the farmer was expected to receive enough returns in subsequent years to permit continued use of improved technologies. It was therefore preferred to utilize the government payment for the purposes for which it was granted and avoid using it for consumption purposes. In this manner, the encumbrance of future income was avoided. An alternative way of writing off swamp development costs, but which was not used in this analysis, would be to depreciate the improvement over a period of three to five years.

Table 10 shows that government payments were in excess of cash development costs. The excess of Le 6.20 in government grants were allocated to miscellaneous expenses in the cost and return budget for the entire farm.

Cash Production Costs

Labor

Once the development tasks were completed, Table 7 shows that there was little need for hired labor for rice production on a four acre inland-valley swamp farm. Only two workdays of hired labor was needed for nursery work at a cost of Le 1.30.

Tool Costs

Hoes and harvesting knives used exclusively in the production activities were depreciated over a period of two years. Fifty percent of their cost was therefore charged to the production of the first crop. Because of their intensive use in swamp development, a large part of matchet and shovel cost was charged to development; the remaining 28 percent of matchet and shovel cost was charged to rice production as shown in Table 11.

Table 11. Tool Charges in the First Year of Rice Production on a Four Acre Swamp Rice Farm, Sierra Leone.

Item			Cost
Matchet Costs	(28 percent)	= Le	0.52
Shovel Costs	(28 percent)	=	1.12
Large Hoe Costs	(50 percent)	=	.80
Small Hoe Costs	(50 percent)	=	.60
Harvesting Knives Cost	(50 percent)	=	.40
Total		Le	3.44

Seed and Crop Expenses

Seed and crop expense included the costs of rice bags, seed rice and fertilizer.

Rice Bag Costs: Rice bags were required for that portion of the rice harvest that was marketed. The commonly used bag is made of jute and has a capacity of about two bushels of husk rice. A yield of 40 bushels per acre was estimated for a crop of RH2 or a total of 160 bushels for the entire farm. The per capita annual consumption of rice in Sierra Leone is 200 pounds of cleaned rice.[4] A household of seven people therefore required 1400 pounds of cleaned rice or 34 bushels,[5] of husk rice for subsistence. Rice bags were consequently needed for 126 bushels of husk rice at a cost of Le 22.05, using the price of 35 cents each.

---

[4] "Rice in West Africa," p. 153.

[5] This figure assumes a milling rate of 50 percent.

Seed Rice Cost: The recommended variety for the inland-valley swamps was RH2 and it was used on 16 of 18 farms that reported rice varieties used. RH2 is a medium tall variety of about 180 days duration. It is sensitive to day length and possesses strong straw that are resistant to lodging. Cooking quality and palatability are good with excellent swelling and good overnight keeping properties.[6] The optimum planting time is June/July for a November/December harvesting.

A seed rate of one bushel (60 pounds) per acre was recommended by the Rice Research Station. This rate was however for broadcasting. As a rule, broadcasting requires a higher seed rate than the transplanting method used in this study. The International Rice Research Institute's recommendations relative to transplanting was a seed rate of 18 to 30 pounds of seed per acre.[7] Several demonstration farms nevertheless obtained seed rice from the MANR at the rate of 60 pounds per acre. Some farms planted at lower seed rates or established larger nurseries to assist in their extension work.

The Research Station's recommendations might have been influenced by the realization that most farmers might not have access to pure seed rice and that many farmers would

---

[6] "Improving Rice Yields in Sierra Leone," p. 4.

[7] Rice Production Manual, p. 86.

broadcast their seed. In broadcasting a higher seed rate is desirable to increase plant population and reduce weed competition.

The seed rate used in this farm plan was 45 pounds of seed rice per acre. This selection was based on the yields obtained by farms that planted at similar seed rates. The seed rice requirement for a four acre swamp farm was therefore 180 pounds. At the price of Le 2.50 per 60 pounds, the cost of seed rice was Le 7.50.

Fertilizer Cost: One hundred weight[8] each of single superphosphate and sulfate of ammonia was recommended and used for an acre of swamp rice. This quantity of the two fertilizers contained about 20 pounds of actual P_2O_5 and 23 pounds of actual nitrogen. The cost to the farmer of fertilizer per acre of swamp rice was Le 1.50 for superphosphate and Le 2.10 for sulfate of ammonia or a total cost of Le 14.40 for the four acre farm.

Total Cash Production Costs

The total cash production cost was Le 53.69 as shown in Table 12. All the cost items in Table 12 have been explained; the only new item being the charge for miscellaneous expenses. In the 1968 rice farming scheme, there were often miscellaneous expenses like the purchase of

---

[8] In Sierra Leone, 1 cwt = 112 pounds.

Table 12. Cash Outlays for Rice Production on a Four Acre Swamp Farm, Sierra Leone.

Item		Cost
Hired Labor		Le 1.30
Tools and Equipment		3.44
Seed and Crop Expenses:		
Rice Bags	Le 22.05[a]	
Seed Rice	7.50	
Fertilizer	14.40	
		43.95
Miscellaneous Expenses		5.00
Total		Le 53.69

[a]Savings might be incurred here by borrowing rice bags from the marketing agent.

corrugated zinc sheets to repair badly damaged bunds and sluices. Le 1.25 per acre or Le 5.00 for a four acre farm was allowed for such expenses.

Total Cash Costs and Returns

Costs

The total cash costs and returns from the entire farm enterprise are shown in Table 13. Since development costs were retired by the Government grant, they are not shown in Table 13. The total cash production costs on a four acre swamp rice farm was computed to be Le 53.69.

The labor input represented the largest cash cost item in the development and rice cultivation on the swamp farm. Cash outlays for hired labor used in swamp development and rice cultivation accounted for 65 percent of total cash costs.

Table 13. Costs and Returns for a Four Acre Swamp Rice Farm Under Single Cropping.

Total Rice Production (40 bushels per acre)		160 bushels
Planning Price per Bushel	Le	2.00
RETURNS:		
Value of Rice Production Consumed (34 bu.)		68.00
Value of Rice Production Sold (126 bu.)		252.00
Government Payment above Development Cost		6.20
Total Returns	Le	326.20
COSTS:		
Hired Labor	Le	1.30
Tools and Equipment		3.44
Seed and Crop Expenses		43.95
Miscellaneous		5.00
Total Cash Costs	Le	53.69
Net Returns to Household Labor and Management		272.51
Net Returns per Workday of Total Household Labor[a]		0.41
Net Returns per Workday of Production Household Labor[b]		0.60
Cash Outlay Per Bushel of Rice Produced		0.34

[a]Refers to household labor used in both swamp development and rice production.

[b]Refers to household labor used only in rice production activities.

Implicit Costs of Swamp Development

In addition to direct costs of swamp development and cultivation of rice in the inland-valley swamps, there are implicit costs involved in planning an exhaustive development of inland-valley swamp program.

