COMPARISON OF METHODS FOR COLLECTING INPUT-OUTPUT FARM DATA: A CASE STUDY FROM THE MANDARA MOUNTAIN INTEGRATED RURAL DEVELOPMENT PROJECT OF THE NORTHERN CAMEROON

by

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I. INTRODUCTION

A. Need of the Study

Lack of sound input-output farm data for economic planning and decision-making is a well known fact throughout the developing countries, particularly the African countries. The situation is even worse when it comes to knowledge about small farmers.

Economic and technical farm data are crucial for effective planning and policy formulation. Planners and decision-makers need to be informed about the resource availability and the various kinds of constraints faced by farmers for a given farming system. They also need an understanding of the patterns of farmers' responses to economic incentives and the factors which influence demand and product supply on individual farms.

Collinson (1972) discussing alternative agricultural development strategies for the eastern African countries, argued that there are two main approaches: the improvement approach which aims to speed up the evolution of the farming systems within the existing structure of agriculture and the transformation approach which sees structural changes such as the amalgamation or consolidation of holdings, imposition of formal land holding rights, or modification of the settle-

pattern--as a prerequisite to development potential. Further, he argued that, to be effective, a transformation approach, just as an improvement approach, must be based on knowledge of the needs of the farmers that are being met by the existing system. It must be shown that these two approaches create the opportunities to satisfy these needs more efficiently in order to give an incentive for participation by the farmers. He pointed out that the potentials indicated by analyses at the micro level will themselves be a factor in policy decisions, especially in choosing between alternative agricultural development strategies of improvement or transformation.

The accurate measurement of input-output farm data, in particular the crop labor inputs at varying yield levels and the corresponding returns to labor, in view of the general constraining effect of labor availability on crop production, is especially important for successful agricultural planning.

To improve the economic planning process at the macro level and to improve management at the household level, accurate and reliable farm data can be extremely useful. Various kinds of data are needed in the process of economic planning, particularly in the agricultural sector, and decision-making process depending upon the objectives in view. It is recognized that the objectives of a study, the resources constraints and type of data are the major factors which influence the choice of data collection methods. In the context of the developing countries, data collection methods typically require

memory recall from farmers in an interview situation.

The most common method has employed a single visit survey. However, some studies have used multiple visits of weekly or even greater frequency. This method has been referred to as the "cost-route" method. One of the more important issues for the choice of data collection method is the required level of accuracy for the data being collected.

B. Objectives of the Study

Farm management research in developing countries originally focused on the collection and analysis of input-output type data obtained by survey method for the purpose of improving resource allocation of individual farmers. More recently, with the belief that this has not been a cost effective approach for developing countries (Collinson, 1972), farm management research has broadened its objectives to provide information to provide a stronger foundation micro-level data that may be used for policy analysis and decision-making. Some modifications of farm management research have been made to fit the situation in developing countries, usually by using more reliable (and more costly) methods, such as frequent visits or field measurement, for obtaining input-output data (Norman, 1973; Spencer, 1972).

The multiple visit method uses carefully designed interview schedules to be administered in repeated visits to participant households during a month and extending over a rele-

evant period, such as a crop season or calendar year. The advantage of the multiple visit approach over other survey types is that less reliance is placed on a respondent's ability to remember distant events. Two factors are critical in the design of a survey using the multiple visits method which affect the cost of collecting, processing and using information as well as its reliability.

The first is interview frequency, or the number of times during a fixed length of time (week, month) a particular farmer is visited. The second is the reference period used in an interview or length of time over which a respondent is requested to report during one interview.

Theoretically, it is argued that the collection of input-output data and certain difficult data stocks (i. e., livestock) the weekly or bi-weekly visits provide greater accuracy than the single visits (i.e., one-shot survey) because the recall period is shorter, all other things being equal.

