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# MICRO-LEVEL FARM MANAGEMENT AND PRODUCTION ECONOMICS RESEARCH AMONG TRADITIONAL AFRICAN FARMERS: LESSONS FROM SIERRA LEONE

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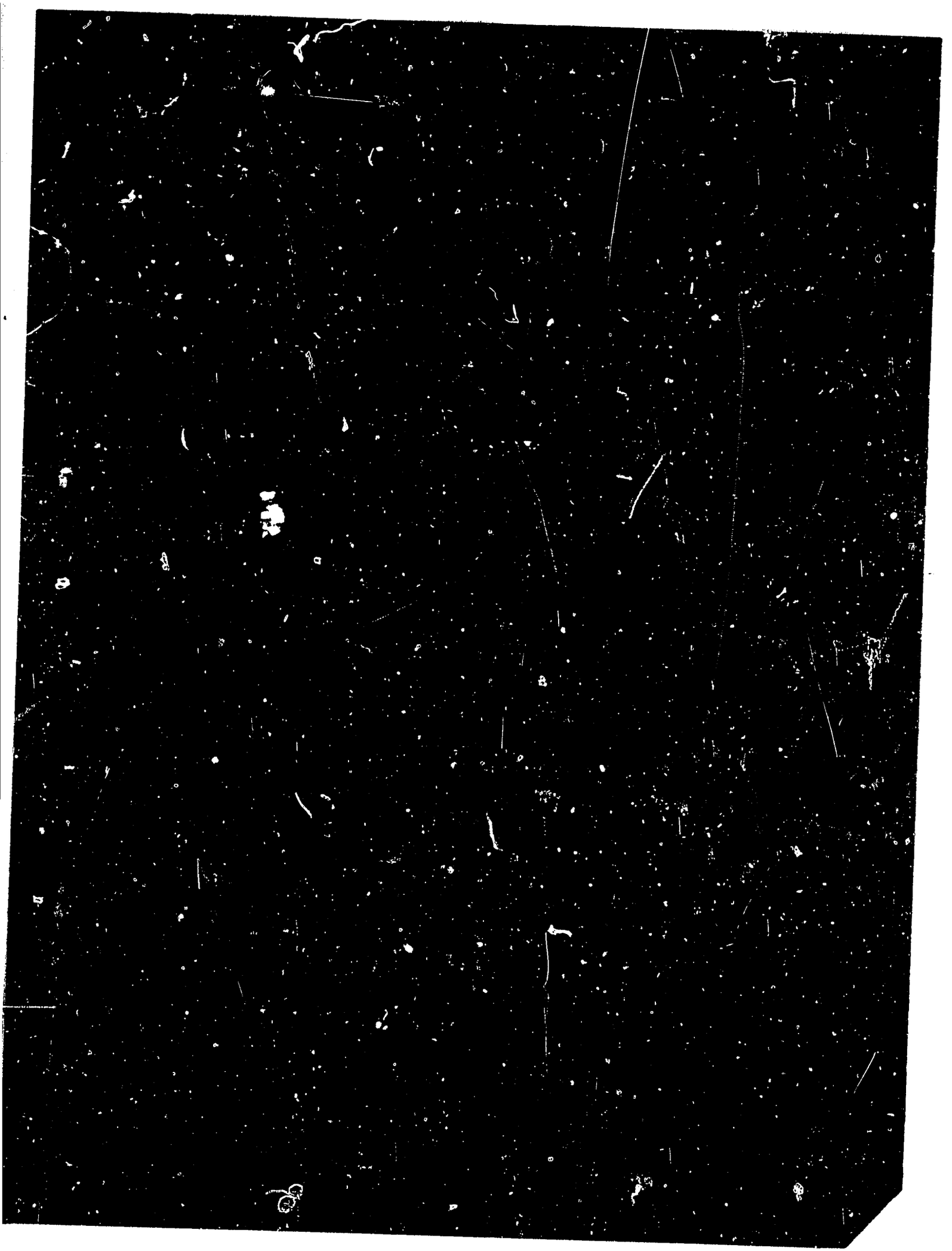

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16. Abstracts

This paper describes experiences in collecting data in West Africa for planning as well as other purposes. Suggestions are made as to how some methodological problems can be handled. Lessons are drawn mainly from a study of rice production in Sierra Leone recently completed by the author.

In the Sierra Leone rice study, a stratified area sampling technique was used to select 240 farmers from which to secure input-output data that could be used in a linear programming study of the rice industry. The author presents recommendations for measuring labor input, capital input, land input and estimating output. General recommendations are made on methods of farm management and production economics research as well as some general principles of field work in Africa.

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# MICRO-LEVEL FARM MANAGEMENT AND PRODUCTION ECONOMICS RESEARCH AMONG TRADITIONAL AFRICAN FARMERS: LESSONS FROM SIERRA LEONE

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# INTRODUCTION

In the field of computer science the adage "garbage in, garbage out" is well known. The implication is that the output from such exercises is only as good as the data input. Data collection must therefore, be as accurate as possible for the results of economic analysis to be meaningful.

In most African countries there is very little accurate data available for economic analysis. Stolper [1966] described planning in Nigeria, where relatively more data are available than in other African countries, as "planning without facts." The situation in some countries has improved somewhat in the past five years, but the scarcity of data for anything but the most rudimentary analysis is still a problem for scholars, and policy makers. The data problem is particularly acute in the agricultural sector which employs over three-fourths of the labor force in most African countries.

In order to generate accurate data for planning and other purposes, surveys of farming systems have been conducted all over Africa in the past decade.[1/] In these studies a whole range of different strategies have been adopted in the data gathering phase. Catt [1966] and MacArthur [1968] have respectively described some of their experiences in Malawi and Kenya. Hall [1970] in his review of farm management work in East Africa highlights some unresolved methodological problems encountered in collecting data from East

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[1/] For a bibliography of such surveys see Cleave [1970].