The first component of implicit cost is the value of produce from the undeveloped swamp. The raffia palms which are removed in swamp development are the source of a range of products including: palm wine, raffia fibre, and raffia palm leaves. Palm wine is a popular beverage in the country; the fibre is important in the rural handicraft industry and the leaves are used in the roofing of houses in areas where suitable grasses are not available.

Another component of implicit cost is the medical cost of treating health problems that may be incurred in the development and cultivation of the swamps. Parasites that can cause various diseases are found in inland-valley swamps. In fact one reason for the aversion of farmers to develop inland swamps in the past was the presence of leeches. Such health hazards related to swamp development may be avoided by the provision of protective footwear and clothing. The cost of such equipment and/or the medical cost of treating health problems must be noted as an implicit cost related to swamp development and cultivation.

The traditional rice farming practiced on the uplands permits mixed cropping that provides a variety of foodstuff for the household. Since the improved cultivation methods

recommended for inland-valley swamps do not include mixed cropping, any possible loss of food variety is another implicit cost that must be considered.

The heavy demand on household labor in swamp development and cultivation may affect other enterprises that were part of the traditional farming system. In addition to rice farms, Sierra Leone farmers have cash crop farms, vegetable gardens, and cassava or yam gardens. If the labor demands of the swamp rice farm is such that these other enterprises cannot be undertaken, the value of produce lost through the elimination of these secondary enterprises should be considered to be implicit costs. Such costs must be covered by the returns from the swamp rice enterprise. However, because of the lack of data and other pertinent information, this study did not evaluate implicit costs relative to the returns from inland swamp rice cultivation.

Returns

The only return from the farm enterprise was the value of rice produced, which was 160 bushels of husk rice.

The variety RH2 was selected for use in the farm plan but in actual fact four varieties were used in the 1968 rice farming scheme. These were Faya, Radin-China-4, RH2 and local varieties. Of these RH2 gave by far the best yield and the highest yield of 58 bushels per acre. Sixty percent of ten farms reported RH2 yields of over 40 bushels per acre.

The average yield of RH2 in the 1968 rice farming scheme was 38 bushels per acre. These results were the basis of the 40 bushel per acre yield used in the farm plan.

The selected yield was lower than Kargbo's estimate of 50 to 55 bushels per acre for RH2. The lower yield is preferred to discourage any overoptimism with regard to the profitability of the inland-valley swamp. The selected 40 bushels per acre is the same as the planning yield used in the Government's plan to develop the inland-valley swamps. The yield of 50 bushels per acre was also not used because in field trials, such yields were only obtained under exceptional management. This study, on the other hand assumed average managerial ability.

The planning price of Le 2.00 was the price received by farmers in the 1968 rice farming scheme for rice sold for consumption. Some farms sold their rice for seed and received Le 2.50 per bushel. Because the greatest demand for rice in Sierra Leone is for consumption, the possibility of selling rice for seed was not included in the farm plan.

The price of rice is not fixed. There are both seasonal and market variations in the price of rice. For more detailed information on the behavior of the market price for rice, the reader is referred to Mutti's study of staple food crops.[9]

---

[9]R. J. Mutti, Marketing of Staple Food Crops in Sierra Leone. USAID/University of Illinois, Urbana, 1967.

Table 13 shows that the return per total workday of household labor (household labor used in both swamp development and cultivation) was 41 cents. For a long range assessment of the profitability of the inland-valley swamp however, the relevant return is the returns per workday of production household labor which was 60 cents.

CHAPTER V

ADJUSTMENTS IN SYSTEMS OF SWAMP CULTIVATION TO INCREASE INCOME

A follow-up study by Njala University College to determine the impact of the 1968 Rice Farming Scheme revealed that farmers were impressed by the increased yields that were obtained as a result of improved technology. One implication of this study of swamp cultivation was that those farmers who willingly provided the labor and who used improved technologies may have higher income objectives than can be obtained from a single crop of swamp rice. Double cropping, ratoon cropping,[1] increase in the size of farm and improvements in labor efficiency are adjustments that may afford such higher incomes.

Double Cropping

The tropical climate which permits a twelve month growing season can be an asset through planned exploitation. The minimum rainfall in any area of Sierra Leone is about 80 inches per annum, and minimum temperatures are such that there is no frost. This environment permits double cropping of rice, provided moisture is available throughout the year.

---

[1] A ratoon crop refers to the second growth of a normally annual crop after it is harvested.

A rice farming demonstration team from Taiwan which has been in the country since 1964 has successfully demonstrated that two crops of rice per year are possible. For demonstration purposes, the team has also cultivated four rice crops per year. Such an intensive system can result in higher incomes that can provide a basis for a viable rural economy.

The higher income potentials of a double crop of rice are obvious from the pattern of labor use under the system of one crop per year. Under single cropping, once the swamp development phase was completed, household labor was unemployed in the months of January through April. The available household labor in these months can be used in the production of a second crop which can increase family income even at modest rice yields.

In addition to the income objectives, double cropping promotes permanent cropping which facilitates extension efforts to upgrade management practices. The future land pressures caused by shifting cultivation of the uplands can also be relieved. Shifting cultivation has been inadequate in its capacity to produce enough rice to meet internal consumption requirements and has added to the soil erosion problem. Shifting cultivation can at best support a maximum population density of only 20 people per square mile.[2]

---

[2]Bradfield, p. 265.

Sierra Leone has a population density of 79 people per square mile, with Koinadugu District in the Northern Province having the lowest density of 28 people per square mile.[3] These statistics suggest an urgency beyond income objectives for a more intense land use farming system.

Proposed Systems of Double Cropping

Table 14 shows three systems of double cropping of rice that have been proposed for the swamps of Sierra Leone. System A and B were proposed by the FAO. Seven dual purpose (swamp-upland) varieties were used to test the systems in a swamp near Kenema, Eastern Province, in 1967.

System C was tried by the Rice Research Station in the mangrove swamps near Rokupr and the results of that test are shown in Table 15. The most important inference from Table 15 was that two crops of rice varieties field tested produced an annual yield per acre larger than a single crop of Radin China-4 which, at the time, was the most suitable inland-swamp variety. Another result of the test as shown in Table 15 was a reduction of about 50 percent of yield in the case of the second crop.

A local farmer in the Northern Province was persuaded to test system C under normal farming conditions on his farm. The farm, because of a lack of water management system,

---

[3] "1963 Population Census of Sierra Leone," Central Statistics Office, Freetown, Vol. 1, Table 3, p. 3.

Table 14. Three Proposed Systems for Double Cropping of Swamp Rice in Sierra Leone.

