AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION

A. PRIMARY: ECONOMICS

B. SECONDARY: AGRICULTURAL ECONOMICS

2. TITLE AND SUBTITLE

MAKING OPTIMUM USE OF NATIONAL RESOURCES: THE CASE OF THE DRIVE FOR SELF-SUFFICIENCY IN RICE PRODUCTION IN SIERRA LEONE

3. AUTHOR(S)

DUNSTAN S.C. SPENCER

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
DECEMBER 1973	21 PAGES	ARC SL-338.1-S745

7. REFERENCE ORGANIZATION NAME AND ADDRESS

MICHIGAN STATE UNIVERSITY
DEPT. OF AGRICULTURAL ECONOMICS
EAST LANSING, MICHIGAN 48823

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

Based on the study reported in this paper this author recommends that government policy for rice production should be modified to include the following programmes ranked as follows:

1. A strong fertilizer demonstration and distribution programme to get upland farmers to use the recommended dose of fertilizer on their upland farms. A programme is also needed that would provide good quality improved seed to upland rice farmers. If the yields on upland rice farms could be increased not only will self-sufficiency be more easily achieved but the acreage of upland rice under cultivation can be reduced.

2. Continue to encourage farmers to develop and plant inland swamp rice but lay less emphasis on getting the swamps developed to the efficient improved level of technology, (water control, complete stumping, etc.), since the traditional inland swamps are almost as profitable, particularly in the Southern and Eastern Provinces.

3. Re-introduce the mangrove swamp clearance schemes of the 1930's for the southern mangrove swamps of Region 2. A subsidy of Le 30.00 per acre of mangrove swamp cleared was programmed in this study.

4. Continue the mechanization scheme but being expensive, it should be ranked below the three schemes described above.

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAA-988	

12. DESCRIPTORS

FERTILIZER, IMPROVED VARIETIES, UPLAND RICE, SWAMP RICE, LAND CLEARANCE, MECHANIZATION, RESEARCH, TRAINING

13. PROJECT NUMBER: 931-17-190-543

14. CONTRACT NUMBER: AID/CSD-3625

15. TYPE OF DOCUMENT: RESEARCH PAPER

AID 590-1 (4-74)

MAKING OPTIMUM USE OF NATIONAL RESOURCES: THE CASE OF THE DRIVE FOR SELF-SUFFICIENCY IN RICE PRODUCTION IN SIERRA LEONE*

Dunstan S. C. Spencer**

Productive Resources

In order to produce food and fibre, a nation needs a supply of productive resources. These factors of production, as they are called, can be grouped into four categories: (a) natural resources, (b) labour, (c) capital and (d) entrepreneurship or management.

Natural resources comprise land (agricultural land as well as mineral resources), water and local climate. This category consists of those gifts of nature which are not the result of human effort.

Labour describes the efforts of human beings. In agriculture it comprises the physical work of farmers, their families and hired workers.

Capital represents man-made resources, i.e., it comprises resources which are the result of past human effort. Capital incorporates real capital items, i.e., stock of physical assets capable of providing services, e.g., machinery, building dams, stock of materials like fertilizer and seed, as well as financial assets, i.e., money and securities.

Enterpreneurship or management describes the function of making decisions about how the other factors of production should be used and carrying out the decisions.

---

*Paper presented at the Third Annual Conference of the Sierra Leone Agricultural Society, Bo Teachers College, September 6-9, 1973.

**Lecturer in Agricultural Economics, Njala University College, University of Sierra Leone

Every nation is endowed with a certain amount of the above productive resources. Some countries are endowed with more resources than others but the economic development of a nation depends to a great extent on the use that is made of the available resources. The stock of natural resources (land, water, climate and minerals) cannot usually be greatly altered but many steps can be taken to alter the quantities of the other resources available to a nation. For example, the stock of labour can be controlled by appropriate population control measures, the stock of capital can be increased by savings and investment while the level of managerial know-how in a country can be altered by education and training programmes.

The problem which every nation faces is how best to utilize its national resources to achieve the ultimate goal of society--the maximization of the welfare of the population. Like an individual farmer, a nation must decide what to produce, how much to produce, what method or combination of methods of production to use in the production of necessary goods and services. There are usually many alternative ways of using the resources of a nation for the improvement of national welfare. Decisions have to be made as to which one or combination of a number of alternatives is best for the nation. The contribution of economics to this decision making process lies in "counting the cost of the different alternatives" [Upton, 1973]. The word cost is used here in its broadest sense to mean not only expenditure of money but also the sacrifice of leisure, cultural values or anything which is valued by the nation. All national choice problems can then be considered in relation to the expected benefits and the costs incurred.

In this paper I attempt to show how one of the tools of economics can be used to indicate how the nation can most efficiently use its resources

in an attempt to achieve one of its national goals--self-sufficiency in rice production.

