AFRICAN RURAL EMPLOYMENT STUDY

African Rural Employment Paper No. 8

METHODOLOGY AND PROBLEMS OF FARM MANAGEMENT INVESTIGATIONS: Experiences From Northern Nigeria

by

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THE AFRICAN RURAL EMPLOYMENT STUDY

The African Rural Employment Study was initiated in 1971 by a network of scholars in order to further comparative analysis of the development process in selected African countries with emphasis on rural employment problems. The research program is jointly designed by scholars in African countries, Michigan State University, other universities in North America and Europe who desire to pursue research on employment problems in selected African nations. Research emphasis is being directed to Sierra Leone, Nigeria and Ethiopia. In addition, individual scholars in other countries, such as Ghana, Zaire, Tanzania and Kenya are carrying out research on rural employment problems and are members of the network.

The research program emphasizes joint and individual studies of rural employment such as the demand for labor in alternative production systems and in the rural nonfarm sector, the migration process as a link between rural and urban labor markets and the impact of macro policies on labor absorption in agriculture. Attention will be directed to developing policy models to trace the consequences of alternative strategies of agricultural development on farm output, employment, income distribution and migration and to incorporating the employment objective into project, sub-sector and sectoral analysis in developing countries.

The study maintains close links with similar networks of scholars in Latin America (ECIEL) and Asia (CAMS) and with organizations such as the FAO, ILO, and the World Bank, who are engaged in research on employment problems.

African Rural Employment Papers are distributed without charge to libraries, government officers and scholars.

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METHODOLOGY AND PROBLEMS OF FARM MANAGEMENT INVESTIGATIONS: EXPERIENCES FROM NORTHERN NIGERIA*

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PREFACE

The African Rural Employment Study is emphasizing the collection of micro-level data in rural areas as a foundation for policy analysis of rural employment and rural development at the local, regional and national levels. As there is little published material on the organization and implementation of primary data collection in rural areas of Tropical Africa, we have requested experienced researchers--Dr. David Norman and Dr. Dunstan Spencer--to share their findings.

Dr. Dunstan Spencer, author of African Rural Employment Paper No. 3, "Micro-Level Farm Management and Production Economics Research Among Traditional African Farmers: Lessons From Sierra Leone", reports on the methodology used and problems encountered in organizing and carrying out micro-level studies on rice production in Sierra Leone.

In this paper David Norman describes the experiences of the Rural Economy Research Unit in carrying out village studies in Nigeria since 1965. Together the papers are valuable aids to network researchers working on various components of the African Rural Employment Study and to scholars undertaking micro-level research in Africa.

Some of the results of Norman's research have been published in African Rural Employment Paper No. 4, "Economic Analysis of Agricultural Production and Labour Utilisation Among the Hausa in the North of Nigeria."

Carl K. Eicher

INTRODUCTION

Until recently, the majority of village studies undertaken in the northern part of Nigeria have been carried out by social anthropologists such as Hill [1968], Smith [1955] and others. Using an anthropological, micro-orientated approach, these studies provide a detailed, descriptive and often nonquantitative account of the communities under study. However, they do not provide the basic quantitative data required by economic planners at the district, state and national levels.[1/]

Over the past decade demand for micro-orientated village studies (often with a farm management emphasis [Collinson, 1972; Eicher, 1970; Lipton and Moore, 1972; U.S. Academy of Science, 1969]) to provide basic quantitative data on the rural areas has increased. These studies provide basic information for planners and policy makers. The results of micro economic studies can be of value in providing a more rational basis for technical research workers in determining their research priorities.[2/] In addition, they give extension workers factual information on the profitability and acceptability of innovations.

Farm management studies are particularly relevant in the northern part of Nigeria where agricultural planning in the 1950's and 1960's was

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[1/] Stolper [1966] has discussed the problems and inherent dangers of "planning without facts" in detail.

[2/] For example, herbicide selection and development of equipment to overcome the labour bottleneck period in June and July, experiments on increasing yields from late-sown cotton (which is a practice adopted by security conscious farmers who earlier in the season concentrated on planting and weeding food crops) and experiments on mixed cropping.

not supported by empirical information for assessing the consequences of alternative strategies and policies. The advantages of farm management studies together with the realization that socio-economic factors play an important role in adopting or rejecting new technology led to the establishment of the Rural Economy Research Unit (RERU) at Ahmadu Bello University in 1964.[3/] The RERU research programme, which commenced in 1965, has until now concentrated exclusively on micro-oriented studies.[4/] Since economic and noneconomic variables are closely linked in African countries [Lipton, 1968], a multi-disciplinary approach has been used in RERU's research programme.[5/]

To develop a coherent research programme, a four stage work plan has been adopted by RERU. The four stages are:

(1) Positive stage, i.e., determining what farmers are now doing.

(2) Hypothesis testing stage, i.e., determining why farmers do thing the way they do.

(3) Normative stage, i.e., determining what farmers ought to do.

(4) Policy stage, i.e., determining how the changes suggested under Stage (3) should be brought about. This stage may also involve a consideration of Stage (2) to determine whether the recommended

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[3/] RERU was established with the aid of a grant from the Ford Foundation. The "pump priming" aspect of the original grant has been successful in that much of the work formerly being undertaken by RERU is now being financed by the Institute for Agricultural Research (IAR) and being carried out by departments, especially Agricultural Economics. The organisational structure of IAR is analogous to a land grant university in the United States.

[4/] Reasons for this included: 1) the paucity of data at the micro level in the northern states; 2) expertise in the macro area available at other Nigerian institutions, e.g., NISER and the Universities of Ibadan and Ife; and 3) the work of technical scientists and extension specialists at IAR is best complemented by socio-economic studies of a micro nature.

[5/] Three disciplines are represented in RERU--geography, rural sociology, and agricultural economics. In the Agricultural Economics Department, there are two--agricultural economics and rural sociology.

policies conflict with the farmers' reasons for doing things in the traditional way.

Much of RERU's research programme to date has emphasized the positive and hypothesis testing stages. With most of the basic groundwork completed, research is increasingly being directed to the normative and policy stages. For example, RERU is now evaluating programmes that have been used to bring about change, e.g., credit cooperatives, farm institutes, etc., and is examining IAR farm level recommendations to determine their technical feasibility, economic profitability and social acceptability.

The Rural Economy Research Unit (RERU) has, for numerous reasons, used the "frequent interviewing approach"[6/] in its farm management studies. Some of these reasons are:

(1) Farmers in the northern part of Nigeria are usually illiterate. Consequently, no records on farming transactions are kept and, therefore, memory recall is critical in collecting data. The more frequent the interview, the lower will be the reliance placed on memory recall (see section below on Data Accuracy).

(2) Other researchers in the northern states have used the "limited interview technique" [Kohlhatkar, 1965; Luning, 1963; Mann, 1967]. If results from the RERU studies correspond with those of other studies, then it implies under ceteris paribus conditions that

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[6/] Spencer [1972] discusses the main approaches used in collecting farm management data in high and low income countries. The types generally used in developing countries range from single visit interviews to frequent interviews. There is considerable controversey as to the advantages and disadvantages of the two approaches [Catt, 1966; Collinson, 1972; Hall, 1970; MacArthur, 1968]. The approach used by the researcher will depend on the financial resources at his disposal and the relative importance he attaches to sampling errors versus measurement or observation errors. Sampling errors can be reduced by using large samples, while most measurement errors are reduced by more frequent visits. Consequently, for a given quantity of resources, lower measurement errors would require high visiting frequency and, therefore, relatively small sample sizes. Under ceteris paribus conditions, this approach would result in relatively high sampling errors.

measurement errors in the latter were within reasonable limits. This situation enhances the value of data already available from studies using the limited interview technique.