System	Activity	Month	Approximate Duration of Crop in Days
A	First sowing in nursery	March/April	
	Harvesting	August/Sept.	153
	Second sowing in nursery	July/August	
	Harvesting	December	153
B	First sowing in nursery	Jan./Feb.	
	Harvesting	June	150
	Second sowing in nursery	July	
	Harvesting	Nov./Dec.	153
C	First sowing in nursery	June 5	
	Transplanted	July 11	
	Harvested	October 28	109
	Second sowing in nursery	September 26	
	Transplanted	October 28	
	Harvested	January 28	92

Sources: A and B: J. Veenstra, "Land Use Planning--Some Notes Towards an Operational Programme for the Introduction of a Permanent Agricultural Land Use Pattern Including Rice Farming in Sierra Leone," Unpublished mimeo, FAO Office, Kenema, May, 1967; C: "Annual Report of the West African Rice Research Station, 1963," Rokupr, Sierra Leone, 1965, Table 1, p. 12.

Table 15. Results of Double Cropping--Rokupr, 1963. (Mean yield in lbs/acre)

Variety	1st crop	2nd crop	Total	Percent drop in yield[a]
52.M.4.3	2500	850	3350	66
52.M.6.1	2120	930	3050	56
51.M.4.1	2020	880	2900	56
52.M.3.6	2020	1070	3090	47
52.M.8.1	2010	1100	3110	45
Dissi Hatif	1950	870	2820	55
52.M.6.4	1910	1040	2924	45
51.M.4.3	1510	900	2410	40
Average	2005	955	2457	51
Radin China-4 (one crop)		--	2340	--

Source: "Annual Report of the West African Rice Research Station, 1963," Rokupr, Sierra Leone, 1965, Table 1, p. 12.

[a]Percentage in yield of the second crop as compared to the first crop.

was not suitable for double cropping, but his first crop of 52.M.6.4 produced a yield of 1,770 pounds of husk rice per acre. The yield of his second crop was 750 pounds, adding up to a total annual yield of 2,520 pounds per acre which was still better than a single crop of Radin China-4.[4]

Radin China-4 has since been replaced by RH2 as the recommended variety for inland-valley swamps. A double cropping system for these swamps should therefore include RH2 and a shorter duration variety. Because the optimum transplanting period for RH2 is June or July for November or December harvesting, system B proposed by the FAO was

[4]"1963 Annual Report of the Rice Research Station," p. 13.

used in the double cropping budget. The system also permitted the use of unemployed household labor in January through April. Of primary importance therefore, was the selection for a second crop, of a variety with a short enough duration to complement RH2 in the system.

Relative to duration from transplanting to harvest, the native varieties have an advantage over improved varieties bred at the Rice Research Station. Faya has the shortest duration of 150 days of all the new varieties recommended for inland swamps. This period is too long to fit into a double cropping system that includes RH2. Many native varieties, on the other hand, are dual purpose varieties and have short duration. They were used in both swamps and uplands before varieties were bred to suit specific rice growing situations. In many areas of the country, farmers still continue to use native varieties in swamps with good results.

In recent trials by Njala University College in the extension farming scheme near the University, a local variety, Jewulei, gave the outstanding yields. Table 16 shows some yield results and days of duration of this local variety. The average yield reported was 38 bushels per acre. The average duration of 110 days fits into the proposed double cropping system quite well. This duration and that of 180 days for RH2 mean that the swamp would be under crop for 290 days in a year. There are also selected varieties from the Far East that might be used as the second crop.

Table 16. Yields and Duration of Jewulei Variety on Some Plots of the Njala University College Demonstration Farming Scheme, 1970.

Plot No.	Date Planted	Date Harvested	Growing Season (days)	Yield Bu/Acre
32	7-5-70	21-8-70	106	40.7
57	7-5-70	21-8-70	106	44.8
88	5-5-70	21-8-70	108	35.5[a]
40	2-5-70	24-8-70	114	33.5[a]
49	2-5-70	24-8070	114	36.7
85	5-5-70	26-8-70	113	37.1
		Average	110	38.1

Source: Results of Njala University College Extension Staff Demonstration Rice Farms.

[a]No nitrogen-potash top dressing used.

A labor flow statement that fits the selected double cropping system is shown in Table 17. In the development of this labor flow it was recognized that certain operations for the second crop could not be done before the first crop was harvested. Burning of straw for instance, was accordingly scheduled for June after the dry season crop was harvested. The total labor requirements were also obtained by doubling the labor requirements of a single crop of rice. The only exception in this adjustment was in the case of harvesting where the labor requirement for the dry season crop was adjusted to crop yields. The addition of the dry season crop resulted in two peak labor periods in January/February and in June/July. Hired labor was required in these two peak labor periods.

Table 17. Days of Labor Flow for Two Crops of Rice on a Four Acre Swamp Farm

Double Cropping (Production Tasks)	MONTHS												
	J	F	M	A	M	J	J	A	S	O	N	D	Total
Burning or clearing of straws						20						20	40
Nursery work						8						8	16
Plowing	50	50				100							200
Puddling	30	30					60						120
Fertilizer Application	1	1					2						4
Transplanting	36	36					72						144
Fencing			20					20					40
Weeding				48				24	24				96
Bund repairs			4					4					8
Pest scaring			4	6	10				4	6	10		40
Harvesting						64					50	50	164
Total	117	117	28	54	10	192	134	48	28	6	60	78	872
Household labor used	75	75	28	54	10	115	115	48	28	6	60	78	692
Hired labor used	42	42	0	0	0	77	19	0	0	0	0	0	180
Available household labor	75	75	75	75	75	115	115	85	75	75	75	85	1000

A partial budget of additional costs and returns due to the addition of the second crop is shown in Table 18. By allocating household labor according to wage rates as explained in the previous chapter, it was calculated that the two crops of rice required 180 workdays of hired labor at a cost of Le 107.40. The hired labor required for the production of a single crop of rice was calculated in the previous chapter as two workdays at a total cost of Le 1.30. The additional cash outlay for hired labor resulting from the double cropping system was therefore Le 106.10 for 178 workdays of hired labor.

Table 18. Partial Budget for a Second Crop on a Four Acre Swamp Rice Farm.

Additional Costs:		Additional Returns:	
178 workdays of hired labor at an average of Le 0.59 per workday	Le 106.10	100 bushels of paddy rice @ Le 2.00 per bushel	Le 200.00
Tool costs	4.72		
Seed and crop expense	41.90		
	Le 152.72		
Reduced Returns:		**Reduced Costs:**	
- None -	-0-	- None -	- 0 -
A. Total annual additional costs and reduced return	Le 152.72	B. Total additional returns and reduced costs	Le 200.00
		Minus A	152.72
		Net change in returns to HHL* and Mgt.	Le 47.28

*HHL refers to Household Labor

Tool Cost: The tools used in the initial development of the swamp were not required for crop production. The tool costs incurred by the selected household for the production of rice are shown in Table 19. It was previously suggested that these tools had a useful lifetime of two years or two crops. Although no new tools were demanded by the introduction of the second crop, their intensity of use in the double cropping system required the complete amortization of existing tools in one year or over two crops. The additional cost of tools or the share of the second crop of tool charges was 50 percent of the tool costs of Table 19 or Le 4.72.