The weekly or bi-weekly visits are said to be appropriate to collect continuous and non-registered data (family labor) while one-shot survey is appropriate for the single point and registered data (hired labor, important crop sales) (Lipton and Moore, 1972; Norman, 1973).

The first objective of this study is to describe the Mandara Area Development Project in the Cameroon where these

two methods (bi-weekly and one-shot survey) are used to collect input-output data at the farm level.

The second objective will be an empirical assessment of the accepted views concerning the one-shot survey and the weekly or bi-weekly visits. Data collected from the Mandara Area Development Project in 1980 will be used. Labor and other input data were gathered by one-shot survey on a recall basis for specific crop enterprises for previous growing season (1979). Labor data and other input data were collected on a bi-weekly basis for two crop and one animal enterprise currently operating on each farm (1980).

The third objective will be to prescribe, based upon the results of the study and empirical evidence from other studies, recommendations for collecting input-output farm data for economic planning and decision-making for the developing countries, particularly for the African ones.

C. Outline of Remaining Chapters

In Chapter 2, we review the literature where the different characteristics and quality of data are described. These factors influence survey design. Also, the recent findings on one-shot surveys and multiple surveys are given.

In Chapter 3, the detailed description of the Mandara Mountains Area is given along with the agricultural production systems.

In Chapter 4, the data collection methodology of the

Mandara Mountains Integrated Development Project is described focusing on the sampling procedure, selection of farmers and selection and training of enumerators.

In Chapter 5, we present results obtained using the correlated t-test to determine whether the differences between the 1980 data and 1979 are significantly different from zero. In addition two villages, Rhumzou and Madakonay, are chosen to test the quality of enumerators.

Finally, Chapter 6 provides a summary and conclusions. Suggestions are given on how to design surveys in order to test the accuracy of data. Variables such as area of fields and crop yields are the leading variables to be estimated in these surveys.

II. REVIEW OF LITERATURE

A. Characteristics/Quality of the Data

A. 1 Discrete vs. Continuous Data

Fox (1979) defined a variable as a characteristic which in a given research project can have more than one value. Value is used to include quantitative and qualitative. A variable can be discrete or continuous. A discrete variable is a variable for which classification or measurement is possible only in whole units (i.e., number of farmers in a given area). A continuous variable is a variable for which measurement is possible in both whole and fractional units (i.e., age of household head in a given farm family). Continuous variables may have both quantitative and qualitative aspects, and can always be conceptualized as representing a continuous progression from the smallest possible amount of the variable to the largest possible amount. There exist various types of discrete variables. A discrete variable can be a dichotomous one when only two gradations are possible (yes or no). A discrete variable can be a limited-category variable when there is three, four, five or six gradations. For example, marital status (i.e., single, engaged, married, separated, divorced).

The third type of discrete variable is the type with

more than six gradation but less than, say, 20 gradations of responses, the multiple category variable which has at least 20 gradations of responses and which has no upper limit.

A. 2 Registered vs. Non-Registered Variable

Variables such as age, weight, quantity harvested of a crop, and the use of labor are continuous variables, for all can be conceptualized as varying along a continuum with measurement theoretically possible at any point along the continuum. Lipton and Moore (1972) have drawn a very useful distinction between single point and continuous data and between registered and non-registered data. They have classified activities along two continua.

(a) There is a continuum ranging from single point to continuous, this refers to the length of time taken to complete the activity concerned. Thus, the use of labor is 'continuous' since it takes place throughout the agricultural year, while the wheat-harvest is 'single point,' in that it is completed in a few days.

(b) There is the continuum ranging from registered to non-registered, this to the extent to which circumstances cause the quantities of any particular activity to be registered by the respondent. Thus, a farmer may remember how much hired labor he had to use because he had to pay out the wages, he may forget the size of his cassava harvested because he pulled out a few roots every day over a period of

months whenever it was required in the kitchen.