African farmers. Collinson [1972] in a recently published book has extensively reviewed the methodological problems of collecting and analyzing farm management data specifically for planning purposes. His suggestions are based almost entirely on East African experiences.

In this paper, experiences in collecting data in West Africa for planning as well as other purposes are described. Suggestions are made as to how some methodological problems can be handled, lessons being drawn mainly from a study of rice production in Sierra Leone recently completed by the author.[1/] Before discussing the Sierra Leone Study, it is useful to review the different methods of farm management and production economics research available to investigators.

## METHODS OF FARM MANAGEMENT AND PRODUCTION ECONOMICS RESEARCH

For collecting micro-level data from farmers we can distinguish four methods, 1) the model or case farm study, 2) farm account books, 3) the farm business survey and 4) the cost route method.

These methods, which are briefly described below, have all been popular at different times in the history of Western countries.[2/] They have all been tried in different parts of Africa with varying degrees of success.

### The Model Farm Study

In the model or case farm study the operations of selected "progressive" farmers are studied in detail and presented as "models" which other farmers are encouraged to adopt. This method was popular in the United States around the

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[1/] Results of the study are currently being analyzed.

[2/] See Case and Williams [1957].

turn of the nineteenth century and is largely attributed to Spillman [1902]. Farms are visited for data recording purposes as often as is necessary. Collection of farm management data from demonstration farms or from progressive farmers is still a common practice today. The major disadvantage of using such data in economic analyses is that the farms studied are atypical; their success is often due to many factors, including unusual managerial ability. Such data cannot be used, therefore, for determining "what is", but can be of use in planning "what ought to be". This method was used in East Africa by Clayton [1960, 1961, 1963] and in the early Kenya whole-farm studies [MacArthur 1968].

## Farm Account Books

The use of records kept by farmers themselves as a source of data for farm management analyses is a widespread practice today in Western countries. Where farmers are literate they can be encouraged to keep records of their farming businesses in standardized but simplified account books prepared for that purpose. An advantage of farm account books is that they not only provide accurate farm management data at a relatively low cost but they can also serve as a useful extension tool, since farmers have more confidence in the records they keep themselves than in the averages derived from a sample of farms and presented to them by an extension worker. In Africa farm account books have rarely been used in collecting data from traditional farmers. The illiteracy of the farmers means that they themselves cannot keep records. Literate children have been used to keep rough notes on their parents activities between the visits of enumerators,[1/] but they can hardly be relied on to keep the detailed records needed for farm management and production economics research.

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[1/] See MacArthur [1968].

## Farm Business Surveys

Economic surveys were first tried in the urban areas of England and Continental Europe. Their application to farm problems was first made during the first decade of this century by district agronomists in Russia and by G. F. Warren in the United States of America [Yang 1965]. In a farm business survey the researcher or his enumerators visit the farmers once or twice to complete a questionnaire. Farm business surveys usually cover a large sample of statistically selected farmers. Sampling errors can therefore be minimized. This technique provides a means of showing the range of conditions found on farms in a region or country. In Western countries and among some groups of African farmers who keep farm records[1/] the farm business survey, using mail questionnaires or personal interviews, is a very useful technique and is widely used. But if this method is used in collecting information from the typical African traditional farmer,observational errors can be quite high. The reason is that traditional farmers keep no written records. They also have complicated farming systems on small farms usually less than five acres in size.

Because it is a quick and relatively cheap way of securing simple data from a large sample of farms, the farm business survey has been used in agricultural censuses and surveys in Africa.[2/] Problems of sampling, selecting and training enumerators for such surveys have been covered by Yang [1965], Hursch [1968] and Hunt [1970]. Collinson [1972] has recently argued that such surveys could also be effectively used in farm management studies where the aim is solely to generate data for planning purposes. The aim then is to

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[1/] For example, the large scale settlement farms in the former white highlands of Kenya.

[2/] For example, the Agricultural Surveys of Sierra Leone carried out in 1965/66 and 1970/71 (Government of Sierra Leone 1967 and 1972).

collect information on the "usual" use of inputs by relying on the farmers experiences rather than on his memory of actual past occurrences.

## The Cost Route Method

The cost route method of collecting farm data was originally developed at Minnesota at about the same time that farm business surveys were being introduced in the early 1900's. The method was described as follows:

> "Three young men. . .were employed as route statisticians and three statistical routes established;. . .Fifteen farmers on each route, chosen as farm statistics cooperators, agreed to be interviewed daily throughout the entire year by the route statisticians, giving a record of each hour of labor performed by each man and by each horse, and giving the field crops or other enterprise upon which the labor was used. A map based on accurate measurements of each field was made on each farm that data might be collected and classified as to show the cost per acre for each crop on each farm, also the average for each route and the state." [Hays and Parker, 1906].

This method has been modified over the years, but retains its main distinction from farm business surveys, which is that farmers are interviewed repeatedly for at least one crop season. The advantage of this method is that events are recorded as they occur and heavy reliance is not put on the farmer's memory. The cost route method has been widely used in farm management and production economics studies carried out in Africa. The frequency with which farmers are visited depends on the researchers confidence in the ability of farmers to remember the required details of their past operations, his willingness or ability to handle the paperwork involved and available financing.[1/]

Since only a small number of farmers can be interviewed by each enumerator using the cost route method, the sample size for a given amount

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[1/] For a summary of the visiting frequences used in different African studies see Cleave [1970], Table 1:1.

of money would be less than that in a study using the farm business survey technique. Thus, there is a trade-off between increased visiting frequency which reduces observational error and increased sample size which reduces sampling error. The exact nature of this trade-off is unknown[1/] but will vary from place to place. Hall [1970] has pointed out that a crucial factor in making a decision on visiting frequency and sampling size will be the degree of inter-farm variability compared to the reduction in observational accuracy as visiting frequency diminishes. This relationship will depend mainly on the size distribution of farms and the complexity of farming systems.