Table 19. Tool Costs for Rice Production by a Household of Four Adults, Sierra Leone.

Tool		Cost
Large hoes	Le	1.60
Small hoes		1.20
Harvesting knives		.80
Matchets		1.84
Shovel		4.00
Total	Le	9.44

Additional Seed Expense: The additional seed expense refers to the cost of seed rice for the second crop. Since local varieties of rice may not be as viable, a higher seed rate of 60 pounds per acre was budgeted for the second crop. The additional seed requirement was therefore 240 pounds of seed rice at a cost of Le 10.00.

Additional Rice Bag Expense: This expense was the cost of rice bags for the additional rice production. The subsistence requirements of the farm household were met by the first rice crop. Rice bags were therefore needed for 100 bushels of rice from the second crop at a cost of Le 17.50.

Additional Fertilizer Cost: The fertilizer requirements for the second crop were the same as for the first crop and therefore the additional expense for fertilizer was Le 14.40. The above arguments resulted in a total additional seed and crop expense of Le 41.90 as shown in the partial budget.

Since the second crop was entirely an addition to the existing farming system and did not substitute for any existing enterprise, no reduced returns or costs are shown in the partial budget of Table 18.

Additional Returns: The additional production from the double cropping system was 100 bushels of rice produced by the second crop. This quantity of rice production was based on an expected yield of 25 bushels per acre from the second crop. The average yield of Jewulei in the Njala Extension Scheme was 38 bushels per acre; but results of double cropping trials suggested a drop in yields of about 50 percent for a second crop. The double cropping trials were however conducted on mangrove swamps which are 12 percent less productive than inland-valley swamps. The effective drop in yield expected from a second crop in inland swamps

was therefore assumed to be 38 percent. This adjustment afforded a yield of 25 bushels per acre or 100 bushels for the second crop when a variety such as Jewulei was used.

The value of this quantity of rice was Le 200.00 which was the only additional return. This additional return and the additional costs already computed afforded a net change in returns to household labor and management of Le 47.28.

Alternative Crop Patterns

An alternative to a double crop of rice is the rotation of other crops with rice. Crop rotation helps maintain soil fertility and by so doing permits a consistent long-term level of production. A successful crop rotation program however demands that certain preconditions be met.[5] These preconditions refer to agronomic, economic, and sociological factors that determine the suitability of selected crops for the crop rotation system. For instance, one of the often suggested elements for crop rotation systems is a forage crop. Forages have the advantages of furnishing nitrogen to the soil and at the same time providing feedstuffs for the development of livestock enterprises. In Sierra Leone however, where rice farmers are traditionally not herdsmen, forages will be difficult to accept as an alternative to rice.

---

[5] P. Silvestre, "Crops and Crop Rotation," Agricultural Research Priorities for Economic Development of Africa, Vol. 3, p. 282.

Low economic returns per acre and a lack of interest by Sierra Leone farmers to suggested rotation crops severely limit the scope of a crop rotation system in inland-valley swamps. A ratoon crop of rice was therefore selected to be the most suitable alternative to a full crop of rice in the inland-valley swamps. One demonstration farm in the 1968 rice farming scheme harvested a ratoon crop of rice. The yield of 8 bushels per acre obtained by that farm was used as a guide in projecting yields from a ratoon crop of rice.

Table 20 is a partial budget of additional costs and returns due to a ratoon crop of rice. There were no additional cash outlays for labor and tools. Household labor satisfied the labor demands of a ratoon crop. No additional tools were required.

The only items that required a cash outlay were rice bags and fertilizer. At the estimated yield of 8 bushels per acre, 32 bushels of rice were produced by the ratoon crop on the four acre farm. Sixteen rice bags were required for this quantity of rice at a cost of Le 5.60. The fertilizer requirement of the ratoon crop was the same as for a full crop and the cost was Le 14.40. The additional seed and crop expense due to the ratoon crop was therefore Le 20.00.

The additional return was the value of 32 bushels of rice produced by the ratoon crop. At the price of Le 2.00 per bushel, this value was Le 64.00. The change in net returns to household labor and management that resulted from

Table 20. Partial Budget for a Ratoon Crop of Rice

Additional Costs:			Additional Returns:	
Hired Labor	Le	0	32 bushels of paddy rice at Le 2.00 per bushel	Le 64.00
Tool Costs		0		
Seed and Crop Expense		20.00		
Reduced Returns:			**Reduced Costs:**	
None		0	None	0
A. Total Annual Additional Costs and Reduced Returns	Le	20.00	B. Total Additional Returns and Reduced Costs	Le 64.00
			Minus A	20.00
			Net Change in Returns to Household Labor and Management	Le 44.00

the cultivation of a ratoon crop was Le 44.00. The ratoon crop like the double crop required suitable moisture conditions in the inland swamp.

Increase in Size of Farm

The previous two sections showed that net returns to household labor and management could be increased by the addition of a second full crop or a ratoon crop. Assuming that unused swamp remain fallow, a third adjustment that may increase income is an increment in the size of farm. In addition to the income effect of such an adjustment, there may also be an improvement in resource use that can offer food rice at lower prices to the nonfarming sector of the economy.

A planned increase of one acre at a time will not require any hired labor. The development of the additional acre will require only 92 workdays of labor.[6] This amount of labor can be provided by the farm household between the months of January through April, even though the labor of the women is not used for the development work.

The labor requirement for producing rice on the new size of farm (5 acres) was calculated to be about 567 workdays. Household labor was also adequate for this phase of the operations without sacrificing timeliness that is necessary for some tasks.

Table 21 is a partial budget of additional costs and returns involved in the development of one acre of swamp and rice cultivation on a five acre farm.

Additional Hired Labor Charge: As explained in the previous two paragraphs, no hired labor was required for both the development of the new acre and rice production on the new size of farm. There was consequently no additional hired labor charge in the partial budget.

Additional Tool Charge: In the last chapter, the tool costs charged to the development of four acres of swamp was computed to be Le 6.20. Twenty-five percent of this cost was charged to the development of one acre of swamp as the additional tool charge.

---

[6]No additional development required for the nursery.

Table 21. Partial Budget for Increasing the Size of a Four Acre Farm by One Acre

Additional Cash Outlays:		Additional Returns:	
Hired Labor:		40 bushels of Husk Rice at Le 2.00 per Bushel	Le 80.00
Development	Le 0	Government Payment (Le 30.00 per Acre)	30.00
Production	0		
Miscellaneous cost	1.25		
Tool Cost	1.55		
Seed and Crop Expense	12.48		
	Le 15.28		
Reduced Returns:		**Reduced Costs:**	
None	0		
A. Total Additional Costs and Reduced Returns	Le 15.28	B. Total Additional Returns and Reduced Costs	Le 110.00
		Minus A	15.28
		Net Change in Household Labor and Management	Le 94.72

Additional Seed and Crop Expense: The additional seed and crop expense shown in the partial budget included Le 1.88 for 45 pounds of seed rice (RH2); Le 3.60 for the fertilizer requirements of one acre of swamp and Le 7.00 for 20 rice bags for 40 bushels of rice produced on the new acre. There is also an additional cost of Le 1.25 for miscellaneous expenses for the new acre.