Different types of data have a bearing on the selection of types of data collection methods. In fact, Norman (1974) and Collinson (1974) have suggested that any data classified in the continuous non-registered class requires frequent interviewing if measurement errors are to be kept at a reasonable level, since memory recall will not be good. The level of accuracy is the key in this issue.

B. Attributes of Reliable Data

Schultz (1978) defined accuracy as the exactness of the estimate of a quantity, while the precision is the exactness of the symbolic representation of the estimate. Accuracy can also be defined as to which estimates are free from errors; it is composed of two main elements: the precision which refers to the dispersion in the sampling fluctuation and the bias which refers to the deviation between the expected value of an estimate and the true population mean. Barnard (1975) includes accuracy as an element of reliability. He concludes that it is desirable that the data being collected are as reliable as possible so as to reduce the likelihood either of their rejection or alternative by their use leading to incorrect decision and action. The various types of reliability are congruence, precision, objectivity and constancy. Reliability may itself be broken down into the three components of accuracy, relevancy and comprehensiveness.

Zarcovitch (1966) lists certain properties, each of which is a necessary although not a sufficient, condition for accurate data including consistency, use of correct tools and procedures, and comparability with existing knowledge.

C. Findings from One-Shot Surveys and Multiple Visits

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 multiple visit interviews. There is considerable controversy as to the advantage 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 errors. Sampling errors can be reduced by using large samples, while most measurement errors are reduced by more frequent visits. Because of lack of appropriate survey designs to test the comparative accuracy of data obtained from one-shot surveys and multiple visits, little evidence is available on this issue. MacArthur (1968) argues that where livestock products are not very important, and where climatic conditions impose a short production season such that all events for the crops concerned can be recorded within only six months or so, the single visit type of study may be appropriate. He argues that although visiting less than weekly

might not be ideal for recording labor inputs, for all other purposes this interval is much too frequent.

Collinson (1972) drawing from his own personal conviction not supported by empirical evidence, argues that when the aim is to collect data solely for planning purposes, a limited visit technique is suitable for collecting even labor input data. Spencer (1973) finds that the Collinson technique is not suitable in situations where the researcher has not in his possession a good body of basic data. He thinks that where detailed farm data are required for production economics studies the cost route or multiple visit method provides the best way of obtaining such information. Norman (1973) finds that frequent visits are required to collect labor, animals and output data while less frequent visits are appropriate to collect other information such as farm inventory, land tenure and retail prices. He suggests the combination of both methods depending upon the kind of data needed.

Farrington (1975) comparing the "work-study"* method in terms of accuracy and costs with other techniques of collecting data, carried out work-study surveys at three frequent visits area in 1973-1974. At most, 4,000 observations were obtained on work performed on the main operations involved in

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*A variant of work - measurement which involved "the direct observation of a worker or a group of workers over a specified time period, followed, at the end of the period, by the measurement of their achievement using the most appropriate physical units" (Farrington, 1975).

five important small-holder crops, disaggregated by crop operation and worker type.

His findings are that, in general, it appears that work-study will produce an estimate of labor requirement some 20%-50% lower than does the frequent visit techniques for field operation and often an estimate of more than 50 percent lower for harvesting operations. Further, Farrington argues that this situation is due by the fact that the work-study operations are of necessity more narrowly defined than are the frequent visit operations.

Collinson (1974) finds two factors are important in deciding the degree of detail and sampling error and the selection of one method or another; the contribution of the activity to the satisfaction of farmers' needs and the absorption of farmers' resources by the activity in question. According to him, when the contribution of the activity to the satisfaction of farmers' needs and the absorption of farmers' resources are large, the activity must be included in the planning model as an independent activity and the sampling error for that parameter is an independent decision. He suggested a standard error of 7.5 percent and 10 percent on parameters judged to be important for the planning model.