The Self-Sufficiency Goal

Although accurate statistics on production are not available it is clear that Sierra Leone was more or less self-sufficient in rice production up to the early 1950's. Coinciding with the diamond boom at that time, Sierra Leone moved from a self-sufficient state to one in which large imports of rice have been necessary [Spencer, 1971]. The Government feels that the expenditure of foreign exchange for the purchase of rice is an unnecessary use of scarce foreign exchange earnings and that the staple food of the country should not be imported, especially as it is believed that Sierra Leone has the best rice lands in West Africa. This has led the government to take steps to increase domestic rice production. This increase, it is hoped, will not only satisfy domestic needs but also provide enough for export to other West African countries and for general movement in world trade if possible.

Many questions arise with regard to this policy. The most important are: (a) is it wise for Sierra Leone to aim for self-sufficiency in rice production (maybe alternative goals might yield greater benefit to the society)? and (b) what is the best method of achieving the goal of national self-sufficiency in rice production given the available resources and factor endowments of the country as well as the social and political facts of life?

In a recent paper the first question has been tackled [Spencer, 1973-b]. It would appear from that study that farmers' incomes would be higher if

alternative goals such as one of maximum farm income or full employment of available farm labour within its region of origin were pursued rather than a goal of domestic self-sufficiency in rice production.

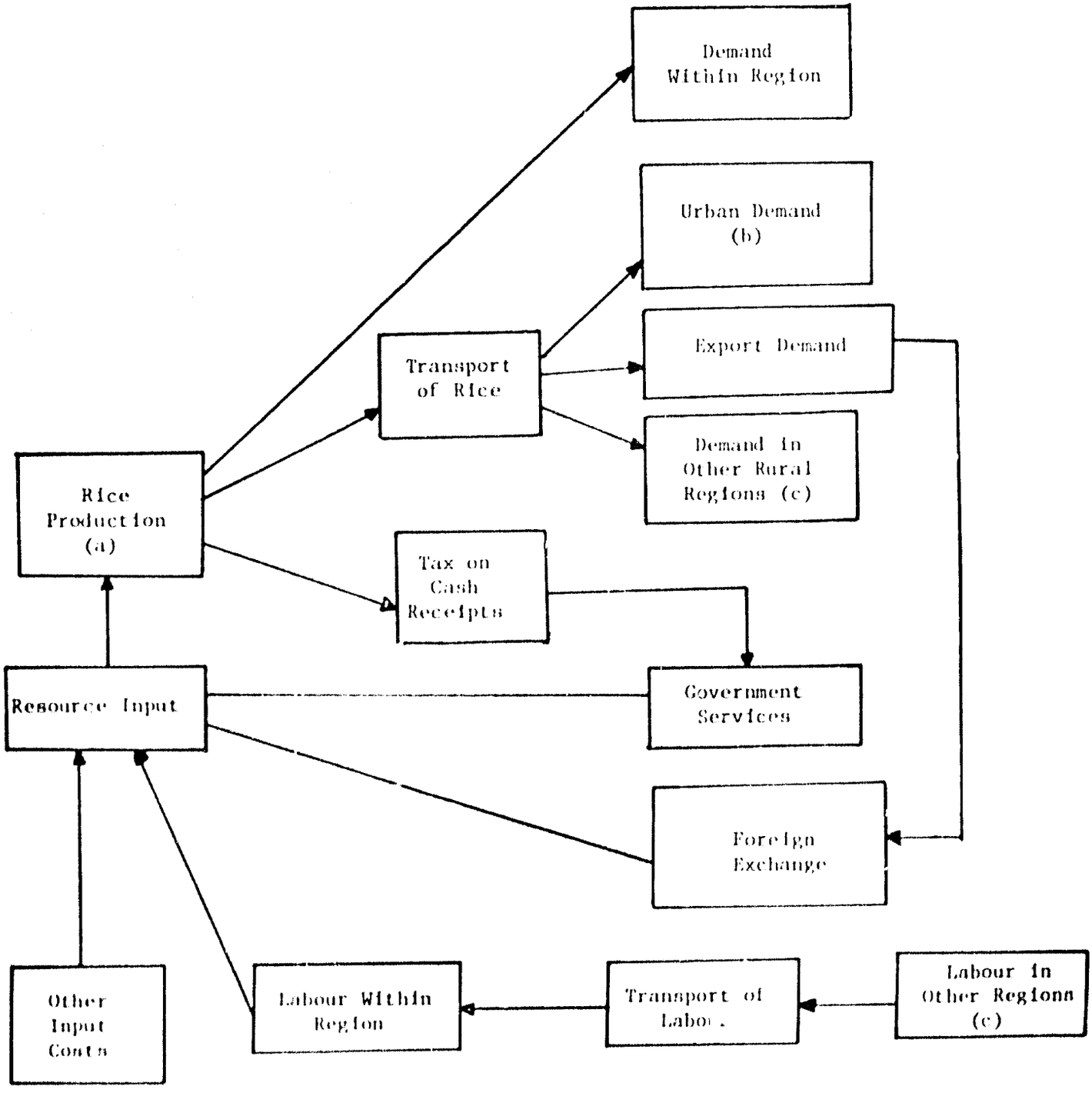
In this paper the second question is tackled using the technique of linear programming.