Additional Returns: Forty bushels of rice valued at Le 80.00 was the additional return due to the new acre.

The government payment for each new acre of swamp developed was Le 30.00. This amount is an additional return that would not be received if the new acre was not developed.

The net change in household labor and management due to the new acre of swamp was Le 94.72.

Improving Labor Efficiency

Swamp rice farming in Sierra Leone depends predominantly on human labor. It was seen that with some adjustments such as in double cropping there was a high demand for labor. This high labor requirement for swamp rice farming created a need for hired labor to complement available household labor. The uneven distribution of available household labor aggravated the problem. In the case of double cropping, 53 percent of the additional returns were used to pay for the additional hired labor requirements. This situation demands means of improving labor efficiency. Any adjustment that can enable a unit of labor to accomplish more work in a day than is currently achieved will not only increase income but will facilitate the development of a commercial farming sector.

One way of improving labor efficiency is the reduction of the dependence of farm operations on human power. This can be achieved by the improvement of existing implements or through some form of partial mechanization. This is important because a farmer's ability to make management decisions and direct factors of production is severely limited when he acts as both a director and producer of

power. This is because most of his energy will be used in meeting the demand for power.[7]

Improvement of Existing Implements

Attempts in the improvement of existing implements have, when successful, considerably reduced the labor requirements for farm operations. With the African hand mortar and pestle for instance, two pounds of husk rice is cleaned in four hours. The Asian treadle mortar speeded this operation by 40 to 60 times.[8] In Nigeria, the construction of machetes from high-carbon tool steel instead of cast iron rendered them more durable and efficient for sharp cutting and digging. The substitution of the sickle for the traditional harvesting knives by Njala Extension staff greatly reduced the time required for harvesting.

Engine Powered Machinery

In Sierra Leone, animal power cannot be considered a reasonable substitute to human power until sleeping sickness can be controlled. The next step of mechanization to improve labor efficiency will therefore have to be the employment of scaled down versions of conventional farm tractors. One such type power unit that has already been tried

---

[7] Agricultural Mechanization in Equatorial Africa. Institute of International Agriculture, College of Agriculture and Natural Resources. Research No. 6 (East Lansing: Michigan State University, December 31, 1969), pp. 1-1.

[8] Ibid., pp. 1-25.

in the country is the walking-type tractor. In one experiment one acre of river terrace was plowed in 10 hours.[9] This was a rate of work about 20 times faster[10] than the 25 workdays established to be the time requirement for human power to complete similar work. Brushing by such a power unit was 8 times faster than could be achieved by human labor.

The cost of operating the walking-type tractor was calculated to be Le 3.12 per acre for brushing and Le 5.44 per acre for plowing. These costs included: the fuel charge, depreciation and repairs and the wage paid to the operator of the machine.[11] At the evaluated wage rates of Chapter IV and the established labor requirements for brushing and plowing, the hired labor charge for brushing one acre of swamp would be Le 3.25 and a similar charge for plowing would be Le 16.25. The walking-type tractor can therefore speed the rate of plowing by about 20 times at a cost 33 percent cheaper than can be achieved by human labor. While the cost of brushing by the walking-type tractor is almost the same as by human labor, the improvement in the rate of work by the use of the machine is an advantage that suggests its employment.

---

[9]Moses Kapu, "The Rate of Work and Efficiency of Operations of a Land Master 150 Walking Type Tractor When Used to Cultivate a Dry Rice Paddy." Unpublished Project Report. Dept. of Agricultural Engineering, Njala University College, May 25, 1968, p. 3.

[10]Assumes an eight hour workday.

[11]Kapu, pp. 8-10.

Other similar improvements in work methods may afford increased incomes and provide a basis for a commercial agricultural sector. The level of mechanization, considering the managerial ability and financial position of most farmers should be modest. If possible the expected costs and returns that will result from a new equipment should be considered carefully before a final decision is made to purchase the equipment.

Test for Research Hypothesis

The general research hypothesis was that by employing existing improved technology, economic returns could be obtained from inland-valley swamps that were competitive to returns from traditional farming and selected nonagricultural opportunities.

Table 22 shows some indices that can be used to test this hypothesis. The most important indicator for testing the hypothesis is the net return per workday of production household labor input. The return per workday of production household labor is Le 0.60 under single cropping, Le 0.46 under double cropping, Le 0.55 for a full crop and a ratoon crop and Le 0.67 for a five acre farm. The system with the lowest net return per workday of production household labor was the double cropping system. This low return was due to the high hired labor requirements of this system in the two peak labor periods. Similar returns were Le 0.20 in

Table 22. Selected Indices of Profitability and Efficiency of Four Systems of Rice Cultivation in Inland-Valley Swamps, Sierra Leone.

		Systems[a]			
		I	II	III	IV
Total labor used for rice production (work-days)		454	872	568	567
Household labor used in production (work-days)		452	692	568	567
Bushels of rice produced		160	260	192	200
Bushels of rice produced/acre of swamp		40	65	48	40
Total Returns	Le	326.20	526.20	390.20	436.20
Net returns to household labor and mgt.		272.51	319.79	316.51	367.23
Net returns/workday of prod. Hhl.[b]		0.60	.46	.56	.65
Cash outlay/bushel of rice produced		0.34	.79	.39	0.34

[a]Systems: I - Four acre farm under single cropping
II - Four acre farm under double cropping
III - Four acre farm under single crop plus ratoon crop
IV - Five acre farm under single cropping.

[b]Refers to household labor.

traditional upland farming and Le 0.43 in the partially mechanized rice farming areas.[12]

There are however limitations to the net returns per workday of household labor shown in Table 22. The returns from the double cropping system are based on double cropping trials in mangrove swamps. Although adjustments were made for the productivity differentials in mangrove and inland swamps, the budgeted yields were still subjective. Returns from the ratoon crop are also limited in that they were calculated on the basis of yields from only one farm. This study, however, used higher wage rates for hired labor than Njoku observed on both the upland and in mechanical rice farming areas. In view of this, it was concluded that the results shown in Table 22 were better than returns from either the uplands or mechanical rice farming areas.

The net return per workday of production household labor and management from any one of the four systems of cropping in inland valley swamps was however below the wage paid per workday of unskilled work in Sierra Leone. This wage which was increased to 85 cents in 1969 is, however, expected to pay for the living expenses in a large town. The increases in the rate of unemployment in the country also suggest that this wage rate is inconsistent with the demand for unskilled workers in the country. It also

---

[12]Njoku, p. 158.

suggests that the opportunity of working as an unskilled worker for a higher wage may be remote if not inaccessible for most people.