The cost route method was recently used by the author in a study of Sierra Leone rice production. In the rest of this paper the problems encountered and some of the solutions worked out in the study are described.

## BACKGROUND TO THE STUDY OF RICE PRODUCTION IN SIERRA LEONE

Rice is the most widely grown crop in Sierra Leone. It alone accounts for about 45 percent of the value of agricultural output and is grown by about 86 percent of all farmers in the country.[2/] There are five systems of rice production in the country, namely Upland, Mangrove Swamp, Riverrain Grasslands, Bolilands and Inland Valley Swamp rice.[3/] Although swampland rice is usually grown in pure stands, upland rice, which accounts for over three-fourths of the total rice acreage in Sierra Leone, is usually grown as a mixed crop interplanted with as many as ten other crops.

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[1/] Findings of the study by J. Njukia on the cost-effectiveness of different survey approaches, using different visiting frequencies, under East African conditions [Hall 1970 p. 20] have not yet been published.

[2/] Government of Sierra Leone [1967, 1971].

[3/] For a general description of production methods in these and other systems of rice production in West Africa see U.S.D.A., U.S.A.I.D. [1968].

With approximately 400,000 tons produced locally and 25,000 to 40,000 tons imported annually, Sierra Leone is about 95 percent self-sufficient in rice. But the value of rice imports as a percent of foreign exchange earnings has ranged as high as 16 percent [USDA/USAID 1968]. The government of Sierra Leone feels that this is an unnecessary use of scarce foreign exchange earnings. This coupled with a belief that Sierra Leone has the best rice lands in West Africa, has led the government to take steps to increase rice production not only to satisfy domestic needs, but also to provide enough for export to other West African countries, and for general movement in world trade if possible.

A project entitled "The Efficient Use of Resources in the Production of Rice in Sierra Leone" was initiated by this author in June 1970 to examine this policy. The aim was to compare the alternative production systems for rice in order to determine through a linear programming model the combinations that maximize the social contribution of the rice industry to gross national product. Since there was hardly any input-output data available on the rice industry, the field work described in this paper was initiated in February 1971, to collect input-output figures which could be used in estimating the budget of resources required by farms to produce rice in the different production systems using a) traditional or current levels of technology and b) the improved technology already developed and available for use by farmers.[1/]

## SELECTING THE SAMPLE OF FARMERS IN THE SIERRA LEONE RICE STUDY

In most of the farm level surveys conducted in Africa efforts have usually been made to select the farmers interviewed by some statistical

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[1/] Field work on the project was completed in July 1972.

method of random choice, but the choice of areas or regions studied have been far from random, many studies focusing on areas growing export crops [Cleave 1970, Appendix A]. The Sierra Leone Rice Study focused on the most important domestic crop and an attempt was made to select areas as well as farmers statistically. A stratified area sampling technique was used.

First, the country was divided into five regions (Figure 1) based on the work of Mitra [1969]. Four of these regions contained Chiefdoms[1/] in which four types of swamp farming were concentrated. Upland farming is practiced widely throughout the country so that no Upland region could be demarcated. Having divided the country into regions, two chiefdoms were selected from each region using a table of random numbers. Each selected chiefdom was then divided into enumeration areas each of which was about 10 miles square and contained an estimated 200 farm families.[2/] The enumeration area with the highest number of adults in agriculture was selected for study.

The selected enumeration areas were then visited by the researcher. In two cases the areas did not contain any of the type of swamp rice farms being sought in that area. As a result, two replacement areas (with the desired rice production systems) were chosen in adjacent locations.

As pointed out earlier each enumeration area contained about 200 farmers located in three to ten villages. It was decided that in order to keep travel by enumerators to a minimum an enumerator would be stationed in each enumeration area. Since it was felt that farmers would not be able to remember the details, particularly of labor inputs that were required in the study for periods longer than one week, it was also decided that selected

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[1/] Local administrative areas.

[2/] This division had already been made by the Central Statistics Office, Freetown, for the population census carried out in 1963. Data were therefore available on the total and farm population of each enumeration area.