The Linear Programming Model

In order to select the optimum investment plan for rice development in Sierra Leone one-period linear programming models were constructed. Linear programming can be defined as "the analysis of problems in which a linear function of a number of variables is to be maximized (or minimized) when those variables are subject to a number of constraints in the form of linear inequalities" [Dorfman, Samuelson and Solow, 1958, p. 8]. Basically, I have constructed a computer model of the Sierra Leone rice economy and used the model to indicate the best way of achieving the goal of domestic self-sufficiency in rice production by 1980. Linear programming models allow many possibilities and alternatives to be examined simultaneously in light of the many restrictions, conditions and requirements put on the rice industry. The models have been described in detail elsewhere [Spencer, 1973a, 1973b]. In this paper only a simple description of the technique is provided.

It is assumed in the models that the objective of the nation is to maximize the returns (income) of rice farmers, subject to a set of conditions (constraints) the most important of which is that national self-sufficiency in rice production should be achieved by 1980. Figure 1 is a schematic representation of the models used in this study.

Figure 1. Schematic Diagram of 1980 Rice Production Model



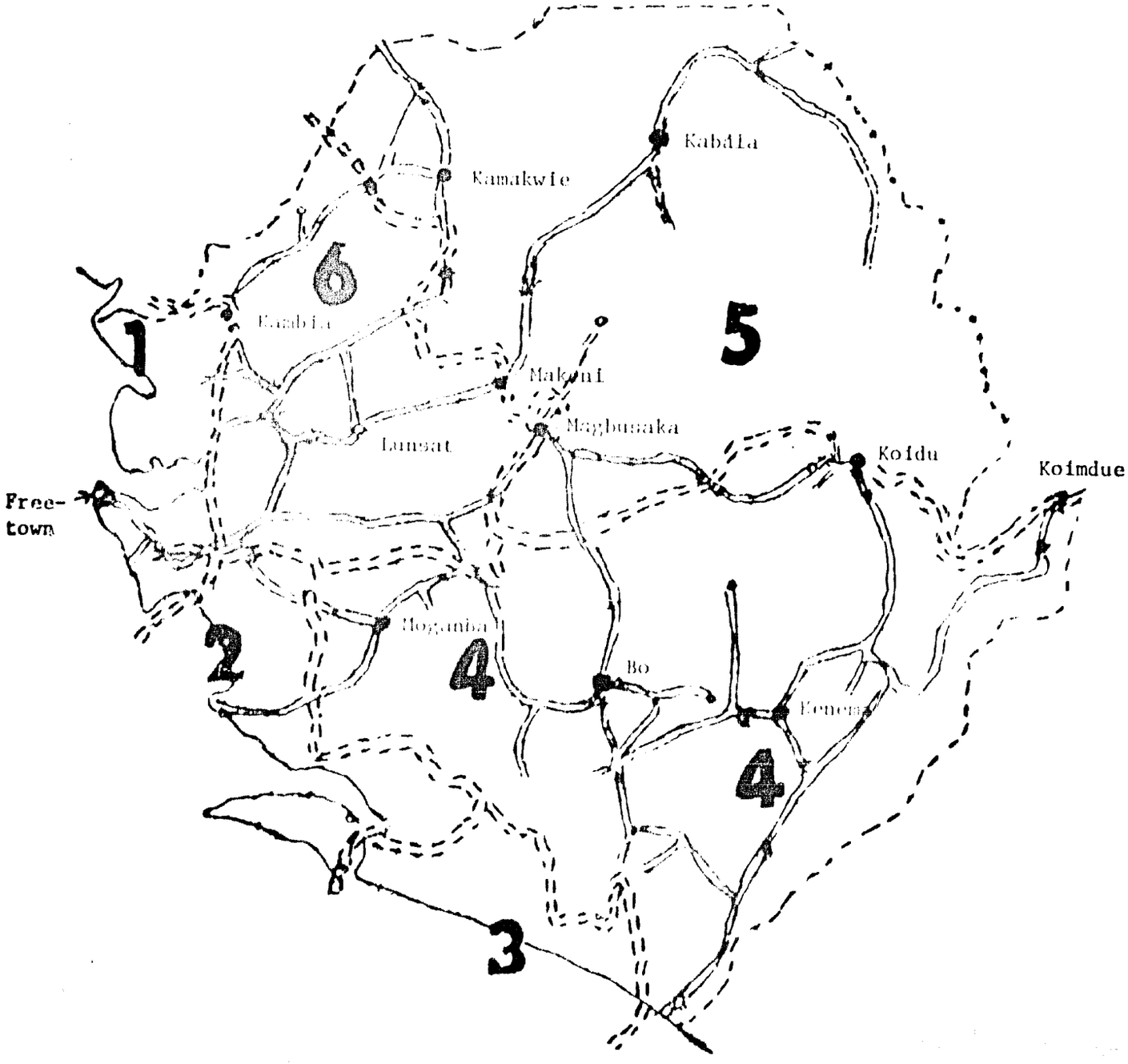
(a) Differentiated by Region, System of Production, and Level of Technology.
(b) Differentiated into Four Urban Areas.
(c) Five Other Rural Regions.