(3) Since RERU wanted to obtain in depth information on the social and economic factors affecting each farming unit, frequent interviews were necessary to obtain the farmers' confidence and reduce measurement errors.

OBJECTIVES OF RURAL FARM MANAGEMENT STUDIES

The objectives defined in the RERU studies were fairly broad.[7/] As a result, the data collected were relatively comprehensive. The objectives were:

(1) to determine the quantity of and the utilisation of the factors of production available to farmers.

(2) to determine the products produced by farmers and to estimate their incomes;

(3) to investigate factor-factor, factor-product, and product-product relationships; and

(4) to develop a suitable methodology for undertaking farm management surveys in the northern states.

[7/] Lipton and Moore [1972] noted the lack of clarity in the objectives of many village studies. However, in undertaking farm management studies in areas where relatively little is known about indigenous farming, it is difficult to define which facets should receive attention. To help define objectives more clearly, Lipton and Moore [1972] recommended a brief exploratory survey. Unfortunately, farm management studies, especially those using the frequent interviewing approach, are influenced by the agricultural cycle. In practice, the pressure to get research underway often prohibits exploratory surveys.

METHODOLOGY USED TO SELECT AREAS, VILLAGES AND FARMERS

Area Selection

Due to limited resources, mainly supervisory, the main farm management studies were spread over a five-year period. In consultation with the Regional and State Ministries of Natural Resources, work has been undertaken in five different areas in the Savannah ecological zone (Table 1). An effort was made in the three areas located in Hausaland to ensure that they differed in population density, and if possible, in the amount of rainfall. It was expected that these variables had a marked influence on farming patterns and perhaps on the degree of emphasis on off-farm employment.

Table 1. Farm Management Studies Undertaken by the Rural Economy Research Unit, 1966-1972.

Ethnic Group	State in Nigeria	Nearest Urban Center	Annual Rain-fall (Inches)	Population Density (Relative)	Years of Study	Number of Villages Sampled	Total Number of Farmers in Master Sample
Hausa	N. Central	Zaria	44	Medium	1966/67 1969/73	3 4	124 9
Hausa	N. West	Sokoto	30	High	1967/68	3	100
Hausa	N. East	Bauchi	43	Low	1967/68	3	118
Yoruba	Kwara	Omu-Aran	49	Medium	1969/70	2	54
Igbirra	Kwara	Okene	53	Medium	1969/72	2	39

Village Selection

To permit an intensive study, only two or three villages were selected in each of the five areas. Villages were selected to represent varying

degrees of distance from an urban area.[8/] As far as possible, villages were selected that would be representative of other villages in the same general location.

To aid in the successful completion of the study several sub-criteria of a practical nature were taken into account in the final selection of the villages:

(1) Some assurance was necessary that the villages would be cooperative throughout the study. Only villages whose leaders (i.e., village heads) were sympathetic with the objectives of the research were selected.

(2) Villages devoid of steep slopes were selected so aerial photography could be used without having to correct field measurements for distortion due to field slopes.

(3) Because of the limited time available for constructing farm maps, villages or sections of villages that did not include more than 1,000 inhabitants for each area were chosen.

(4) To ensure adequate supervision of the enumerators even the most isolated village had to be accessible, at least by bicycle, during the rainy season.

Identification of All Families and Farms in the Villages (Phase A)

The studies were undertaken in two phases. Phase A involved the collection of information from all the families in the village, while Phase B was concerned with collecting data from a sample of families. Families included in Phase B constituted the master sample. The main

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[8/] This was done in cognizance of Schultz's locational matrix hypothesis [1953], which suggests that farmers' incomes will tend to be higher nearer urban areas than those located further away owing to greater efficiency of the factor and product markets. The adoption of this criterion usually meant that villages were located in areas of different population density since population density is often higher close to urban areas. This has a marked impact on the farming system adopted, and theoretically on the availability of nonfarm employment.

objective of Phase A was to obtain a frame of farming families from which the master sample could be drawn.[9/]

Two and usually three steps were involved in deriving a frame of farming families for the selection of the master sample to be used in Phase B of the study.[10/]

(1) A compound was defined as a single physical housing unit. In Moslem Hausa areas, for example, this usually consists of a number of huts surrounded by a wall and an entrance hut. Numbers were painted on every compound in the village for identification purposes and to avoid possible confusion over people with similar names.[11/]

(2) A demographic survey was undertaken at the beginning and at the end of the study. The objectives of the survey were to delineate families and record changes in family composition during the survey. A family or household was defined as "those people eating from one pot." This definition was chosen as it was the closest approximation that could be found for a work and consumption unit

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[9/] Other researchers have used the following frames with varying degrees of success: farmers on tax lists, members of cooperative societies and sellers of particular crops to marketing boards or under contract to processing plants, etc. The tax list, which was the only type available for villages in the northern part of Nigeria, was not considered sufficiently reliable for the purpose of the RERU studies.

[10/] In three of the study areas rural sociologists and geographers helped collect these data.

[11/] It was surprising that no villagers objected to this. In fact, it became a type of status symbol and complaints arose when a compound was mistakenly left unnumbered. Enumerators soon learned to identify individuals with particular compound numbers.

(i.e., a group who usually work and eat together).[12] A compound often had more than one family or household and consequently was identified as 23(1), 23(2), etc. (i.e., households 1 and 2 in compound 23). A frame of families from which the master sample could be drawn arose out of this demographic survey.

(3) All the fields farmed by individuals listed in the frame were identified in the four areas using aerial photographs. A field was defined as a contiguous piece of land farmed by one family. Fields farmed by the family and those over which household members held jurisdiction (i.e., usufructuary rights) during the survey year constituted a farm or holding. (This definition of farm did not include those fields, which during the survey year were loaned, pledged or leased by the family to other households or families.)

Aerial photographs were taken of most villages in the middle of the dry season (February or March) when the vegetation cover is at its lowest density. An area of 36 square miles centered on each village was flown at a scale of 1:10,000.[13] Two-diameter enlargements of a limited number of photographs were made for use in the field. The boundaries of the fields farmed by each individual in the frame were delineated on the enlarged aerial photographs by visiting senior staff members.[14]

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[12] These families may be simple units (iyali) or composite units (gandaye) [Buntjer, 1970; Goddard, 1969].

[13] Canadian Aero Service took the aerial photographs and charged $926 per village in 1969. This included two sets of contact prints.

[14] In the Okene area where aerial photographs were not available only those fields farmed by families delineated in the master sample used in Phase B were identified on the ground.

Field measurements are discussed in a later section (i.e., see Estimating Distance and Area).

Selection of Master Sample and Data Collected (Phase B)

In the RERU studies, no statistical method was used to determine sample sizes. Ideally, the sample size should be determined by the degree of precision required [Yang, 1965]. However, in most variables in RERU farm management surveys no prior estimates of variances are available to enable use of formal statistical procedures. Nonetheless, the sampling percentages for each village were relatively high[15/] for the following reasons:

(1) The villages enumerated in Phase A were fairly small in terms of population, (i.e., less than 1,000 persons per village).