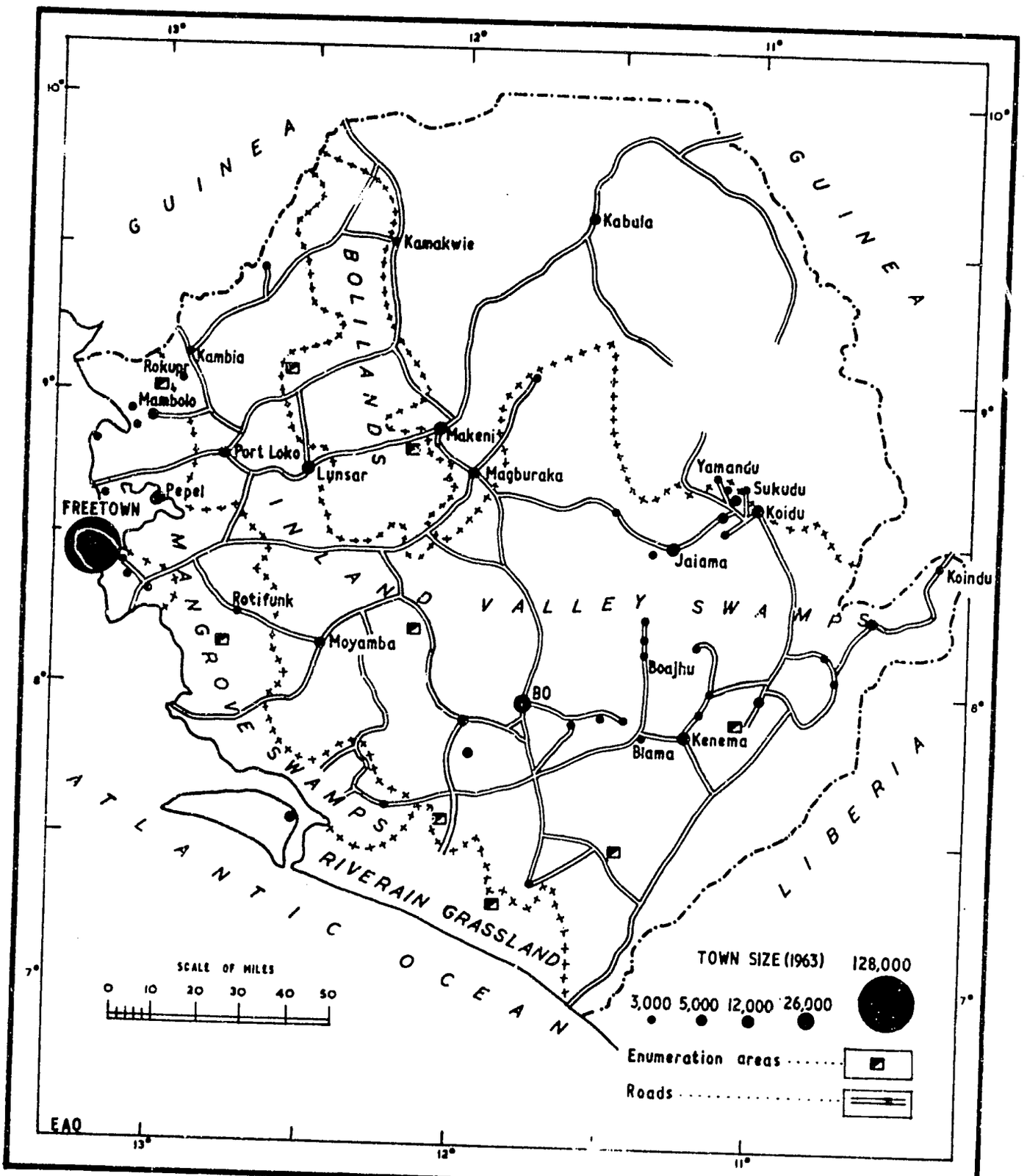


Fig 1. AREAS WHERE DIFFERENT TYPES OF SWAMPLAND ARE CONCENTRATED IN SIERRA LEONE, URBAN AREAS AND LOCATION OF ENUMERATION AREAS.

farmers would be interviewed at weekly intervals. More frequent visits might be necessary,where it is thought necessary to record man-hours of labor input rather than man-days as was done in the Sierra Leone Rice Study, or where more complicated farming systems are being studied in such depth as to include details of family consumption and nonfarm activities.[1/] Although farmers were visited weekly, resource use per day during the preceding week was recorded.

Enumerators conducted their interviews in the evenings after farmers returned home from their farms.[2/] Since farmers usually returned to their homes at dusk, and it was estimated that the basic weekly input-output questionnaire would normally take 15-20 minutes to complete, enumerators could not be expected to complete more than five questionnaires each evening, i.e., each enumerator could be expected to interview about 30 farmers each week. It was therefore decided that 30 farmers would be selected from each enumeration area for weekly interviews.

As a first step in selecting the 30 farmers, enumerators prepared lists of all heads of households[3/] in their enumeration area and heads of households

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[1/] Examples of such detailed studies are the study of Yoruba farmers in Western Nigeria [Hedley 1971] and farmers in the north of Nigeria [Norman 1969, 1970].

[2/] Farmers could have been interviewed on their farms but enumerator travel time would have been greatly increased. Also, farmers would have been interrupted at work possibly adding a nuisance value which might have reduced or even eliminated farmer cooperation over the long period of field work. Enumerators traveled between groups of villages within their enumeration area during the day. They also carried out all the other required operations on their program (cadastral surveys of fields, estimation of distances traveled by farmers between their homes and fields, laying yield plots and weighing the products from the plots, etc.) during the day. In fact, all enumerators employed were overworked at some time of the year although the most efficient were periodically underemployed.

[3/] Each household was defined as all the people eating their meals together.

were asked whether the household intended to cultivate rice during the coming season and the type of rice to be cultivated.[1/] This list formed the sampling frame from which 30 of the farmers who intended to plant rice were selected using a table of random numbers.

The number of farmers interviewed in each enumeration area was determined by the complexity of the questionnaires and the frequency of visit chosen. The national sample size was further determined by the number of enumeration areas selected for study.[2/]

The listing exercise took two to three weeks to complete. It was necessary because there was not staisfactory alternative sampling frame in existence. My experience revealed that chiefdom tax lists are unsuitable sampling frames since they usually contain many inaccuracies.[3/] A pre-enumeration listing exercise is almost unavoidable in Africa if a stratified sample of farmers is to be selected based on such variables as age, size of family, income, type of farm, etc. since this type of information is not recorded on existing tax lists. Even where, as in the Sierra Leone Rice Study a

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[1/] Form ERP-2 (Appendix A) was used for this purpose.

[2/] The number of enumeration areas chosen for study was constrained by the amount of funds available. The 240 statistically selected farmers represented 0.96 percent of the total number of farming households in the country and 1.11 percent of all rice farming households.