First of all rice is produced on rice farms which are differentiated by region, system of production and level of technology. The country was divided into six rice regions (Figure 2) in which different systems of rice production are concentrated. For example, Region 1 has only mangrove swamp rice, while Region 2 has mangrove and upland rice production systems and Region 3 has only riverain grassland rice. Furthermore each system of rice culture in each region is divided into traditional culture (the present technology) and improved technological systems, e.g., stumped, bunded and irrigated inland swamps. Average farms were modeled. In order to produce rice farm uses productive resources, i.e., land of a particular type, labour, foreign exchange, government funds, and other input costs. The quantities of the various productive resources used, as well as the output (rice) of each farm type programmed are given in Appendix A. These input-output coefficients, as they are called, were determined during field work in Sierra Leone during the 1971/72 crop year [Spencer, 1972].

The quantities of resources available for rice production in Sierra Leone are of course limited. The estimated quantities of available land and labour are given in Appendices B and C.

A maximum of 2 percent of national foreign exchange reserves, which averaged about Le. 31 million in the past 10 years, was programmed as being available initially for rice production activities. This amounted to Le. 827,800 which could be utilized for importation of fertilizers, machinery and tools, but not for importation of rice since a requirement of the present government policy is that foreign exchange reserves should be conserved. But the models allow for additional foreign exchange to be utilized for production if it is generated within the rice industry itself by export of rice.

Figure 2. Areas Where Different Types of Swampland are Concentrated in Sierra Leone, Urban Areas and Location of Enumeration Areas



Le. 853,300 of government funds is projected to be initially available for rice production activities in 1980. This is about a third of the expected total government expenditure on agriculture and non-mineral resources. Government revenue is used for provision of extension services to farmers as well as for various subsidies.

As shown in Figure 1 rice produced is used to satisfy domestic and foreign demand. Domestic demand is broken down into demand within the rural region in which the rice is produced, demand in other rural regions and demand in urban areas. The quantity of rice necessary for self-sufficiency in 1980 is estimated to be 589,133 long tons of husk rice broken down as follows:

Urban Areas	
Western Area	71,485
East	28,862
North	12,997
South	9,746
Rural Areas	
Region 1	44,144
Region 2	25,034
Region 3	13,377
Region 4	187,660
Region 5	107,922
Region 6	87,906

Any additional rice produced is available for foreign export. Rice produced in a region for consumption in urban areas, other rural areas or for export has to be transported to the consuming centre at a cost to the economy. Labour available for rice production in one region can also be transferred for use in another region at a cost.

Because of the fact that labour available in one region can be transferred for use in other regions and rice produced in one region can also be

transferred to other regions, the model as described above not only allows regions to compete for available national resources such as government funds and foreign exchange, but also allows the systems of rice production listed in Appendix A, to compete freely with each other for the supply of the domestic needs of the country, subject only to the physical amount of the resources available. In such a model economic considerations are the only ones that determine the outcome. For example, if inland swamp production is more profitable than upland production, all available inland swamps would first be used for rice production before uplands are utilized. If, as in the case in Sierra Leone, there are enough available swamps to produce all the domestic needs of the country and other resources such as labour, needed for swamp rice production are not limiting, uplands would not appear at all in the recommended solution. Such a model (Model 1 in this study) tells the productive potential within an economy. In this case it tells what the situation should look like in 1980, if the economy undergoes massive transformations. But as practisioners rather than theoreticians we know that some types of transformations required would be extremely difficult to achieve. For example there is no possibility of Sierra Leone rice farmers switching completely from upland production to exclusive swamp rice production by 1980. What I consider to be more realistic behavioural assumptions were therefore tested in Models 2 and 3.

Another look at Appendix A will show that some yields obtained during field work in 1971/72, and programmed in Models 1 through 3 above are different from what we can call the "accepted guesses" used by the Ministry of Agriculture and Natural Resources. In Models 3A and 3B the effect of yield variations on the optimum solution of Model 3 are investigated.

The models used in this study can be summarized as follows:

Model 1: All production systems (traditional and improved) in each of six regions compete freely for all national resources and markets.

Model 2: Same as Model 1, except that 70 percent of the 1970/71 acreage of upland rice, i.e., about 448,000 acres, must remain in production, with a minimum of 67 percent of this acreage (300,000 acres) remaining under strictly traditional cultivation (i.e., no fertilizers used).