Another nonagricultural opportunity that is competitive to inland-swamp farming is diamond digging. Income from diamond digging, however, largely depends on luck. While there are many unusual stories of financial success in diamond digging, it is also true that for every success story there are sad stories of failure. The uncertainties regarding income from diamond digging puts farming ahead of it as a reliable source of income. These considerations and the calculated returns from inland swamp rice farming confirmed the general hypothesis of the study.

CHAPTER VI

SUMMARY AND IMPLICATIONS OF RESULTS

Summary

Most of the rice production in Sierra Leone is from rainfed uplands. Current knowledge of rice farming in the country, however suggests that the inland-valley swamps can be substituted for the low productive uplands. A successful substitution of a more intensive farming system for a traditional system demands that the individual farm household realize increased returns for the additional efforts required.

The hypothesis of this research was that by the use of existing improved technology, increased net returns competitive to returns from alternative agricultural and selected non-agricultural opportunities could be obtained from the inland-valley swamps for rice cultivation.

The objective of the study was to provide an analysis of resources, technology and management practices necessary for successful rice farming in the inland-valley swamps at the family farm level. This was achieved through the assembly of data from technical literature that was pertinent to successful rice cultivation in the inland-valley swamps. The kinds of resources, especially labor used on individual rice farms were determined. Adjustments that increased the level of income were also considered.

The study referred to the relative importance of inland-valley swamps in the government's strategy to increase rice production in the country. Rice is the most important crop in Sierra Leone. It is grown by 86 percent of the farmers on 700 thousand acres of land. The annual production of husk rice is estimated to be about 400 thousand metric tons. This production is inadequate to meet internal consumption requirements, therefore the government imports 5 to 10 percent of the annual domestic requirements.

To save foreign exchange that is necessary for rice imports, the government is determined to increase rice production through a program of development of inland-valley swamps. These swamps are estimated to obtain the highest yields among the various rice growing situations in the country. They are also widespread in all regions of the country. This enables the involvement of local farmers in their development without any relocation of interested producers. Necessary technologies can also be easily used in inland swamps for improved rice production. Inexpensive bunds can be used for water management that is essential for successful rice farming. Since, unlike other rice growing areas in the country, inland swamps are not subjected to the vagaries of climate, permanent cropping is possible.

In addition to increasing rice production, the development and cultivation of inland swamps will hopefully provide a realistic alternative or supplement to upland farming and provide the basis of a viable rural economy.

The study reviewed physical and environmental factors that are essential to swamp rice farming. The high rainfall in Sierra Leone and the warm climate were both evaluated in the context of swamp rice farming. The soils were deficient in some essential nutrients. The structure of the soil is however of less significance when rice is grown under flooded conditions. The need of fertilizer use and an efficient water management system that would permit flooding to partially compensate for the inferior soil quality was noted in a general management plan for inland swamps.

Experiments in Sierra Leone have shown that inland swamps are responsive to nitrogen and P_2O_5. The results of such experiments indicated the use of one hundred weight each of superphosphate and sulfate of ammonia per acre of swamp as the economic dosage of fertilizer.

Water was considered to be the most important factor in rice production. A system of bunding was therefore used for water management. A volume of 27 thousand gallons of water per acre per hour was used to determine the dimensions of the drainage system for efficient water control. For a water catchment area of 40 acres, a maximum width of sluice of 10 feet in combination with a height of 16 inches of water could allow a rate of flow of 1119 gallons of water per hour for efficient water management by the selected bunding system. The bunds were constructed from local materials.

Other cultural practices important in swamp rice culture were proper seed rice processing, nursery preparation and transplanting. Viable seeds reduced production costs per bushel of rice.

The two kinds of nurseries used in swamp rice culture are the wet and dry types. The nursery should be well prepared and plowed to a depth of 6 inches. About 350 square yards of nursery space provided the seedlings required for transplanting an acre of swamp.

The value of transplanting is not understood by most farmers, especially when the high labor requirements are noted. The process however affords the seedlings a head-start over weeds in well puddled swamps. It permits the raising of healthy seedlings in the nursery. Transplanting also permits easy weeding and optimum plant spacing.

The key element in the determination of the profitability of inland swamps was the establishment of the labor requirements for both swamp development and rice production. It was also necessary to develop a schedule of monthly labor requirements for the rice enterprise. This helped to fit the intensive swamp rice farming system into the existing activity calendar. Such a schedule provided a measure of the quantity and monthly hired labor requirements. In a low income economy, where a class of landless laborers is lacking, and where funds are not readily available to pay for hired labor, a measure of monthly labor requirements may be critical to the success of a farm plan.

Labor requirements were separated into the swamp development phase and the swamp cultivation phase. Development operations were performed only once for a given swamp and their cost represented an investment that increased the value of swamp. Swamp cultivation tasks on the other hand were performed each time a crop was produced.

In the establishment of the labor requirements for both swamp development and cultivation, the labor records of the 1968 Peace Corps Rice Farming Scheme were carefully evaluated. The various records reported a wide range of labor use for similar tasks. This called for some subjective judgments in the establishment of labor requirements. The quality of farm records, difficulties of performance and the nature of individual tasks were also considered in establishing labor requirements.

The labor required for developing an acre of swamp was established to be 94 workdays. Seventy percent of this requirement was for bunding and stumping. The production of rice on one acre of swamp was established to be 133.5 workdays. This labor was primarily for plowing, puddling, transplanting, weeding and harvesting.

The labor requirements for swamp rice farming can be obtained from many sources. Because of the subjective and sometimes arbitrary arrangements for obtaining farm labor, only household labor and hired labor for which cash wages are paid were evaluated for use in the farm plan. The household labor supply depended on the size and composition

of the household. A household of seven was assumed. The composition of the household was established to include, two adult males, two adult females, and three school age children. The entire household was estimated to be available for 1000 workdays in the year. This total available household labor was unevenly distributed throughout the year. In those months when available household labor was inadequate to meet farm labor requirements, hired labor was employed to complement household labor.

The profitability of inland-swamp rice farming was determined by the use of budgeting techniques. This included the determination of the components of total cost and returns from the farm operation. Rice production costs included labor costs, seed and crop expense and tool costs. Because the return to household labor and management was assumed to be the factor to be maximized, the labor costs used in the budgets referred to cash outlays for hired labor only.

Cash outlays for hired labor were determined after the evaluation of various wage rates for various tasks. To accurately determine the profitability of rice production relative to alternative opportunities, the costs were separated into development costs and rice production costs. This was done because development costs were subsidized by the Government and were incurred during the first year the swamp was cultivated.