[3/] In an attempt to save time and funds, tax lists were used as a sampling frame in a pilot study of farmers credit operations by S.S. Deen of Njala University College. Needless to say, some selected farmers could not be located and some villages did not even appear on the tax lists. Similar experiences were apparently recorded in Uganda [Hall 1970, p. 20], but Welsh [1965] in Nigeria managed to use the list with some success.

list is compiled for sampling purposes, difficulties might arise as selected farmers might not pursue their expressed intentions.[1/]

## MEASURING THE LABOR INPUT

In traditional African agriculture labor is the most important input, accounting usually for over three-fourths of the total cost of production. Its empirical measurement was the center of the controversy over disguised unemployment and underemployment which raged in the economic literature during the sixties. I do not intend to review the literature in this paper, but would like to point out that before the onset of field work a researcher has to decide whether to measure the labor input in man-hours or man-days. Theoretically it is more desirable to have records of hours of work, but to obtain such measures under African conditions involves a large input of enumerator time. Since farmers do not generally have clocks or watches one has to resort to work measurement techniques in measuring hours of labor use, i.e. enumerators need to follow farmers to their fields to record the times spent on different activities. An enumerator cannot, using this technique, cover more than one family a day. Researchers who have carried out work measurement studies have often estimated work hours for small plots on a sub-set of their much larger sample using the derived figures as weights for the total sample.[3/] This leads to an upward bias in per acre rates

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[1/] In the Sierra Leone Rice Study about 95 percent of the farmers fulfilled their aim of planting rice crops. Almost a quarter of the sampled farmers, however, did not follow strictly their intended cropping pattern because they had to cultivate a different type of rice (e.g., swamp rice instead of upland rice) or change the combination they had planned at the on-set of the cropping season.

[2/] For a review and comment on the literature on disguised unemployment see Kao et. al. [1966]. Further insights have been provided by Luning [1967] pp. 59-62 and Byerlee and Eicher [1972] pp. 10-16.

[3/] For the examples of work measurement studies in Africa see Norman [1970] and Okai [1966].

because overhead elements are classed as work (getting to and from the plot, getting ready for work, getting ready to leave) and are the same on large and small plots. When figures derived from small plots are aggregated these overhead elements distort the rate of work figures [Hunt 1970] [Collinson 1972].

The length of the actual working day among traditional farmers depends on what Cleave [1970] described as the "arduousness and urgency" of the task to be performed as well as the opportunity cost of the farmers labor in terms of alternative nonfarm activities including leisure. The exact nature of the trade-offs are unknown. Their determination is of interest mainly in making value judgments as to whether levels of labor inputs are low or high in Africa. For many research purposes, it is sufficient to measure labor use in man-days. The assumption in measuring man-days is that the length of the working day is a given part of the cultural pattern of the society. As alternative opportunities become available,[1/] farmers being "economic men" will reallocate their time to take advantage of them. Another reason for measuring man-days rather than man-hours is that farm labor in Africa--whenever hired--is usually paid by the day and never by the hour. In the Sierra Leone Rice Study work days were recorded, i.e. the number of adult men, women and children who worked on the farm on a particular day were recorded.

Another problem in measuring the labor input is the problem of deciding what weights to use in aggregating man, woman and child days. Work rates may be affected by the age and sex of the worker as well as by the task being performed. Some researchers have used complicated weighting procedures

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[1/] These alternative opportunities must be in a form that the farmers can pursue. As Luning [1967] points out, employers usually demand a continuous supply of labor for a certain number of days per week or per month so that farm labor unutilized for a few days a month at the off season may not be employable.

for aggregating the different categories of labor.[1] It is doubtful whether such elaborate weighting procedures are necessary for the following reasons:

(1) Dividing the sample into different age classes may involve substantial errors since the ages often have to be estimated because farmers cannot tell their ages in years. In Sierra Leone enumerators estimated the ages of sampled farmers by using a list of reference dates provided for them. This list contained historic, local as well as national dates. Other occurrences, such as the year a person entered a secret society, were used in estimating the ages of people.

(2) In many parts of Africa women and children rarely participate in jobs in which they are less efficient than adult males. Where they are commonly employed (weeding, birdscaring and harvesting) women and children

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[1] Njoku [1971] used the following weights in Sierra Leone

Workday Conversion Scale

| Upland Farms | Brushing & Felling | Burning & Clearing | Ploughing | Harrowing | Weeding |
|---|---|---|---|---|---|
| Very Old Man | 1/3 | 1/3 | 1/3 | 1/3 | - |
| Very Old Woman | - | - | - | 1/3 | 1/3 |
| Old Man | 1 | 1 | 1/2 | 3/4 | - |
| Old Woman | - | - | - | 1 | 1 |
| Young Man | 1 | 1 | 1 | 1 | - |
| Young Woman | - | - | - | 1 | 1 |
| Child (Male) | 1/3 | 1/3 | 1/3 | 1/3 | - |
| Child (Female) | - | - | - | 1/3 | 1/3 |

Partially Mechanized Farms

| | Clearing | Weeding |
|---|---|---|
| Very Old Man | 1/3 | 1/3 |
| Very Old Woman | 1/3 | 1/3 |
| Old Man | 1 | 3/4 |
| Old Woman | 3/4 | 1 |
| Young Man | 1 | 1 |
| Young Woman | 3/4 | 1 |
| Children | 1/3 | 1/3 |

Source: Njoku 1971, p. 180.

are as efficient as men. For these reasons woman and child-days (less than 15 years of age) were converted to man-day equivalent in the Sierra Leone Rice Study by using weights of 1.0 and 0.5, respectively.

## MEASURING THE CAPITAL INPUT

Inputs of capital in traditional African farming systems are usually very low. They can be handled in the traditional way by applying appropriate depreciation rates determined during field work [Collinson 1972].

## MEASURING THE LAND INPUT

Cadastral surveys of agricultural land are a rarity in Africa.[1/] Traditional farmers have only a vague concept of the size of a hectare or an acre. Also there are usually few standard local measures of area which can be converted to acres or hectares.[2/] Researchers, therefore, have two options open to them. Where fields are permanently or semi-permanently cropped, or where plot boundaries stay the same, crop acreages can be calculated from aerial photographs (where they exist or can be specially commissioned). Norman [1969, 1970] used this method in Northern Nigeria.

Where shifting cultivation is practiced and a new plot of bush is cleared for cultivation each year it is not possible to use the above method unless the aerial photographs are specially commissioned, a facility not available in many African countries. As a result, fields need to be measured

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1/ They are available in some African countries which have had land reform programs, e.g., Egypt and Kenya.