Model 3: Same as Model 2 with the additional possibility of developing up to 48,000[1/] acres of efficient improved inland swamp farms with maximum limits of 39,360, 6,224 and 2,400 acres in Regions 4, 5 and 6 respectively.

Model 3A: A variation of Model 3 in which the yields of upland rice in Regions 2, 5 and 6 and riverain rice in Region 3 were increased by one standard deviation above the 1971/72 yields programmed for Model 3, ceteris paribus (an increase of about 240 pounds per acre for uplands and 280 pounds per acre for riverain grasslands).

Model 3B: Same as Model 3A except that the yields of mangrove swamps in Region 4 were reduced by one standard deviation (a decrease of about 860 pounds per acre).

[1/] This is actually the acreage which the UNDP/FAO planning team recommended that the Sierra Leone Government aim at having under this sytem of rice production by 1980 [UNDP/FAO, 1970].

Results

The major objective of this study was to determine what system or combination of systems of rice production, i.e., pattern of production, is best for achieving the nation's goal of self-sufficiency in rice production. Production patterns in the different models in this study are shown in Table 1.

Taking Model 1 first, since it is the most general model, we see that traditional upland does not enter the solution in any of the regions. Improved upland farming is competitive only in Region 4, where 54,155 acres come under cultivation. Only 5,247 acres of partially mechanized riverain grassland rice are recommended, but 50,000 acres of boliland are recommended for mechanical cultivation. Hand cultivation of riverain grassland, clearing of new mangrove swamps do not enter the optimum solution of Model 1 (or any of the models tested in this study). But clearing of new mangrove land is recommended for the southern mangrove swamps (Region 3). Basically Model 1 shows that if all but 54,155 acres of upland are taken out of production by 1980, and the resources saved (labour, government funds and foreign exchange) are transferred to other production systems, not only will self-sufficiency in rice production be achieved but over 91,000 tons of husk rice will be provided for export. But as pointed out earlier, this is a state that will be impossible to achieve by 1980, because it would require large movements of population from one region to another and the almost complete substitution of inland swamp cultivation in Region 4, for upland cultivation in all other regions.

It will be observed that no data are presented for Model 2, the most traditional model in which 70 percent of the present upland acreage is

TABLE 1

Objective Function Value (Returns to Farmers) and Acreage Under Rice in Each Type of Rice Farming System in the Optimum Solutions of the Linear Programming Models for the Sierra Leone Rice Industry, 1980.

Farm Type	Model 1	Model 3	Model 3A	Model 3B
		ACREAGE		
Region 1				
Mangrove on old land	48,110	31,028	48,147	42,409
Mangrove on new land	0	0	0	0
Double Crop Mangrove	0	0	0	0
Region 2				
Mangrove on old land	15,000*	15,000*	15,000*	15,000*
Mangrove on new land	21,756	15,767	4,188	4,189
Traditional Upland	0	10,363**	10,363**	10,363**
Improved Upland	0	4,635	16,138**	16,138**
Region 3				
Hand Riverain	0	0	0	0
Mechanized Riverain	5,247	0	18,021	4,868
Region 4				
Traditional Upland	0	168,051**	168,051**	168,051**
Improved Upland	54,155	199,879	94,914	174,521
Traditional Inland	329,910	66,557	72,173	29,918
Average Improved Inland	0	0	0	0
Efficient Improved Inland	n.p.	29,580	39,360**	39,360**
Region 5				
Traditional Upland	0	65,442**	65,442**	65,442**
Improved Upland	0	32,257	89,943	91,872
Traditional Inland	0	0	0	0
Average Improved Inland	83,986	23,028	1,168	0
Efficient Improved Inland	n.p.	6,240	6,240*	6,240**
Region 6				
Traditional Upland	0	56,550**	56,550**	56,550**
Improved Upland	0	28,252	28,250	28,252
Traditional Inland	0	0	0	0
Average Improved Inland	13,638	0	0	0
Efficient Improved Inland	n.p.	2,400*	2,400*	2,400*
Hand Bolt	50,000*	10,260	46,924	30,370
Mechanized Bolt	50,000	75,000	0	45,652.
Objective Function Value (000 Leones)	57,225	49,562	55,885	54,190

Notes: N.P. – activity not programmed in model
* – activity or resource at maximum limit level
** – activity or resource at minimum limit level

assumed to remain under production in 1980 with 67 percent of this acreage remaining under the strictly traditional culture where no fertilizers are applied. This is because the solution to Model 2 is infeasible. The requirement of self-sufficiency in rice production for Sierra Leone could not be met using the levels of technology and resources specified in Model 2, the restricting resource being the amount of labour available for rice production.

Adding the efficient improved inland swamp activities to Model 2 resulted in a feasible solution (Model 3), i.e., the achievement of the goal of self-sufficiency (but farmers incomes are much lower than in Model 1). A look at the resulting production pattern in Table 1 shows that 75,000 acres of boliland would need to be mechanically cultivated while 64,000 acres of inland swamp are under improved management (average and efficient) and about 16,000 acres of new mangrove swamp are cleared in the southern mangrove swamp belt (Region 2).