(2) At least two enumerators were stationed in each village during the entire survey. Each enumerator was able to interview from 15 to 20 farming families every three to four days. Therefore, to occupy the enumerators fully, a sample of about 30 to 40 farming families was required in each village.[16/]

(3) Other investigators [Smith, 1955] have mentioned the problem of uncooperative farmers. To guard against such an eventuality and to ensure a reasonable number of complete farm records at the end of the survey year, a large sample of families was selected.

(4) The lack of time available to analyse the results of Phase A precluded the possibility of selecting any form of stratified random sample based on land per resident strata. Consequently, a high

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[15/] For example in the North Central State study the sampling percentages of the three villages were 43, 29 and 39 percent [Norman, 1972].

[16/] The lower figures for Okene (Table 1) were the result of having to measure all the fields on the ground which was very time-consuming.

sampling percentage was used to increase the probability that post-stratification would yield representation in each stratum.

Enumerators living in the villages collected most of the detailed information by interviewing each household head in the sample. The data collected from the farmers in the sample can be divided into two classes on the basis of the frequency of collection:

(1) Class 1. Data collected twice weekly.

(2) Class 2. Data collected infrequently.

Copies of the survey forms together with a detailed discussion of the statistics collected are presented by Norman. A summary of the survey forms together with the frequency of collection is given in Table A-1.[17/] The type of data collected was as follows:

Data Collected Twice Weekly (Class 1)

A cost accounting or cost route approach was used in collecting this data.

(1) Data were collected by day and by field on:

(a) Labour

i. Household: The number of household members working in a specific field on a specific day, worker class as determined by age and sex, type of work (planting, weeding, etc.), and the time worked.

ii. Nonfamily: the same data as above plus details on household location, type of labour and wages paid.

(b) Animals

i. Household: type (donkey, horse, etc.) and numbers of animals used, type of work performed, and for pack animals the number of loads carried, and the time they were used.

ii. Nonfamily: the same data as above plus information on whom they were hired from and the cost of hire.

[17/] The survey forms together with instructions on how to complete them have been published elsewhere. [Norman (1967-1972), Part 2]

(c) Seeds, cuttings and fertilizer (organic and inorganic): type, source, cost and amount used (in local units of measure) on a specific day on a particular field.

(d) Cattle corralling: number of cattle corralled on a specific field on a particular day, the name of the cattle owner, and data on any compensation.

(e) Output: total number of units harvested from a specific field on a particular day, condition of crop (whether threshed or not), weights of five units of the crop selected at random and, where there were yield plots, the weight of the crop harvested from those plots.

(2) Additional data were collected by day on:

(a) Other activities of household members

i. Work on farms of other households: number, class and time worked and remuneration received.

ii. Work on crafts, trading and services: number, class and time worked with details of type of work.

iii. Working with cattle: number, class and time spent with cattle belonging to the household.

(b) Sales and marketing costs of farm products: name, condition and number of units sold, place of sale, revenue received and mode and cost of transport to the place of sale.

Data Collected Infrequently (Class 2)

Data in this class were collected at less frequent intervals on:

(a) Farm inventory

i. Livestock: numbers, class, ages and sale value.

ii. Tools: numbers, type, ages and sale value.

iii. Buildings: numbers, ages and replacement costs.

(b) Retail prices in local measures by crop and month in the local markets.

(c) Crop rotation patterns by fields during the three years prior to the survey year.

(d) Land tenure pattern by field, method and cost of acquiring fields and number of years the current cultivator has controlled the field.

(e) Crop mixtures by plot and field.

(f) Purchases, sales, births, deaths, consumption and productive capacity of livestock.

(g) Conversion ratios: weight in pounds and ounces of local measures of crops, e.g., mudu of sorghum, bundles of sugar cane, etc.

(h) Threshing and shelling percentages.

PROBLEMS IN ORGANIZING THE SURVEYS

Many problems were encountered in organizing the farm management studies, several of which have arisen in other micro-orientated studies carried out by RERU. Problems can arise with respect to the representativeness of and cooperation by the villages, and training and supervising the enumerators.[18/]

Representativeness of the Villages

This decision to undertake intensive studies of a few villages did not permit the use of an objective sampling procedure to reduce sampling errors. Instead reliance was placed on subjective judgements that villages picked would be representative of other villages in the same general location. Little can be done to ensure that such villages are representative apart from taking considerable care and time in selecting them. Significant

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[18/] See Zarkovich [1966] for a detailed discussion of the types of errors that can arise.

differences in the natural resources are obvious. This and the relative degree of emphasis on nonfarm employment may, in fact, be the most relevant criteria in assessing the representativeness of the selected villages.[19/]

Village Cooperation

To increase the probability of village cooperation, the following approaches were used by RERU.

(1) The support of the Provincial Agricultural Office and particularly the local authority was enlisted before contacting any villages. With this in mind, visits were paid to the traditional ruler in the area (e.g., Emir, Sultan, etc.), and the District Heads who provided representatives to explain the project to the villagers.

(2) Considerable time was spent in convincing village heads of the value of the studies. To convey an element of prestige, it was emphasized that their villages had been specially selected. (They were free to refuse permission for the studies to be undertaken in the villages).[20/]

(3) Once permission was granted, the village heads held meetings for interested villagers and study objectives were again explained.

(4) The village heads were always included in samples of families drawn and informed of the progress of the studies at every stage. In

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[19/] The use of capital increases the range and variability of combinations of resources and enterprises. However, in many developing economies (e.g., northern states of Nigeria), capital is still not a significant input in traditional farming. The possibilities of wide variations in resource and enterprise combinations in a hand labour system of agriculture are limited thereby simplifying the selection of representative villages [Clayton, 1964].

[20/] This, in fact, has never occurred. In areas where the power structure is based on the clan system and there is no well defined village head, the head of each clan at the village level was approached to enlist support.

some areas, the village heads helped select the master sample (i.e., used in Phase B of the studies) by drawing names of family heads at random out of a tin. Each name was read aloud to bystanders as it was drawn. Having the village heads pick the sample of families allayed any possible criticism of the researcher by the villagers.

(5) Each family selected in the master sample was given the opportunity at the beginning of the study to refuse being interviewed, but once the regular interviewing was started every effort was made to ensure continued cooperation.[21/]

(6) Efforts were made to quickly settle any misunderstandings that arose. If complaints arose concerning an enumerator, action was taken after seeking guidance from the village head.

(7) RERU senior staff visited each village at least once a week to assure the villagers of their continued interest in the studies. On each visit an effort was usually made to greet the village head.

(8) Farmers in the master sample in the North Central State study, were given a promissory note at the end of each month entitling them to a reward of one half of a bag of fertilizer for that month's cooperation, to be delivered at the end of the survey year. The wisdom of such a reward can be questioned since it created problems in obtaining data from the same farmers on subsequent studies. In the studies undertaken in the other areas no such remuneration was promised or found to be necessary.[22/]

[21/] In general this has not been a problem. Overall the drop-out rate through noncooperation has been less than about five percent.

[22/] In some of the areas small gifts were given at the end of the survey year as a sign of appreciation, but not on a promissory basis, e.g., in one village some cement was given to build a mosque, in another buckets were issued, etc.

Selecting and Training Enumerators

Enumerators are the key link between the farmer and the research worker. In the RERU studies, an attempt was made to recruit staff who had a West African School Certificate (WASC),[23] pleasant personality and who were indigenous to the study areas but not known in the villages selected for the studies. The most suitable enumerators proved to be those between secondary four level[24] and failed WASC.[25] Due to short supply, it was often necessary to employ individuals with little or no secondary school education. Intelligent individuals of such an educational level were able to complete the forms adequately, provided they were closely supervised.