2/ In Sierra Leone, officers of the Ministry of Agriculture and Natural Resources and many researchers have long used the quantity of rice seed planted as a proxy for acreage, one bushel (60 lbs) of seed being assumed to be planted per acre. Preliminary analysis from the current rice research project has shown that seed rates vary depending on the system of production. It might be possible to draw up new constants for use in estimating acreage based on seed rates. The advantage of using such constants is that farmers have a good idea of the quantity of seed planted so that crop acreages can be quickly estimated for output forecasts by asking a sample of farmers the quantity of seed they planted.

using tapes and field compasses.[1/] In Sierra Leone each enumerator with the help of one hired laborer measured all the rice fields of the 30 selected farmers in each enumeration area. Measurements were checked for errors using a Plancette before the fields were plotted and acreages calculated.[2/]

Differences in soil fertility might complicate the definition of the land input. The relative share of labor in the input-output mix might be different on fertile and poor soils. Since detailed soil survey maps are usually not available in Africa, broad categories of land resource have been used.[3/]

## ESTIMATING OUTPUT

Where no records are kept by farmers there are two general methods of estimating crop yields.

(a) The yield plot (crop-cutting) method: A plot is marked out in the field of the farmer sometime between the planting and harvesting of the crop. It is advisable to mark out yield plots soon after the crop is planted as this minimizes crop damage. Plots are pegged out[4/] and the farmer asked to cultivate the plots in the same way as the rest of the field, but not to harvest any of

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[1/] Descriptions of various techniques of field measurement have been provided by Hunt [1970] and Collinson [1972].

[2/] About a third of the fields had to be resurveyed because the "closing gaps" were excessive.

[3/] In the Sierra Leone Rice Study the land resource was divided into five categories (Upland, Inland Swamp, Boliland, Riverrain Grassland and Mangrove Swamp) which varied in fertility and water regimes.

[4/] Yield plots should be laid out using some random method. In Sierra Leone yield plots were laid at the time fields were measured. Two random numbers each less than half the perimeter of the field were selected. The first number determined the point on the periemeter of the field, measured from a selected starting point, that the enumerator was to enter the field. The second number determined the number of feet the enumerator was to go into the field at right angels to the side of the field to lay the yield plot. Yield plots were 22 feet square on Upland rice fields and 11 feet square on swamp rice fields. Enumerators were provided with a standard measuring wire for laying yield plots. These wires were 44 feet long with loops at 11 feet intervals for measuring the sides of the square plots. The wire also had a knot tied at 15 feet 6 1/2 inches from one side and another at 31 feet 1 inch from the same side. These two points marked the length of the diagonals of the two yield plots.

the crop in the plot. At about the major harvest time of a crop the yield plot is also harvested.[1/] By this method the total yield of the crop is estimated directly. A disadvantage of this method is that it takes time to lay out the yield plots and harvest them. The input of time is further increased where yields of individual crops fluctuate widely from one part of the field to another and it becomes necessary to lay more than one plot per field.[2/] Also, yield estimates obtained by this method usually have an upward bias because biological yield (the weight of the whole crop from the sample plot) may be quite different from the useful yield (that which the farmer has available for disposal) [Zarkovich, 1966] [Hunt 1970]. Care must be exercised in ensuring that the gap is as small as possible. This can be done by ensuring that the method used in harvesting and processing the crop from sample plots are the same as that used by farmers. The major advantage of the method is that the output is estimated directly. The different uses to which the farmer puts the output including storage and other losses can then be estimated separately. If the crop harvested from the plot is returned to the farmers after it has been weighed there should be no difficulty in getting farmers to cooperate. Crop density counts could also be made in the yield plots to determine the proportion of the land area devoted to different cropsin a mixed crop.

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[1/] Before the major crop harvest part of the crop in a field might be harvested for home consumption or other use, but the yield plot is not harvested. The yield plot can be harvested by the enumerator or by the farmer. The ideal situation is for the farmer to harvest the plot since the harvesting method is then likely to be the same as that employed in harvesting the rest of the field. Harvest losses can then be assumed to be similar. The difficulty with getting farmers to harvest yield plots is that if enumerators are not present when harvesting is done (a difficulty thing to always ensure) farmers might ignore the boundaries of yield plots. In the Sierra Leone Rice Study enumerators were present when most plots were harvested by farmers. This was because of the great rapport established between enumerators and farmers. During the major harvest period (up to two weeks in duration) enumerators met the harvesting team in the field and persuaded farmers to harvest the plot while they were present (a job which usually only took a few minutes).

[2/] Where regional averages of crop yields are desired it may not be necessary to lay mroe than one plot per field even where yields fluctuate widely within fields provided the sample size (total number of fields sampled) is large enough. Where it is thought necessary to explain variations in yields from farm to farm, e.g. in production function analyses, more than one plot may be required per field. In the Sierra Leone Rice Study five plots were land on a third of all the farmer's fields, the rest had one plot per field. Analysis of the data to determine the cost effectiveness of one versus multiple plots per field in Sierra Leone conditions is in progress.

(b) Indirect year-end estimates of total output: There are several possible variations of this method. Farmers can be interviewed at the end of the crop year and asked to estimate the quantity of each crop harvested during the year.[1/] Questions on family consumption and sale of the crop can be included provided units are recorded in local measures. These local measures can then be converted to standard units by applying conversion rates determined by the researcher.[2/]

In another version of this method the quantities of the harvested crop allocated to different uses are recorded as they occur. Quantities consumed at home, quantities sold, gifts, etc. are carefully recorded. This "consumption study" approach was used by Zuckerman in his study of Yoruba smallholder cropping systems[3/] and requires a very high visiting frequency.[4/]

Most studies in West Africa have employed more than one method of crop yield estimation. As is to be expected, there are usually discrepancies in the results but if properly applied it should be possible to adequately explain most of these discrepancies.[5/]

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1/ For an example of this method in West Africa see Norman [1970]. Form ERP-8 (Appendix) shows the form used in estimating total production by this method in the Sierra Leone Rice Study.