The results of Model 3A where increased yields were programmed for riverain rice in Region 3 and upland rice in Regions 2, 5 and 6 and Model 3B where in addition reduced mangrove swamp yields were programmed in Region 1, show that total returns to all farmers (objective function values) are much higher. Also partially mechanized boliland production does not occur in Model 3A showing that if average yields are one standard deviation higher than those observed in 1971/72 mechanized boliland production would not be necessary. If at the same time the average mangrove swamp yields were one standard deviation lower than the average recorded in 1971/72 mechanized boliland production would be necessary, but on a reduced scale (Model 3B compared to Model 3).

Summary and Conclusion

The aim of this paper is to show how economic principles could be used to determine the most efficient way the resources of the nation ought to be deployed if the goal of self-sufficiency is to be attained. To this end one-period regional linear programming models were constructed for 1980. The major findings of this study are as follows:

1. National self-sufficiency in rice production is not achievable by 1980 under the strictly traditional conditions specified in Model 2, where 448,000 acres of uplands are under cultivation and about 300,000 acres of these remain under strictly traditional technology (no fertilizer used). But if 64,000 acres of improved inland swamps (stumped and bunded swamps, using improved seed and fertilizers) could be brought under cultivation using Le. 30 per acre of government subsidy, self-sufficiency could be achieved (Model 3).
2. Returns to farmers could be increased, given the traditional conditions of Model 3, under conditions of self-sufficiency if upland yields in Regions 2, 5 and 6 could be increased (Model 3A) even though mangrove swamp yields in Region 1 are reduced (Model 3B).
3. Returns to farmers could also be increased, self-sufficiency achieved, and surplus rice provided for foreign export if upland rice cultivation could be completely eliminated by 1980 (Model 1) an impossible situation to visualise or as shown elsewhere [Spencer 1973a] if the upland acreage that remains under cultivation is all under improved culture where fertilizers are applied even if local unimproved seed is used.

Elsewhere I have also shown that under the traditional, and most realistic conditions, specified in Model 3, the twin goals of domestic self-sufficiency in rice production and full employment of labour within its region of origin are incompatible [Spencer, 1973]. For self-sufficiency to be achieved, labour must be transferred from regions with less efficient systems of rice production, e.g., Region 3 to regions with more efficient systems, e.g., Region 4. If labour is fully employed within its region of origin then self-sufficiency will not be achieved, the net shortfall of rice being about 29,000 tons of clean rice. Also income distribution could be better and total income higher under a maximum income policy.

The conclusion to be drawn from the above with regards to the feasibility of achieving the goal of self-sufficiency is that under the conditions specified in the models[1/] self-sufficiency under the most realistic assumption of Model 3 and its variations would require:

(a) Substantial transfer of labour between regions,

(b) An adverse income distribution and reduced total returns to farmers, and

(c) A major effort by the government which would need to spend over Le. 3 million per year in productive services to rice farmers (extension education, as well as subsidies on mechanical cultivation, inland swamp development, fertilizer use and clearance of mangrove swamps).

But there is a big potential for rice production in Sierra Leone if the more traditional and less technologically advanced systems could be eliminated or made more efficient by technological developments not yet available. For

---

[1/] For more details of these conditions, see Spencer [1973a, 1973b].

example even if 70 percent of the present upland acreage remains under cultivation a small surplus of rice could be exported if all upland farmers would apply fertilizers!

Recommendations for Government Rice Production Policy in Sierra Leone

Despite its cost the policy of domestic self-sufficiency in rice production is one that is likely to be pursued in the immediate future. In such a situation the relevant policy question is therefore "what is the best way of achieving this goal".

Based on the study reported in this paper this author recommends that government policy for rice production should be modified to include the following programmes ranked as follows:[1/]

(1) A strong fertilizer demonstration and distribution programme to get upland farmers to use the recommended doses of fertilizer on their upland farms. This is based on the assumption that it will be difficult to get farmers away from upland rice farming, as is shown by the fact that upland rice acreages continue to increase despite the efforts of extension personnel to get farmers to switch to inland swamp cultivation. A programme is also needed that would provide good quality improved seed to upland rice farmers. If the yields on upland rice farms could be increased, not only will self-sufficiency be more easily achieved but the acreage of upland rice under cultivation can be reduced.

[1/] This ranking is a partly subjective one made by this author. It is based on my impressions of the case of effecting the changes recommended, as well as on the effect of the changes as determined in the linear programming models tested in this study.

(2) Continue to encourage farmers to develop and plant inland swamp rice but lay less emphasis on getting the swamps developed to the efficient improved level of technology (water control, complete stumping, etc.), since the traditional inland swamps are almost as profitable, particularly in the Southern and Eastern Provinces (Region 4). The improved inland swamps could probably be more useful in increasing productivity and incomes in the North (Regions 5 and 6), because of the high level of labour use on traditional inland swamps in the north and the poorer soils.