Each enumerator was provided with a reference manual giving details on how to complete each form. Most training was done in the field, but records of each farmer for the first few days of the survey were not analyzed. However, it is important to stress the necessity of close supervision and frequent checking of the interview forms throughout the survey year. This practice tended to boost the morale of the enumerators by expressing interest in the results of their work and ensured, as far as possible, that data were not being concocted by the enumerators without visiting the farmers. Consequently, a senior staff member visited each enumerator at least once a week to resolve any problems, check interviews and collect completed interview forms.[26]

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[23] Equivalent to grade 10 in the U.S. educational system.

[24] Grade 8 level.

[25] Unlike those who have passed WASC and aspire to better jobs, such individuals have fewer alternative employment opportunities and generally proved to be the most conscientious and reliable employees.

[26] A full time senior staff member, who was provided with a landrover or minimoke, was stationed in each area throughout the study.

A number of details contributed to maintaining the morale of enumerators. For example, at least two enumerators were stationed in each village for the whole survey year to provide companionship. In addition, suitable housing was located for the enumerators at the beginning of the study and a small duty allowance over and above their normal salary was paid in recognition of their relative isolation from the amenities at Ahmadu Bello University.

DATA COLLECTION PROBLEMS

Many problems are encountered when collecting data for farm management studies. These may range from the choice of the survey period to data accuracy. Until recently, [Collinson, 1972; Lipton and Moore, 1972] little information has been published about these problems. Some of the problems encountered in the RERU studies are discussed in the following section.

Choice of the Survey Period

The survey began at a time when agricultural activities were at their lowest ebb (i.e., March or the beginning of April) and lasted 365 days.[27/] However, problems were encountered in collecting certain data. For example, land clearing, which was undertaken before the survey began should have been included in labour estimates for crops grown during the survey period. This, however, was partially accounted for in data collected towards the end of the survey.

[27/] Whenever possible, interviewing began earlier than the start of the survey year to enable enumerators to familiarize themselves with the forms. However, this information was excluded in the analyses.

The Effect of Seasonal Variation

Due to limited resources, data were collected for only one complete year in the main RERU farm management studies.[28/] Since there are sometimes wide annual and seasonal variations in weather conditions, particularly the amount and distribution of rainfall, the results from the survey year may not always be representative.

The effect of variations in weather conditions will depend on the variables being measured. For example, crop yields are likely to be more sensitive to such variations than labour inputs. In analysing the results of the studies, care has been taken to document whether or not the survey year was normal from the farmers' view point, e.g., unusual disease problems, prices, etc.

Data Collection by Field and Plot

Detailed input-output data were collected by fields to estimate inputs and outputs of different crop enterprises. Each field was identified by a number during the field enumeration in Phase A of the studies. Since the farmers could not be expected to remember these numbers, they were asked to give each field a name usually based on the location or crops grown on the field (e.g., gonar bayan gida, gonar kofa yamma, fadama rake, etc.)

Complications sometimes arose because farmers changed the field names or gave the same name to more than one field. Therefore in the two Kwara State studies, fields were identified by color rather than name. Different colors and combinations of colors were painted by staff on tree trunks, rocks and stakes located in each field farmed by each household. This method worked satisfactorily.

[28/] RERU records of seven farmers over a five-year period should provide interesting information on the effects of weather variation.

It was difficult to divide fields into plots[29] because: 1) different persons in the family farmed different parts of the field; 2) different usufructuary rights (e.g., inherited, gift, rented, etc.), applied to different parts of the field; and 3) different crop enterprises (e.g., millet, millet/guinea corn)[30] were grown on different parts of the field. Thus, an attempt was made at the beginning of the survey year to collect input and output data by plot rather than field in the North Central State study. This approach was abandoned since farmers did not always differentiate between plots, especially where the third criterion was used. Their inability to differentiate such plots caused problems in deriving labour and yield estimates by crop enterprises[31] in fields with several crops.

Estimating Time

Data were collected in terms of both hours and days in order to estimate the length of the average working day in the study areas. Most farmers did not have watches, but with the prevalance of Islam in northern Nigeria it was possible to construct a table of approximate times, in hours, based on the Moslem prayer times.[32] However, it was not possible to obtain data on actual working time versus resting.[33]

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[29] For example, in the farm management study conducted in the North Central State area, almost 46 percent of the fields contained two or more plots with different crop enterprises.

[30] A crop enterprise may be a sole crop (e.g., sorghum) or a mixed crop (e.g., millet/guinea corn).

[31] See Estimating Labour Inputs and Yields by Crop Enterprises.

[32] See Appendix A, Table 2. For example, if the farmer started work at the end of the first prayer time and finished at the end of the third, the figure entered on the interview forms as a result of consulting the table was 9.5 hours.

[33] This could only be obtained through a work-study approach [Haswell, 1963]. However this may not be a serious limitation. Presumably, under *ceteris paribus* conditions and assuming a representative sample of observations, time spent resting is related to the monotony and/or arduousness of the task. Consequently, estimates on labour time required for a task can include the resting period.

In farm management studies in areas where farms are fragmented the time spent walking to and from the fields is an important component of labour time. In the RERU studies, this time was estimated separately from that actually spent in the field by multiplying the estimated direct distance of the field from the compound by an assumed walking rate of 1.5 mph. Because considerable time spent in travelling can often be spent talking and doing things en route, this time was not included in labor estimates by crops as this would have biased upwards the labour inputs for crops located in fields further from the compound.

Obtaining estimates of time in hourly terms of nonfarm activities was more difficult since a great deal of the time spent in some activities, (e.g., trading, cutting finger nails, etc.), was nonproductive. No attempt was made to collect estimates of labour time in hours spent on nonfarm activities.

Estimating Distance and Area

Farmers usually have very little idea of concepts such as miles and acres, so distances and areas must be estimated directly. In the four areas in which aerial photographs were available, it was possible, after identifying the field boundaries in Phase A of the studies, to measure the size of each field with a planimeter [Goddard, et. al., 1971; Norman, 1967]. In the Okene area, where aerial photographs were not available an alidade was used.[34/] This method proved fairly satisfactory, but because of its complexity, the presence of a senior staff member was required.

[34/] A telescope equipped with vertical circle and stadia cross hairs.

In recent RERU studies, several methods have been used to measure fields [Collinson, 1972; Hunt, 1969; Zarkovich, 1966]. Generally, the most satisfactory method was to use a measuring wheel and an angle finder, or large home made protractor. All sides and angles were measured in the field by the enumerators. A quick check on the accuracy in the field was possible by comparing the sum of the angles with 180(n-2) where n equals the number of sides. If the two differed markedly the field was remeasured immediately.

A further check on the accuracy can be made by drawing the field to scale in the office. If the closing error is too large (e.g., more than 10 percent) of the circumference, the field should be remeasured.[35/] Measuring fields involves some skill and, as a result, RERU now uses specially trained staff for this task.