2/ In Sierra Leone five bundles of the harvested crop were weighed at monthly intervals. Norman [1970] weighed five units of the crop (bundles, baskets, etc.) to determine conversion rates.

3/ Personal communication with Douglas Hedley, International Institute of Tropical Agriculture, Ibadan, Nigeria.

4/ Farmers were visited every other day in the Zuckerman study. Six full time and nine part time enumerators were employed to interview 100 farmers [Hedley 1971].

5/ Results from the Sierra Leone Rice Study are currently being analyzed and will be presented at a later date.

## SOME GENERAL PRINCIPLES OF FIELD WORK IN AFRICA

In applying the cost route method in African conditions certain principles, which are described below, need to be followed.

(1) Farmer Cooperation: It is important to ensure that the purpose and scope of every survey is well understood by government officials, local tribal leaders and the farmers themselves. Potentially good field studies can be ruined by the lack of cooperation on the part of farmers resulting from the misunderstanding of a researcher's intentions. In Sierra Leone we found it useful to emphasize the following a) the information collected would not be available to government for tax assessment purposes; b) the enumeration area and farmers had been selected by chance; c) the information collected would be used to write books describing the farming methods of Sierra Leone rice farmers which would be used as text books in place of foreign books and d) farming problems would be identified and written up for policy makers to study.

It is also necessary to include the village head in all samples being studied. This ensures that the local leaders are involved in the project.[1/] The question of rewards should be carefully examined by the researcher.[2/] Not only is the accuracy of the data gathered affected by farmers cooperation but the possibility of collecting any data at all depends on it.

(2) The Enumerators: Enumerators play a very important part in ensuring

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1/ Records obtained from such leaders can be omitted when the data are analyzed if they were not in the original randomly selected sample.

2/ It has not been found necessary to offer farmers any material reward for their cooperation in Sierra Leone. Norman [1970] offered farmers in Northern Nigeria half a bag of fertilizer for each month of cooperation in his earlier studies, but got equal cooperation in later studies among a different group of farmers without any offer of reward.

farmer cooperation so they must be selected, trained and supervised with care. Enumerators are the intermediaries between the farmers who have the information sought and the researchers who need the information. This vital link must operate effectively at all times.[1/] The following points need to be stressed.

(a) Enumerators must be fully conversant with the purpose and scope of the study. They cannot explain the project to farmers if they do not themselves fully understand it. They must also be fully conversant with the questionnaires and survey procedures. Since supervisors cannot always be available to enumerators stationed in remote areas, they must be provided with a reference manual in which the survey methods and instruments are explained in detail.[2/] In Sierra Leone enumerators attended a two week training session before being sent to the field.

(b) An enumerator must speak the language of the farmer he is interviewing although it is not advisable that he be a "son of the soil" in the sense that he is from the same area.[3/] So long as they speak the local

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[1/] Skepticism about the possibility of making this link work effectively is one of the reasons that led Polly Hill [1966] to advocate anthropological type studies where the researcher himself collects all the information needed directly from farmers.

[2/] The enumerators reference manual used in the Sierra Leone Rice Study was written in English and contained four main sections. The first section contained a glossary of terms used in the manual. In the second section, enumerators were provided with information on the nature and scope of the survey as well as a description of their responsibilities as enumerators. This section also contained instructions on how to conduct interviews, when to meet farmers, etc. The third major section, contained a description of the survey instruments, with detailed instructions on how each question on each questionnaire was to be completed, and how fields were to be measured and yield plots layed and harvested. The fourth section contained general administrative instructions and was followed by a series of appendices which included the local names of different crops and tables of random numbers for field plot location.

[3/] Getting rid of inefficient enumerators can be a problem if they are local sons. The situation is compounded if, as was the case in one of our enumeration areas in the Sierra Leone study, the enumerator hails from the ruling family (and they are likely to be the educated sons!). Firing such an enumerator may mean abandoning a whole area or village in which data collection may have proceeded for a number of months.

Language enumerators seem to have little difficulty being accepted by the host community. The desirable educational level of enumerators depends on the complexity of the tasks they are required to perform. MacArthur [1968] reports that seven to eight years of schooling was all that was needed in East Africa. In Sierra Leone enumerators were employed with nine to twelve years of schooling, i.e. with two to five years of secondary school education. It was found necessary to supervise the enumerators with the lower educational level more than those with the higher level. Since salaries are likely to be uniform our experience would seem to indicate that it is advisable for enumerators to have had at least four years of secondary education for the type of survey conducted in Sierra Leone.

(c) Enumerators must be enccuraged to stay on the job. For the type of study in which farmers are visited regularly it is an advantage to keep an enumerator in the same area for the duration of the project. At the same time efforts have to be made to ensure that enumerators do not become so familiar with the farmers that they falsify information.[1/] To ensure that enumerators stay on the job they must be employed full time[2/] with an attractive salary. They should also be provided with transportation if they are expected to cover a wide area.[3/]

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[1/] This is where supervision is essential. Enumerators must be visited regularly, but not at fixed intervals. During such visits the data recorded should be carefully examined and a small sample cross-checked with farmers for accuracy. See Zarkovich [1966] for different sources of errors in collecting sample statistics and how they can be minimized.

[2/] MacArthur [1968] has also stressed the need to employ enumerators full-time so that they have no other responsibilities which may cause them to neglect their duties. The dangers of using enumerators with other duties are exemplified by the Nigerian study where a sample of 217 farmers was selected for regular interviews by Ministry of Agriculture field staff but only 32 records were usable [Osifo and Anthonio, 1970, pp. 306-307].

[3/] Enumerators were paid Le 30.00 ($36.00) per month in Sierra Leone. They were required to purchase a bicycle or canoe depending on their location. An interest free loan was provided for that purpose. Enumerators only received Le 20.00 per month during the project, the rest of their salary being withheld as a surety for the successful completion of their assignments. No enumerator left the project on his own during the 14 months of field work.