(3) Reintroduce the mangrove swamp clearance schemes of the 1930's for the southern mangrove swamps of Region 2. A subsidy of Le. 30.00 per acre of mangrove swamp cleared was programmed in this study.

(4) Continue the mechanization scheme but being expensive, it should be ranked below the three schemes described above.

Also, it is necessary to continue technical research which would lead to improved technologies for the different rice systems in the country.

Appendix A

Summary of the Input-Output Coefficients in the 1980 Linear Programming Models of Sierra Leone Rice Farms. (Average per Farm)

	Region 1			Region 2			
	Mangrove Old Land	Mangrove New Land	Mangrove Double crop	Mangrove Old Land	Mangrove New Land	Upland Traditional	Upland Improved
1. Size of farm (acres)	2.2	2.2	2.2	3.7	3.7	4.3	4.4
2. Output							
(a) Husk rice Yield per acre (lbs)	3187	3187	4775	1527	1527	514	817
(b) Husk rice per farm (tons)	3.13	3.13	4.69	2.52	2.52	0.99	1.57
(c) Firewood sales (Leones)	—	—	—	—	—	—	—
3. Labour input (man-days)[1]							
(a) Season 1	22	22	44	36	36	63	63
(b) Season 2	200	200	400	93	93	94	96
(c) Season 3	129	129	250	119	119	84	94
(d) Season 4	70	70	122	77	77	47	52
4. Value of other farm inputs (Leones)							
(a) Hand tools[2]	1.86	1.86	3.72	0.92	0.92	0.37	0.37
(b) Machinery hire cost[3]	—	—	—	—	—	—	—
(c) Fertilizer cost	—	—	—	—	—	—	21.93
(d) Seed cost	13.04	13.04	26.00	11.73	11.73	5.41	5.41
(e) Total other costs	15.90	15.90	31.00	12.65	12.65	5.78	27.71
5. External input cost (Leones)							
(a) Foreign exchange[4]	0.37	16.50	0.74	0.18	27.75	0.07	23.65
(b) Government services[5]	2.20	29.48	3.30	3.70	49.58	4.30	13.55

A P P E N D I X A (continued)

	Region 3		Region 4				
	Riverain Land	Riverain Mechanized	Upland Traditional	Upland Improved	Inland Traditional	Inland Efficient Improved*	Inland Average Improved*
1	0.8	3.7	3.9	3.9	1.7	4.0	4.0
2(a)	568	670	1294	2062	2307	2875	2875
2(b)	0.20	1.11	2.25	3.59	1.75	5.14	5.14
2(c)	—	—	1.97	1.97	—	—	—
3(a)	54	89	41	41	32	74	74
3(b)	102	162	120	122	28	255	530
3(c)	0	0	162	176	104	117	156
3(d)	117	227	71	76	40	140	146
4(a)	0.51	0.51	2.39	2.39	1.84	3.44	3.44
4(b)	—	25.90	—	—	—	—	—
4(c)	—	—	—	19.89	—	14.40	14.40
4(d)	2.78	7.07	7.49	7.49	2.57	10.00	10.00
4(e)	3.29	33.48	9.88	29.77	4.41	27.84	27.84
5(a)	0.10	25.27	0.48	21.45	0.37	41.92	41.92
5(b)	0.80	55.50	3.90	12.28	1.70	42.52	42.52

* These systems are also programmed in Region 5 and 6.

A P P E N D I X A (continued)

	Regions 5 and 6				
	Upland Traditional	Upland Improved	Inland Traditional	Bolilland Hand**	Bolilland Hand**
1	3.9	3.9	1.1	3.0	3.5
2(a)	722	1285	2188	1910	1244
2(b)	1.26	2.24	1.07	2.56	1.94
2(c)	1.24	1.24	--	--	--
3(a)	46	46	0	0	0
3(b)	151	153	102	103	22
3(c)	191	212	94	95	18
3(d)	97	85	71	87	70
4(a)	2.32	2.32	1.66	1.88	1.45
4(b)	--	--	--	--	21.00
4(c)	--	19.89	--	4.80	5.60
4(d)	8.47	8.47	5.29	9.79	8.20
4(e)	10.79	30.68	6.96	16.47	36.26
5(a)	0.46	21.45	0.33	15.39	42.15
5(b)	3.90	12.28	1.10	9.00	56.00

** These systems occur only in Region 6.

[1] Woman and child days (under 15 years of age) converted to man-day equivalents using ratio of 1.0 and 0.5 respectively. Seasons 1 - 4 are February - April, May - July, August - October, November - January respectively.

[2] Total value of investment prorated over 3-6 years depending on the type of equipment. Also includes 10 percent interest on the investment.

[3] Fee paid by farmers for custom ploughing, harrowing and seed harrowing (Region 3 only) by the M.A.N.R.