Indirect methods can also be used for estimating areas by converting local units of area, or proxy variables related to area, (e.g., quantity of seed planted), to acreage terms [Hall, 1970; Hunt, 1969]. Although this method is generally less accurate, it may be useful in special circumstances. For example, in one village in the Sokoto area many lowland fields flooded during the rainy season, making it difficult to differentiate field boundaries. Consequently, the acreage for a number of such fields was estimated with an alidade. Farmers of these fields were then asked how many days it would take one man to dig them. A linear regression

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[35/] As Collinson [1972] notes, one is forced to accept a compromise between a low degree of closing error and the loss of morale of junior staff which results from frequent remeasuring.

equation was estimated by relating these two variables [Goddard, et. al., 1971].[36/] This equation was finally used to estimate the acreages of the remaining lowland fields from data on numbers of days to dig.

In addition to the problem of accurately measuring fields that have been identified, the farmer may inadvertently or deliberately not disclose all his fields when the farms are fragmented into a number of scattered fields. Where aerial photographs are used and field identification is done systematically this problem is minimized, although fields farmed outside the village area could escape identification.

A check survey on field boundaries of all the fields farmed by families in the master sample was carried out later in the year by a senior staff member in conjunction with junior staff and farmers. At the same time, estimates of the relative sizes of different plots in each field together with the crops enterprise growing on each plot were made.

Estimates of Quantities of Inputs

Most products and many of the inputs are handled in local measures based on volume. Measures may vary within and between villages, and from season to season (e.g., mudu) or from farmer to farmer or field to field (e.g., bundle, sack, mangala, etc.). This complicates the conversion of such measures to standard units.

[36/] For example, in Kaura Kimba village the following regression equation was estimated and used in predicting the sizes of other lowland fields:

$$Y = 0.2349 + 0.2007\ X \quad (0.0335)$$

$$R = 0.7494^{**}$$

$$n = 30$$

Where:

n = number of fields measured directly
Y = size of lowland field in acres
X = number of man-days required to dig the field for planting rice
** = significantly different from zero at the one percent level.

Estimates of small quantities (e.g., seed) and items that were applied over a long period of time (e.g., organic manure) varied considerably and were unreliable. The scale of the RERU study was too large to permit direct observation and weighing [Lipton and Moore, 1972]. Rather, the estimates of seed rates were based on what was considered the more reliable data of a smaller number of farmers.

An additional problem encountered was measuring the amount of manure dropped by cattle corralled on fields. These quantities were estimated using the various assumptions proposed by Luning [1962].[37/]

Measuring Crop Yields

One of the most difficult problems encountered in the farm management surveys was the measurement of yields. Ideally, yields could be obtained by weighing the whole crop from each field. However, this is only practical in small surveys on single crops harvested over a short period.[38/] In practice, some sort of sampling procedures must be used. In the RERU studies, estimates were obtained by two or three of the following methods: 1) the yield plot method; 2) the five-unit method; and 3) the year-end method.

1) The Yield Plot Method: This is the classical method of estimating yields. However, in most areas studied, it was of limited value for a number of reasons. First, many of the fields contained more than one plot, each of which usually contained at least two crops in mixtures. Thus a large number of yield plots would have been required.[39/] Yields of individual

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[37/] Luning assumed a cow produces 9.2 lbs of manure per day.

[38/] See, for example, the harvest of cotton in Table 2.

[39/] Assuming each plot only grew one crop would have necessitated the laying of 1,053 yield plots in the Zaria study, with only one yield plot per plot. Since most plots grew more than one crop, two or more crops would have had to be harvested, usually at different times.

Table 2. Authentic Average Yields of Crops Using Different Methods of Estimation: Cotton Project Results in North Central State, 1970-71[a]

Type of Practice	Village	Number of Observations	Yield Plot Estimates	Yields Derived From Weighing Total Field Crop
Improved				
	Daudawa	5	714	594
	Malumfashi	6	876	706
	Yalwa	13	469	402
Traditional				
	Daudawa	28	370	227
	Malumfashi	4	197	153
	Yalwa	5	290	176

[a]Observations included in the table are only those fields for which both estimates of yield were available. Weighing the whole crop (one of the methods used in this table) is the most accurate estimate of yield. Yields are in terms of seed cotton.

crops tended to fluctuate greatly from one part of the plot to another. Therefore, more than one yield plot per plot of land was needed to obtain reliable estimates. Secondly, pegs demarcating yield plots were often eaten by termites or removed by children. Finally, if an enumerator was not present farmers tended to ignore the boundaries of the yield plots during harvest. Thus, yield plots often included some of the crop from outside the yield plot.[40/] Evidence of this bias in inflating yields is presented in Table 3.

[40/]One way to partially overcome this problem is to let the plot size be determined by the usual size of a unit of harvest of the particular crop, e.g., one bundle of sorghum is usually harvested from 0.1000 of an acre.

Table 3. Average Yields of Crops Using Different Methods of Estimation: Farm Management Results in the Zaria Area Study, 1966-67[a]

	Millet	Sorghum	Groundnuts	Cowpeas
Number of observations	23	25	19	5
Threshed or shelled yield per acre using different estimates				
(1) Yield plot[b]	595	1297	1296	432
(2) Five-unit	249	479	449	88
(3) Year-end	215	459	436	105

[a]The observations used in the table are for crop mixtures only. Observations included in the table are only those fields for which all three estimates of yield were available.

[b]These estimates are much higher than those prevailing in the study area. Yield plots were 0.025 acres in size.

Because of these complications, yield plots were only used for five households in most villages. However, where crops were harvested periodically over a long period of time and other methods were not feasible (e.g., maize and yams in Kwara State), extensive use was made of yield plots.[41/]

2) Five-Unit Method: Because of the problems experienced with the yield plot method, the five-unit method was used extensively throughout the study. The average weight of a unit of a crop from each field was calculated by weighing five units of the crop (e.g., bundles, baskets, etc.) drawn at random from those harvested from the field. The total yield could then be computed by multiplying the total number of units harvested from the field in question by the average weight per unit. This method is less time consuming than the yield plot method.[42/] However, it depends on accurate information from the farmer about the number of units harvested.

3) Year-End Method: During the middle of the survey year, all fields farmed by each household were visited again to ascertain the crops actually growing on each plot. For various reasons (e.g., especially minor crops in mixtures), not all the crops from every field were recorded under the five-unit or yield plot method. To ensure that estimates of all crop yields were obtained and to provide a further check on data already collected under these methods, household heads were again asked for estimates of yields in terms of harvest units at the end of the survey year.

[41/] The square yield plots were 0.0250 acres for upland (gona) crops and 0.0125 acre for lowland (fadama) crops.

[42/] In the Zaria area study, over 3,500 units of different crops were weighed.

A further estimate of yield was then obtained by multiplying the number of units harvested by the weight of an average unit. Since well after harvest such units are not available for weighing it was necessary to use the weight of an average unit for that field obtained under method (2). If such data were not available then an average weight of all the units harvested by the household farming the field was used. If none were recorded, then an average weight of unit for the crop for the whole village was used.

In each method, estimates of threshed or shelled yields were obtained by multiplying the estimated crop yield by the relevant threshing or shelling percentages. These were obtained by direct weighing of a few units of each crop which had been threshed or shelled using indigenous methods.