(3) Collecting "Sensitive" Information: Information on sales, credit and indebtedness of traditional farmers is difficult to collect even under the best of situations. There must be strong rapport between enumerators and respondents for there to be any chance for accurate information to be collected. Such information is best collected towards the end of field work. Questionnaires on credit and indebtedness of farmers should be short and simple. There is a higher chance of obtaining the desired information with a series of short questionnaires rather than with one detailed questionnaire.1/ It is also better to interview farmers in private. They will not provide accurate answers, if they provide any at all, in the presence of even their own immediate family members.

## COST OF DATA COLLECTION

The major cost components in the data gathering stage of any project using the cost route method are the cost of hiring enumerators and the cost of supervising them. Other cost components such as the cost of printing questionnaires and purchasing equipment are minor.

The cost of hiring enumerators depends on the sample size and visiting frequency, which determine the number of enumerators needed and the duration of their employment. Supervision costs are mainly transportation costs. They depend to a certain extent on the quality of enumerators employed, but

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1/ An attempt to collect credit information using a long detailed questionnaire two months after field work started in Sierra Leone ended in failure. Only 20 percent of the interviews were completed. The information was later collected using three much simplier and shorter questionnaires administered during the last two months of field work.

mainly depend on the location of the areas in which field work is going on relative to the central base of the researcher and his supervisors.[1/]

## CONCLUSIONS

The details of any method used in collecting micro-level farm management and production economics data in any research project will depend on the objectives of the project and the type of analyses planned.

In the Sierra Leone study described above, the immediate objective was to generate input-output data that could be used in a linear programming study of the rice industry. Since there was no existing detailed production study of the industry the author decided to collect information which could be used to describe the industry and for production function and other analyses, in addition to the linear programming analysis planned. The cost route method was chosen since it allowed the detailed collection of input and output data (especially of labor input) so that the range of conditions found between farms as well as between regions and systems of production could be adequately described.

Collinson [1972] has argued that when the aim is to collect data solely for planning purposes a limited visit technique (the farm business survey method) is suitable for collecting even labor input data. It is this authors view that the amount of pre-survey enumeration necessary to

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[1/] Field work in the Sierra Leone rice study cost about $10,800. About 53 percent of this was the wages of enumerators and laborers hired to help them with field measurements, 41 percent was the travel cost of supervision, the remaining six percent being the cost of printing questionnaires, purchasing equipment, etc. Records were collected from 260 farmers at a cost, therefore, of about $41.40 per farm record. An additional $1,000.00 would probably be used for analyses of the records. These costs are higher than those recorded by MacArthur [1968] in Kenya (about $22.00 for a full set of business records), but less than those of Zuckerman in Nigeria where costs for data collection and analysis were about $150.00 per farm record (personal communication with Douglas Hedley of I.I.T.A., Ibadan).

make Collinson's technique operational is such that in areas being surveyed for the first time the input of time and money is likely to be no less than would be the case if the cost route method was used. Collinson's technique could be used to collect simple data quickly for planning and forecasting purposes in areas where the researcher already has available a good body of basic economic data. It is true that large variances may be obtained for averages derived using the cost route method because of variations in farmers methods and performance in any particular area or season. The fact that these variances might be reduced by drawing on the accumulated experiences of farmers rather than on their recollection of what actually happened in a particular period is not, in my opinion, necessarily an advantage of the farm business survey since it "hides" variations from the researcher and may lead to inaccurate generalizations on his part. This is expecially true in areas for which there is very little available economic data, a situation still common in much of West Africa. Collinson himself described two other factors which prevent the effective use of limited-visit techniques.

> "Where workers switch from task to task, there is less basis for a general framework of experience which the method can exploit. Where continuous cropping is practiced, the timing of limited visit surveys may fail to cover the period when some crops are in the ground." [Collinson, 1972, p. 243]

It is therefore this authors view that where detailed production economics and farm management data are required in Africa the cost route method provides the best way of obtaining such information. But the cost route method is expensive. To keep costs to a minimum methodological mistakes should be kept to the barest minimum. It is hoped that the suggestions made in this paper will help future workers minimize their mistakes by avoiding some of the common pitfalls which have been experienced by many researchers in Africa.

## APPENDIX A

### Questionnaires Used in the Study of Rice Production Systems in Sierra Leone*

1. Form ERP-2: Listing of Heads of Households

Enumerators listed all the heads of households in all villages in their assigned area, indicating whether the household intended to cultivate rice in the on-coming season and the quantity of seed planted in the previous season. This list formed the sampling frame from which 30 households were selected at random for study of their rice farming activities.

2. Form ERP-3: Stock Questionnaire

The stock of labor (household members), equipment, produce, livestock and economic trees were recorded in this form for each of the 30 selected farmers.

3. Form ERP-4: Weekly Input-Output Record

Enumerators visited each of the 30 selected households once a week with this form to record information on labor use on the rice farm, expenditure, income, loans given and loans received.

4. Form ERP-5: Field Questionnaire

This form was used to record information about every rice field cultivated by the household. Each field was first of all measured for acreage estimation then information on the type of land, location of the field, land tenure arrangements, fertilizer and machinery use, etc. were recorded.

5. Form ERP-6: Yield and Density Recording Form

With this form enumerators recorded information about the crops growing on a field (seed planted, amount to be sold or consumed at home, etc.)

*Single copies of the questionnaires, Forms ERP2-9, may be obtained from the African Rural Employment Study, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48823.

and for a statistically laid yield plot they recorded the number of stand or tillers of rice and the quantity harvested.

6. Form ERP-8:

With this form enumerators recorded the distances between farmers fields and their homes and the weights of harvested sheaves of rice.

7. Form ERP-9: Supplementary Questionnaire:

This questionnaire was used to collect a host of other economic and social information. Questions were asked on the nature of the crop season, use of the harvested crop, cultural practices, desires of farmers, their awareness of and contact with change agents and their main farming problems.

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