The total cash outlay for developing a typical swamp rice farm (which was assumed to be 4 acres) was Le 113.80, 92 percent of which was for hired labor. The only other component of development cost was the charge for tools and implements. Government payments of Le 30.00 for each new acre of swamp that was developed were used to retire the entire development cost. The payments were made to promote swamp development and encourage use of improved technologies. Part of the surplus of Le 6.20 of government payment over total cash outlays for development were allocated to miscellaneous expenses in rice production.

Cash outlays for rice production on a four acre farm were computed to amount to Le 53.69, 80 percent of which was for seed and crop expenses. The other components of this outlay were for tools and hired labor.

The total returns from a four acre swamp rice farm using recommended technologies was Le 326.20. The total net return was Le 272.51 and the net return per workday of household labor was Le 0.60.

Adjustments that were evaluated to increase this net return included double cropping, ratoon cropping, increasing the size of the farm and improvements in labor efficiency. Double cropping on a four acre farm using RH2 and a shorter duration local variety such as Jewulei resulted in a net increase to household labor and management of Le 47.28. The additional return to household labor and management from the

second crop was Le 200.00. Fifty-three percent of this return was used to pay for the hired labor used which was higher for double cropping than for any other system considered.

Because of economic, and other limitations, a ratoon crop of rice was considered to be the best alternative to a full crop of rice. A ratoon crop of rice did not require any additional hired labor. The total return from a ratoon crop was Le 64.00 which afforded a net increase in returns to household labor and management of Le 44.00.

A planned increase of one acre in the size of farm did not require any hired labor. The development of the new acre was scheduled for a period when household labor was unemployed. Government payment of Le 30.00 for developing the new acre also retired the development costs. The net increase to household labor and management due to an increase of one acre in the size of farm was Le 95.97.

Enough data were not available for an accurate determination of the income effect of the improvement in labor efficiency. Literature was however cited to show how improvement in existing implements speeded up farm operations in both Sierra Leone and other parts of Africa. Considering the financial status and managerial ability of these farmers, only modest levels of mechanization should be considered to complement human power. One such piece of equipment is the walking-type tractor which, according to field trials in the river terraces of Sierra Leone, can speed up plowing

by about 20 times and brushing by about 8 times, over work achieved by human power alone.

The general hypothesis of the study was that by using existing technology, economic returns that were competitive to returns from traditional farming and selected non-agriculture opportunities could be obtained from inland-valley swamps. The index used to test this hypothesis was the net return per workday of production household labor. This index was Le 0.60 for a four acre inland-swamp rice farm under single cropping; Le 0.56 for a full crop plus a ratoon crop; Le 0.46 for a four acre farm under double cropping and Le 0.65 for a five acre farm under single cropping.

The net returns per workday of household labor and management from any of the four systems of rice cultivation in the inland-valley swamps were thus higher than similar returns that are obtained from traditional upland rice farming and from the partially mechanized rice farming area. Estimates from studies were Le 0.20 for upland rice farms and Le 0.43 for the partially mechanized rice farming areas. Returns to labor in swamp cultivation were nevertheless below the wage rate of Le 0.85 per workday of unskilled work paid by the MANR, Njala University College and other institutions hiring agricultural workers. The recent increases in unemployment in the country however suggest that this latter wage rate is unrealistic with respect to the demand for unskilled workers.

Another non-agricultural opportunity that was evaluated as an alternative to inland-valley swamp rice farming was diamond digging. The uncertainties regarding income from this source however subjects it to an inferior position as a reliable source of income. The calculated returns from rice farming in the inland swamps and the shortcomings of alternative employment opportunities confirmed the general hypothesis of the study.

Implications of Results

The economy of Sierra Leone is predominantly agrarian. A logical approach to the economic development of the country should, under these circumstances, give priority to agricultural development. Since rice is the staple food in the country, it is the basic crop to which Sierra Leone farmers are most strongly attached. The government's plan to achieve self sufficiency in this important cereal is therefore a step in the right direction. It will be difficult to inspire support for other development projects when people still worry about how their next meal will be obtained.

An increase in rice production that can guarantee enough of the basic food crop for all people at modest prices will also result in a surplus of energy and funds. Such surpluses in addition to the increased rural income that can be obtained by an increase in rice production can be invested or utilized in projects that can sustain economic growth.

The profitability of the inland-valley swamps as established in this study therefore confirms the prudence of the government's plan. The high labor requirements of swamp rice farming particularly in peak labor months limits the scope of adjustments that promote a commercial level of production. This suggests the need of public support in the improvement of labor efficiency through partial mechanization of rice cultivation. The profitability of inland-valley swamps largely depends on the improved technologies used. The current enthusiasm of farmers to cultivate inland-valley swamps should therefore be sustained by an extension support that can assure the availability and continued use of such technologies.

Limitations of Study

A major limitation was the nature of data used. None of the 21 farms in the sample kept complete records on all details of both development and cultivation. The lack of some details can be related to the unfamiliarity of the record keepers of rice farming, working habits of hired laborers and to other difficulties that are characteristic in the determination of labor inputs in tropical agriculture.[1]

---

[1]R. Chabrolin, "The Study of Labor Inputs in Tropical Agriculture," Agricultural Research Priorities for Economic Development in Africa, Vol. 3, p.277.

The first of these difficulties was the heterogeneity of the environment which posed problems in the comparison of similar tasks. Plowing labor requirements were influenced by dryness of swamps which varied in different areas. Weed density was different amongst swamps and affected weeding labor requirements. Harvesting labor requirements vary with the size of the harvest which depended on the quality of soil fertility.

In addition to the problem of heterogeneity was a lack of definition for farm operations. Some records combined puddling and plowing labor inputs. Others reported labor used for "brushing and land preparation" which included several tasks ranging from clearing through plowing. These practices made it difficult to accurately determine the labor requirements of some tasks, and to compare the labor input of one farm to those of others.

The performance of hired workers was also not homogeneous. The work of an ablebodied young man cannot be compared to that of an old man or woman. Since the age, sex, and vigour of hired workers were not evaluated, adjustments were not made for variations in work performance. Work performance in the tropics can also be affected by the time of day. Work that was accomplished in the cool morning would be difficult to accomplish in the hot afternoon. The lack and availability of food for workers could also affect work performance. Since the influences of such factors were hard to measure, the accuracy of the labor records were, to the extent of

these influences limited.

The unit of measure, the man-day, which was used in the records also added some limitations. Theoretically, a man-day refers to work done by an able-bodied man in an eight hour day. The records however showed that in some farms and for some tasks, work was not actually continued for eight hours each day. This study therefore used the workday which did not imply an exact time measurement of work.

In addition to the difficulties in establishing labor coefficients, the small size of sample added to the problem of measurement. The average of a large number of observations might tend to eliminate biases since the inaccuracies cancel out. The divergent range of labor inputs reported for similar tasks in a sample of only 21 farms required further analysis by the researcher.