By using a combination of the above methods, two or three estimates of yields were often available. To determine which one to accept, different estimates were expressed in per acre terms. These were then compared with the normal crop yields in the survey area derived from other studies and knowledge of people familiar with the area. The estimate closest to the normal yield was accepted. This approach tends to eliminate extreme yields and provide an objective way of deciding which estimate of yield to accept. The main disadvantage of this approach is the difficulty of choosing valid normal yields, particularly in areas where data are lacking.[43/]

Missing Data

Whenever data are collected by enumerators rather than the researcher, there is a danger that some information is omitted. Enumerators cannot

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[43/] The ideal approach of weighing the whole crop from the field is generally only practicable in relatively small surveys on single crops which are harvested during a limited period, and preferably all sold, e.g., cotton in Table 2.

always discern what information would be useful to the researcher over and above that specifically required on the interview forms. Furthermore, it is virtually impossible to construct interview forms that can take care of all possible contingencies. The solution to such problems is the training of indigenous researchers. With their knowledge of the culture, together with direct discussions with the villagers, they can obtain greater insights into the working of the communities than outsiders.

Because only the household head is interviewed, data on some family activities may have been omitted. The household head is expected to give an account of the economy and the activities of the household. As household head, he usually has such information, but there are some exceptions.[44/] For example, he may not have information about the time spent on and the yield of fields under the jurisdiction of other household members (i.e., gayauna fields).[45/] To obtain accurate records of labour allocation and to detect missing information about individuals, each household member was given a code number to identify his or her work activities.[46/] Since labour data were also collected by field, it was obvious that data were being omitted if no activities were recorded on particular fields.

Sometimes the household head does not know the income earning activities of women in the household as any such money earned is often kept by them. For example, when preparing cooked foods for sale, women often buy the raw

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[44/] Bessel, Roberts and Vanzetti [1968] noted that accurate answering by one respondent may be difficult in large households especially those which are poorly motivated.

[45/] These fields accounted for only 7 percent of the total in the Zaria area study [Norman, 1967].

[46/] The Zaria area study was the only one in which this differentiation was not done.

materials from the household head, prepare the food and get children to sell it outside the compound.

Time spent by women on these activities and on shelling and threshing the crops is also unlikely to be known by the household head. Also, there was no way of ensuring that women's activities were well documented since the practice of auren kulle (seclusion of women) precluded the male enumerators from interviewing women.[47] Consequently, in estimating labour inputs for crops, post-harvest operations undertaken within the compound were not included in the RERU studies.[48]

Sensitive Data

Establishing a good rapport between the respondent and interviewer when collecting sensitive data is very important. Trust on the part of the respondent in the discreteness and goodwill of the organization collecting these data is also important. Farmers were sometimes reluctant to disclose all crop sales. Presumably this reflects their unwillingness to permit others to know about their liquidity position. An additional survey was carried out at the end of the survey year to determine the proportion of the total production of each crop sold [Norman, 1972].

Data on livestock, especially cattle, were also difficult to collect because people owning cattle in Nigeria are subject to a cattle tax (Jangali). Some information on cattle was collected at the end of the survey year when a good relationship had been firmly established between respondents and interviewers.

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[47] Valuable information was recently obtained on such activities as a result of a RERU consumption study undertaken with female enumerators on the same farms as those included in the farm management study.

[48] This is probably not a serious limitation since time is not a constraint on tasks spread over a whole year.

Finally, certain types of data were not collected in the RERU farm management studies, particularly data on loans and debts.[49/] Attempts to collect such data might jeopardize the whole study, and even if collected, it would be unreliable. However, lack of such data is a serious deficiency in the farm management studies.

Data Accuracy

The problem of ensuring that measurement errors are reduced to an acceptable level is discussed in this section. The accuracy of the data collected depends on several factors including:

(1) quality and competence of the enumerator;

(2) intelligence and cooperativeness of the farmer;

(3) quality of the relationship, including trust, that exists between the farmer, the enumerator and other staff members;

(4) supervision of data collection;

(5) type of data required;

(6) method used to collect data; and

(7) frequency of interview.

The first four factors are obvious. In the case of the fifth factor, type of data required, problems can arise from the fact that household heads are not used to thinking in the same terms as the way in which the question was posed (e.g., age of family members). Also, because of custom or some other reason, farmers may not feel free to talk about certain subjects (e.g., the unwillingness of household heads to mention the names of their first wives and/or first child).

[49/] Such data have, however, been collected relatively easily in later studies in the Zaria area using the same farmers.

The type of data required will partially determine the method used to collect this data. Often, the direct observation and interview methods are used. Generally, although, lower measurement errors can be obtained using the direct observation method (measuring the fields by oneself rather than relying on farmers' estimates), this approach is expensive and time consuming. Thus, for many types of data the interview method is used.

The type of data required will influence the frequency of interview that is needed to achieve a particular degree of accuracy. In this respect, Lipton and Moore [1972] have drawn a useful distinction between single point and continuous data and between registered and nonregistered data (Table 4). The continuum ranging from single point to continuous data refers to the length of time taken to complete an activity. The continuum ranging from registered to nonregistered refers to the extent to which circumstances influence the respondent's ability to remember the quantities of an activity.

Any data classified in the continuous nonregistered class requires frequent interviewing to ensure accurate collection. However, the twice weekly frequency of interviewing in these studies was subjectively determined. Although measurement errors should decrease with an increase in the interview frequency, the costs of obtaining that data also increase. Ideally one should decide the acceptable degree of measurement error and then determine the minimum frequency of interview and necessary research resources to meet the requirement.

Table 4. Types of Agricultural Data in Northern Nigeria[a]

	Inputs		Products	
	Single Point	Continuous	Single Point	Continuous
Registered[b]	Inorganic fertilizer	Money for hired labour	a) Cash crop sales b) Harvest of major food crops c) Harvest of cash crops	Sale of food crops
Nonregistered	Seed	a) Family labour use b) Quantity of hired labour used c) Organic fertilizer	Harvest of minor crops	a) Yam and cassava harvest b) Consumption of farm-produced products

[a]This breakdown is based on a concept developed by Lipton and Moore [1972].

[b]The continuum ranging from registered to nonregistered refers to the extent to which circumstances influence the respondent's ability to remember the quantities of an activity.

DATA ANALYSIS PROBLEMS

As with data collection, there is no standardized way of analyzing data collected in farm management studies. Published results give little attention to how individual statistics and analyses were derived.[50] This makes the comparison and assessment of the value of individual statistics virtually impossible. Because of the unique characteristics of traditional agriculture, there are methodological problems in the analytical stages of farm management studies in the developing world that still have not been solved satisfactorily (e.g., analysis of crop mixtures, methods of incorporating the security stategy into farm planning exercises, etc.)

Several basic analytical problems arose from the farm management studies. These included: 1) post stratification; 2) estimation of man equivalents; 3) arithmetic versus weighted averages; and 4) labour inputs and yield estimates by crop enterprise.[51]

Post Stratification

A lack of time precluded the selection of a stratified random sample. Consequently, a post-stratification design was chosen. A two-way stratification scheme was used: 1) stratification by village or section or both and 2) stratification by land-per-resident ratios.

The village stratification enabled researchers to gain some idea about the influence of population density, ease of access to the main city, degree

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[50] Collinson's [1972] recent book provides a notable exception. In addition to discussing analytical problems, he has also considered the problems of data collection.

[51] The problems which arose once the basic analysis was complete (e.g., test for significant differences between strata means that were composed of different numbers of observations, comparison of sole crops and crop mixtures, gross margin analyses, etc.) are considered in detail elsewhere [Norman, 1972].

of market orientation, emphasis on and type of off-farm employment, intensity of farming, etc.

Since capital inputs in traditional farming in many parts of Africa are very limited, Clayton [1964] and Collinson [1972] advocate stratification by land-per-resident ratios because differences in these ratios will be more important than capital utilization when determining type of farming activities, intensity of farming and off-farm employment.