[4] Calculated from Due and Harr(1973) Table 11, with the following modifications: (a) for all traditional systems of production 20 percent of the value of expenditure on hand tools was taken as foreign exchange expenditure (purchase of imported cutlasses etc); (b) the foreign exchange expenditure is increased by Le 0.75 per acre wherever fertilizer is used. This is to cover the foreign exchange component of the lorries used in transporting fertilizers to the rural areas (not taken into account by Due and Harr); and (c) 75 percent of the value of tools used for developing mangrove swamps (1968) was used rather than the figures reported by Due and Harr. Other components of foreign exchange expenditure are the foreign exchange expenditure on purchasing fertilizers and purchasing machinery for the government contract ploughing services.

[5] Expenditure on government services to rice farmers comprise expenditure on extension services and subsidies on (1) fertilizers (32 percent of CIF freetown price (1), plus cost of delivery to farmer), (2) mechanical cultivation(Le 6.83 per acre, (3) improved (average and efficient) inland swamp development (Le 30.00 per acre prorated over 5 years) and (4) development of mangrove land (Le 52.00 per acre prorated over 5 years).

APPENDIX B

Maximum Quantity of Different Categories of Land Available for Rice Production in Sierra Leone ? (000 acres)

Type of Land		REGION 1	2	3	4	5	6
Upland[a]		--	26.5	--	394.2	167.4	144.7
Mangrove[b]	-Old	65.0	15.0	--	--	--	--
	-New	18.0	137.0	--	--	--	--
	-Double crop	12.0	--	--	--	--	--
Riverain[c]		--	--	105.0	--	--	--
Inland Swamp[d]		--	--	--	585.0	95.9	30.3
Bolliland[e]	-Total	--	--	--	--	--	100.0
	-Mechanizable	--	--	--	--	--	75.0
	-Hand cultivable	--	--	--	--	--	50.0

a Calculated from Agricultural Statistical Survey Reports (3,7) by assuming a possibility of up to a 10% increase in acreage between 1970/71, and 1980 for Region 4 (where fallow periods are already shorter), but a possibility of up to a 20% increase in other regions.

b Derived from Roddan 1950 and Venkataswamy, 1969a

c Derived from Mitra, 1968 and Venkataswamy, 1969b.

d Total national acreage (Government of Sierra Leone 1970) distributed among regions in proportion to the percentage of total land area in each administrative province that was in each region programmed.

e Derived from Government of Sierra Leone, 1957.

A P P E N D I X C

Projected Quantity of Labour Available for Rice C Production by Region in Sierra Leone in 1980 (000 man-days)

Region	Season			
	1 (Feb-April)	2 (May-July)	3 (Aug-Oct.)	4 (Nov-Jan.)
1	1089	4377	2821	1540
2	786	1091	2344	1492
3	580	1092	330	1368
4	4631	8155	1358	5715
5	2664	6924	7792	4137
6	2169	4291	4486	3206
Urban	625	625	625	625

REFERENCES

Dorfman, R.; Samuelson, P. and Solow, R. [1958] Linear Programming and Economic Analysis. New York: McGraw-Hill Publishing Company.

Due, Jean and Karr, G. L. [1973] "Strategies for Increasing Rice Production in Sierra Leone," African Studies Review, 16, 1 (April): 23-71.

Government of Sierra Leone. [1957] Annual Report of the Department of Agriculture. Freetown: Government Printer.

_____. [1970] "Development of Inland Valley Swamps," unpublished mimeo, Ministry of Agriculture and Natural Resources, Freetown.

Mitra, G. M. [1959] Agricultural Survey of the Existing and Potential Rice Lands in the Swamp Areas of the Little Scarcies, Great Scarcies, Port Loko and Rokel Rivers. Freetown: Government Printer.

Spencer, D. S. C. [1971] "Rice Production and Marketing in Sierra Leone," Proceedings of the Conference on Factors of Agricultural Growth in West Africa. Legon, Ghana.

_____. [1972] "Micro-Level Farm Managmment and Production Economics Research Among Traditional African Farmers: Lessons from Sierra Leone," African Rural Employment Paper No. 3, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

_____. [1973a] "The Efficient Use of Resources in the Production of Rice in Sierra Leone: A Linear Programming Study," unpublished Ph.D. Dissertation, University of Illinois.

_____. [1973b] "Activity Analysis of the National Goal of Domestic Self-Sufficiency in Rice Production in Sierra Leone," paper presented at the Second Annual Conference of the West African Association of Agricultural Economists, Fourah Bay College, July 16-19, 1973.

Upton, M. [1973] Farm Management in Africa. Oxford: Oxford University Press.

Venkataswamy, T. [1969a] "Rice Production in the Tidal Mangrove Swamps of Sierra Leone," unpublished report, UNDP (SF)/FAO, Project IDAS, Freetown (memeo).

_____. [1969b] "Rice Production in Deepflood Areas and Other Riverain Grasslands of the Southern Province," unpublished report, UNDP (SF)/FAO, Project IDAS, Freetown (mimeo).