Only two of the 21 farms in the sample were in the Eastern Province. The Eastern Province has the largest acreage of inland-valley swamps and is the geographic area in which past technical information has been generated. This raised the question as to the applicability of the results of the study to any given region in the country. This question will only be answered by further resarch to test the results of this one.

Also the study did not consider the economic effects of an exhaustive development of inland-valley swamps which involves the complete removal of all raffia palms. Raffia

palms are the source of the raffia fibre which is important in the rural handicraft industry; palm wine, which is a popular beverage in the country and palm leaves that are used in the roofing of houses in areas where suitable grasses are not available. Data on which the study was primarily based were also for the first year of operations of the 1968 Rice Farming Scheme.

These limitations should not dismiss the usefulness of the study which was an initial attempt to determine the profitability of a more intensive system that is recommended to substitute for traditional farming methods. Instead, they point to a cautious use of the results and a need for follow-up studies that will eventually result in an accurate Farm Management Manual for rice cultivation in the inland-valley swamps of Sierra Leone.

BIBLIOGRAPHY

Bradfield, Richard. "Farming Systems in Africa: Management of Crops, Soil and Water, Mechanization." Agricultural Research Priorities for Economic Development of Africa. U.S. Academy of Sciences, National Research Council, Vol. III, 1968.

Bradford, Lawrence A. and Glenn L. Johnson. Farm Management Analysis. New York: John Wiley and Sons Inc., 1967.

Chabrolin, R. "The Study of Labor Input in Tropical Africa." Agricultural Research Priorities for Economic Development in Africa. U.S. Academy of Sciences, National Research Council, Vol. III, 1968.

Chinese Agricultural Mission, Sierra Leone. "Release." Unpublished mimeo, 1969.

Gledhaf, J. "Practical Inland Swamp Improvements in the Eastern Province of Sierra Leone." African Soils. Vol. XII, 1965.

Gregory, Stanley. Rainfall Over Sierra Leone. Research Paper No. 2. Department of Geography, University of Liverpool, 1965.

Hill, Dr. W. "A Summary of Fertilizer Work on Rice in Sierra Leone. Unpublished Mimeo. Rice Research Station, Rokupr, undated.

Hobby, Alan. "The Introduction of Intensive Swamp Rice Cultivation in the Eastern Province of Sierra Leone." Unpublished Mimeo. Department of Agriculture, Kenema, Sierra Leone, 1966.

Imperial Bureau of Soil Science. "Tropical Soils in Relation to Tropical Crops." Technical Communication No. 34, Harpendon, England, 1936.

Institute of International Agriculture. Agricultural Mechanization in Equatorial Africa. College of Agriculture and Natural Resources, Michigan State University, East Lansing, 1969.

Jordan, H. D. "Rice in the Economy of Sierra Leone." World Crops, Vol. 17:4, 1965.

Kapu, Moses. "The Rate of Work and Efficiency of Operations of a Landmaster 150 Walking Type Tractor When Used to Cultivate a Dry Rice Paddy." Unpublished Project Report. Department of Agricultural Engineering, Njala University College, 1968.

Kargbo, A. B. "Guide Notes to Swamp Rice Cultivation and Seed Multiplication Techniques in Sierra Leone." Unpublished Mimeo. Rice Research Station, Rokupr, 1965.

Karr, G. L. "The Costing of Mechanical Cultivation for the Njala Extension Farming Scheme." First draft of mimeo. University of Illinois, Urbana, 1970.

Karr, G. L. "The Use of Subsidies for the Promotion of Inland Swamp Development." Economic Trends. Bank of Sierra Leone, November-December, 1969.

Karr, G. L. and M. Hanson. "Evaluation of the 1968 Small Packet Rice Seed Distribution Scheme." Unpublished Mimeo. Njala University College, 1968.

Little, K. "The Mende Rice Farm and Its Costs." Zaire, Vol. 5:3, 1951.

Mellor, J. W. "The Use and Productivity of Farm Labor in the Early Stage of Economic Development." Journal of Farm Economics, Vol. 45:3, August, 1963.

Mutti, R. J. Marketing Staple Food Crops in Sierra Leone. University of Illinois, Urbana, 1968.

Njoku, A. O. "Labor Utilization in Traditional Agriculture: The Case of Sierra Leone Rice Farms," Unpublished Ph. D. Dissertation, University of Illinois, Urbana, April, 1971.

Norman, D. W. "Labor Inputs of Farmers: A Case Study of Zaria Province of the North Central State of Nigeria." The Nigerian Journal of Economics and Social Studies. Vol. 2:1, 1969.

Odell, R. T. and J. C. Dijkerman. Properties, Classification and Use of Tropical Soils, with Special Reference to Those in Sierra Leone. Njala University College, 1967.

Rice Research Station. "Annual Report of the West African Rice Research Station, 1963." Rokupr, 1965.

Rice Research Station. "Improving Rice Yields in Sierra Leone." Unpublished Mimeo. Rokupr, undated.

Roddan, G. M. "The Cultivation of Swamp Rice in Sierra Leone." Tropical Agriculture, Vol. XIX:5, 1942.

Sierra Leone Government. "Department of Agriculture Annual Report, 1963." Government Printer, Freetown, 1965.

Sierra Leone Government. 1963 Population Census. Central Statistical Office, Freetown, 1965.

Sierra Leone Government. Agricultural Statistical Survey 1965/66. Central Statistics Office, Freetown, 1967.

Sierra Leone Government. "Fertilizer Newsletter." Department of Agriculture/F.A.O., Freetown, 1967.

Sierra Leone Government. "Development of Inland-Valley Swamps." Unpublished Mimeo. Department of Agriculture, Freetown, 1970.

Saylor, Ralph Gerald. The Economic System of Sierra Leone. Durham, North Carolina: Duke University Press, 1967.

Silvestre, P. "Crops and Crop Rotation." Agricultural Research Priorities for Economic Development of Africa. U.S. Academy of Sciences, National Research Council, Vol. III, 1968.

Todd, Bill. "Swamp Clearance and Water Control in the Eastern Province of Sierra Leone." Unpublished Mimeo. Njala University College, 1967.

United States Department of Agriculture, U.S.A.I.D. Rice in West Africa. Washington, D.C., 1968.

United States Department of Agriculture. "Food Balances for 30 Countries in Africa and West Asia, 1959-61." ERS Foreign 119. Economic Research Service, Washington D.C., 1965.

University of Phillipines, International Rice Research Institute. Rice Production Manual, undated.

Veenstra, J. "Land Use Planning--Some Notes Towards an Operational Programme for the Introduction of a Permanent Agricultural Land Use Pattern, Including Rice Farming in Sierra Leone." Unpublished Mimeo. F.A.O. Office, Kenema, Sierra Leone.

Whittaker, Victor A. "The Economics of Mechanical Cultivation of Rice Lands in Sierra Leone." Unpublished Ph.D. Dissertation, University of Illinois, Urbana, 1971.