Estimating Man Equivalents

Before direct comparisons can be made between different types of labour, it is necessary to express days and hours in terms of a common denominator (i.e., man-days and man-hours, respectively). Much controversey exists in the literature over the relative weights to use [Collinson, 1972]. This problem is further complicated because relative work productivities vary depending on the type of task being performed [Hall, 1970]. However, too much variation in the allocation of weights becomes cumbersome. Such decisions on weights, therefore, are usually arbitrary and open to bias.[52/]

In the RERU farm management studies two simplifying assumptions were employed in assigning weights:

(1) Physical labour productivity is initially positively correlated and then negatively correlated with age increases.

(2) The physical productivity of women is lower than that of men.

On the basis of these assumptions the male adult equivalents assigned were those depicted in Table 5. It is unlikely that any substantial

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[52/] A work-study approach must be used to provide an objective way of assigning weights.

distortion was introduced in the analysis as a result of these weights since the bulk of the work on the farm in Moslem areas is undertaken by men.[53/]

Arithmetic Versus Weighted Averages

Somewhat surprisingly, little discussion appears in the literature on the relative merits of arithmetic and weighted averages in analyzing farm management data. In many studies, it is not clear which average was used in estimating, for example, labour inputs and crop yields.

The advantages of the arithmetic mean are:

(1) It is relatively simple to calculate standard errors and confidence limits.

(2) Each field receives equal weighting in the final estimate of yield or labour inputs. Assuming each farmer has one field in the sample, any biases in the information given by respondents are, in effect, given equal weight. Consequently, it would appear to be the best indicator of the value of the statistics for the average farmer.

The advantages of the weighted mean are:

(1) Larger plots are relatively more important in determining the final estimate than smaller plots.[54/] Consequently, it would appear to be a better estimate than the arithmetic mean for a particular area.

(2) It eliminates the "scale effect" [Collinson, 1972] that could introduce a calculation bias in estimating the arithmetic mean. For example, work rates and relative yields may be higher on smaller plots.

[53/] In the Zaria area study, almost 89 percent of the family work on the average farm was contributed by male adults, 10 percent by large children and less than 1 percent by female adults.

[54/] A biased respondent with a large field could markedly affect the final estimates.

Table 5. Man Equivalents Used in the RERU Farm Management Studies

Labour Class	Age	Male Adult Equivalents
Small child	Less than 7	0.00
Large child	7-14	0.50
Female adult	15-64	0.75
Male adult	15-64	1.00
Female adult	65 or more	0.50
Male adult	65 or more	0.50

On balance, it is difficult to choose between the arithmetic and weighted average. At times they can give markedly different results. To decrease the difference, Collinson [1972] has suggested that observations on exceptionally small or exceptionally large fields should be excluded. In the RERU studies more use was made of arithmetic means although some weighted means have also been calculated.

Estimation of Labour Inputs and Yields by Crop Enterprise

Some observations on both labour inputs and crop yields were available from well identified fields devoted completely to one crop enterprise (e.g., sorghum, millet/sorghum/groundnuts, etc.). From these it was possible to determine the preliminary estimates of labour requirements and yields of specific crop enterprises. However, it was sometimes difficult to find many observations of these variables according to the above specifications because:

(1) large numbers of different crop enterprises were found in the fields farmed by a master sample.[55/]

[55/] For example, in the Zaria area study, 200 different sole crops and crop mixtures were grown on the 980 acres cultivated by 124 farmers.

(2) a high percentage of the fields contained more than one plot,[56/] while data was collected on a field basis; and

(3) confusion sometimes occurred over field names, and therefore, input and output data for such fields could not always be differentiated.

An attempt was made to develop a method of enabling some of the data falling in categories (2) and (3) above to be used in estimating the labour requirements and yields of different crop enterprises.

Estimating Labour Requirements

To obtain additional observations for this purpose, it was necessary to assume that the ratio of the estimate of the labour requirement per acre of crop enterprise i to that of the labour requirement of crop enterprise i + 1, derived from crop enterprises which could be measured directly (i.e., the preliminary estimate) is also true for crop enterprises that could not be directly measured.

The estimate of labour inputs for crop enterprises in fields devoted to more than one enterprise where labour estimates could not be directly measured were obtained in the following manner:

Let: C_i = Crop enterprise i.

AC_i = Acres of crop enterprise i in the field

PC_i = Proportion of the total acreage of the field that is devoted to C_i.

TL = Total labour input on the field.

BC_i = Preliminary estimate of the labour input per acre for crop enterprise i.

LC_i = Estimated labour input in the field devoted to crop enterprise i.

k = Number of crop enterprises growing in the field.

[56/] In the Zaria area study, almost 46 percent of the fields contained more than one plot.

Then:
$$PC_i = \frac{AC_i}{\sum_{i=1}^{k} AC_i}$$

$$LC_i = \frac{(PC_i)(BC_i)(TL)}{\sum_{i=1}^{k} (PC_i)(BC_i)}$$

The LC_i estimate was then used as an observation for calculating the average labour requirement for crop enterprise i. An empirical example of this estimation procedure is given in Table A-3 in the Appendix.

Estimating Yields of Crop Enterprises

In an analogous approach to that used in estimating labour requirements, it was assumed that the ratio of the yield per acre of crop y in crop enterprise i to the yield of crop y in crop enterprise i + 1, derived from crop enterprises that could be measured directly (i.e., preliminary estimates) is also true for crop enterprises that could not be measured directly.

The estimates of individual crop quantities for fields devoted to more than one crop enterprise where yield could not be directly measured were derived in the following manner.

Let:
- C_i = Crop enterprise i.
- AC_i = Acres of crop enterprise i in the field.
- PC_i = Proportion of the total acreage of the field devoted to C_i.
- TY_y = Total quantity harvested of crop y from the field.
- D_yC_i = Preliminary estimate of the yield per acre of crop y in crop enterprise i.
- Y_yC_i = Estimated quantity of crop y that was harvested from crop enterprise i in the field.
- k = Number of crop enterprises growing in the field.

Then:
$$PC_i = \frac{AC_i}{\sum_{i=1}^{k} AC_i}$$

$$Y_yC_i = \frac{(PC_i)(D_yC_i)(TY_y)}{\sum_{i=1}^{k} (PC_i)(D_yC_i)}$$

For checking purposes:

$$TY_y = \sum_{i=1}^{k} Y_yC_i$$

The Y_yC_i estimate was then used to calculate the average yield of crop y in enterprise i. An empirical example of this estimation procedure is given in Table A-4 in the Appendix.

Estimating Net Returns and Income

It is difficult to assign prices to the outputs and values to the inputs in traditional agriculture. The prices of the products used in the RERU studies were the average retail prices prevailing in each study area throughout the survey year. It was difficult to value incomes derived from certain types of nonfarm employment (trading, crafts, etc.), which involve purchased inputs. Incomes attributed to different types of nonfarm employment were based on a certain remuneration per day worked derived from case studies. There are difficulties in handling family labour in the calculating of net returns [Hunt, 1969]. Three definitions of net return were therefore used by RERU depending on how labour was priced. These are:

(1) Labour was given a value of zero.

(2) Only hired labour was priced.

(3) All labour was priced at the rate at which it would cost to hire it. This assumed the opportunity cost of family labour was the same as the wage of hired labour.

CONCLUSION

A wide range of problems encountered when collecting and analyzing data for farm management surveys have been discussed here. There is no perfect solution to these, particularly in developing countries. In the end, researchers usually have to accept an approach that falls short of the ideal. Since no well defined pragmatic guideline has been estabished, the methods used tend to differ widely reflecting to some extent the biases of the researcher and to a great extent the financial and supervisory resources available. The approach advocated in the RERU studies involves working with small numbers of farmers and maintaining frequent interviews over a full crop year. Although this approach is relatively costly per farm interview, measurement and large sampling errors are reduced and in depth knowledge is acquired on the socio-economic variables influencing family decision making. 57/

57/ Spencer [1972] investigating a single crop, rice, incurred a cost of $41.40 per farm record, while he quotes a more general study by Zukerman in Nigeria as costing $150 per farm record. As a comparison, the RERU studies undertaken in the North West State cost about $139 per farm record. This includes the cost of aerial photographs, depreciation of the landrover, salaries of junior and senior staff, travel, equipment, stationery and other expenses.

APPENDIX

List of Tables

Table A-1. Forms Used in Collecting Data in Phase B

Class of Data	Survey Form: Farm Number	Survey Form: Title	Frequency of Completing Form	Notes
-	A1	Fields farmed by the household	--	Derived from Phase A: Basic information required after completing Forms S1-S10
-	A2	Household names and code numbers	--	
-	A3	Date of interview record	Daily	
1	S1	Field operation sheet	Twice weekly	
1	S2	Hired and communal labour and hired animal inputs	When used	
1	S3	Contract labour and contract animal inputs	When used	
1	S4	Fertilizer and seed inputs	When applied	
1	S5	Work carried out on farms of other households	Twice Weekly	Forms S1 to S9 were stapled together. When one of the forms (e.g., S2, S4 etc.) was completed a new set was issued.
1	S6	Sales and marketing costs of farm products	Twice weekly	
1	S7	Time devoted to occupations other than farming, but including working with livestock	Twice weekly	
1	S8	Coralling of cattle on this and other farms	Twice weekly	
1	S9	Completed harvesting	Twice weekly	
1	S10	Individual field crop yield	When harvesting done	
1	S11	Crops to be weighed and weights of crops	When harvesting done	Information on these forms was transferred to S9 and S10 at frequent intervals.
2	A4	Farm inventory	Start and end of survey year	
2	A5	Current price collection	Monthly	
2	A6	Supplementary field and plot identification	Once between Aug-Oct	
2	A7	Land tenure and crop rotation patterns	Once between Dec-Jan	
2	A8	Conversion ratios	Once in January	
2	A9	Threshing or shelling percentages	Once in January	
2	A10	Livestock enquiry	Once at end of survey year	

Table A-2. Conversion of Moslem Prayer Times to Hours Worked[a]

From \ To	B of 1st pr	E of 1st pr	Mid-day	B of 2nd pr	E of 2nd pr	B of 3rd pr	E of 3rd pr	B of 4th pr	E of 4th pr	B of 5th pr
B of 1st pr	-	2.0	7.0	8.5	9.5	10.5	11.5	13.5	14.5	14.5
E of 1st pr		-	5.0	6.5	7.5	8.5	9.5	11.5	12.0	12.5
Mid-day			-	1.5	2.5	3.5	4.5	6.5	7.0	7.5
B of 2nd pr				-	1.0	2.0	3.0	5.0	5.5	6.0
E of 2nd pr					-	1.0	2.0	4.0	4.5	5.0
B of 3rd pr						-	1.0	3.0	3.5	4.0
E of 3rd pr							-	2.0	2.5	3.0
B of 4th pr								-	0.5	1.0
E of 4th pr									-	0.5
B of 5th pr										-

[a]B = Beginning, E = End, pr = prayer time

Prayer Time	Time
1	5:00 - 7:00 a.m.
2	1:30 - 2:30 p.m.
3	3:30 - 4:30 p.m.
4	6:30 - 7:00 p.m.
5	After 7:30 p.m.

Table A-3. Calculating Labour Inputs for Different Plots on Fields 144 and 245 Farmed by Household 10 in Dan Mahawayi April 1966-March 1967.

Plots (C_i)		Acres (AC_i)		Proportion of Total Acres (PC_i)	
Millet/guinea corn	C_1	0.15	AC_1	0.09	PC_1
Guinea corn/groundnuts	C_2	1.51	AC_2	0.91	PC_2

Total labour input (man-hours) devoted to the field during the survey year (TL) = 408.5

Preliminary estimates of labour requirements obtained from fields with one enterprise (man-hours/acre) (BC_i):

$$BC_1 = 253 \qquad BC_2 = 217$$

Estimates of labour inputs devoted to each crop enterprise in the field (LC_i):

$$LC_1 = \frac{(0.09)(253)(408.5)}{(0.09)(253) + (0.91)(217)} = 42.2$$

$$LC_2 = \frac{(0.91)(217)(408.5)}{(0.09)(253) + (0.91)(217)} = 366.3$$

Plot (C_i)	Estimated Labour Inputs (LC_i)
Millet/guinea corn	42.2
Guinea corn/groundnuts	366.3
Total	408.5

Table A-4. Calculating Crop Yields for Different Plots in Field 85 Farmed by Household 28 in Hanwa Village, April 1966-March 1967.

Plots (C_i)		Acres (AC_i)		Proportion of Total Acres (PC_i)	
Millet/guinea corn	C_1	0.76	AC_1	0.50	PC_1
Millet/guinea corn/cowpeas	C_2	0.30	AC_2	0.20	PC_2
Millet/guinea corn/groundnuts/cowpeas	C_3	0.45	AC_3	0.30	PC_3
Total		1.51		1.00	

Quantity (lb) of crops from whole field (TY_y):

Millet $TY_1 = 451$ Groundnuts $TY_3 = 558$

Guinea corn $TY_2 = 784$ Cowpeas $TY_4 = 147$

Preliminary estimates of yields (lb/acre) (D_yC_i):

$D_1C_1 = 342$ $D_2C_1 = 683$ $D_3C_3 = 380$

$D_1C_2 = 378$ $D_2C_2 = 642$ $D_4C_2 = 148$

$D_1C_3 = 329$ $D_2C_3 = 322$ $D_4C_3 = 121$

Estimates of quantities of crops harvested from each crop enterprise in the field (Y_yC_i):

$$Y_1C_1 = \frac{(0.50)(342)(451)}{(0.50)(342) + (0.20)(378) + (0.30)(329)} = 223$$

$$Y_1C_2 = \frac{(0.20)(378)(451)}{345.30} = 99$$

$$Y_1C_3 = 129$$

$$Y_2C_1 = \frac{(0.50)(683)(784)}{(0.50)(683) + (0.20)(642) + (0.30)(322)} = 472$$

$$Y_2C_2 = \frac{(0.20)(642)(784)}{566.50} = 178$$

$$Y_2C_3 = 134$$

$$Y_4C_2 = \frac{(0.20)(148)(147)}{(0.20)(148) + (0.30)(121)} = 66$$

$$Y_4C_3 = 81$$

Table A-4. Continued

Plot (C_i)	Estimated Quantities of Crops ($Y_y C_i$)			
	Millet	Guinea corn	Groundnuts	Cowpeas
Millet/guinea corn	223	472	-	-
Millet/guinea corn/cowpeas	99	178	-	66
Millet/guineacorn/groundnuts/cowpeas	129	134	558	81
Total	451	784	558	147

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