Because of lack of appropriate survey design to compare the accuracy of data obtained from one-shot surveys and multiple visits or cost-route method, conclusive evidence is difficult to find. However, some general conclusions seem to

emerge: the frequent visits appear to be more appropriate for the continuous non-registered data. But even here, there is no consensus on how often farmers must be visited (i.e., the period of recall). Muthiah (1965) has estimated that in south India, weekly interviews with cultivators are sufficient to obtain information on hired labor for different crops with a degree of accuracy of $\pm$ 15%. Collinson (1975) finds from his own personal experiences that on the whole, the greater the detail needed or the more complex the system, the more frequently the farmer must be visited. Connell and Lipton (1977) argue that the larger the sample of people, the more questionnaires can be administered over time in a staggered fashion to reasonably typical sub-samples, and the more homogeneous the year with regard to the information sought, the shorter the period over which recall is needed for a given degree of data reliability.

Friederich (1974) argues that while daily interview intervals are felt to involve too much pestering of the farmers, any interval longer than three days results in over-lap or loss of accuracy and is regarded as seriously affecting survey results. Bi-weekly interview intervals are regarded as providing the best tradeoff even though suffering from being costly and generating results that are slow in forthcoming. Further, he affirms that one-shot surveys, properly timed at the end of the production cycle, when farmers have already assessed in their minds the input-output, profit-loss position, have a definite place in the methodology of data collection

and should be--in the light of the magnitude of the general data gap--more widely promoted.

Lynch (1980) in her paper "Analysis of Interview Frequency and Reference Period in Rural Consumption Expenditure Surveys," finds that a tendency for the one period interview subset to generate expenditure estimates which are higher than those based on two interviews per month. On the average, the expenditure estimates of the former are approximately 5.3 percent higher than those of the latter. She also finds that in comparing expenditure estimates from each of the first days of recall with those from each of the second and third days of recall, expenditure estimates based on the first interview are considerably larger than those of the later. In percentage terms, expenditure estimates from the first days are approximately 57.3 percent larger and expenditure estimates from the sum of the second and third days are 30.5 percent larger. This difference is attributed to the presence of conditioning and/or telescoping. But it was not possible to separate these two factors.

Two main implications of the study of Lynch are that an intensive survey methodology is unnecessary for purposes of collecting baseline statistical information on population and expenditure levels and habits and survey designers have to be sensitive to the significant changes in the quality of memory from one day to the next.

She argues that if trained personnel are not available

it may be prudent not to attempt the implementation of the complex multi-visit methodology. When adequate staff is lacking, a simplier survey design might actually generate more accurate results.

It is a general consensus that appropriate improved field collection methodologies for the developing countries will not consist of choosing between one-shot survey or multiple-visit methods but a new one which might be in between. The general conclusions which can be drawn from this review of findings of one-shot surveys and multiple visits are that the kind of data, the objectives of the study and the resources available are the key factors in choosing one method or another.

D. Data Collection Systems and Methods

Critics of the survey methods based upon written questions by the researchers argue that the disadvantage of these methods is that there is, by means of the written questions, a preconception of what is important and records of non-recurent behavior depend for their validity on the accuracy of the memory of the respondent. Connel and Lipton (1975) argue that these methods place a structure, which may be inappropriate, on the data collection process and this becomes especially serious where the questionnaire is not completed by an individual researcher but is delegated to an assistant. Additionally, the questionnaire places special strain on the memory of respondents. Although some reliance on memory is inevit-

able in all types of surveys, a questionnaire demands considerable powers of recall (depending on the time period), with limited possibilities for continuous checking by the field worker or researcher director.

With these short-comings of the survey methods based upon written questions, Byerlee and Tripp (1981) find other shortcomings for the farm management research which, they argue, usually generates an information "bank" at one point in time, or at regular intervals to be called on for general use; data collection is usually confined to input-output information and attempts to understand the systems are made ex post with the aid of farm models constructed with this input-output data.

With the failure of farm management research in solving specific needs felt by farmers, particularly small farmers in developing countries, farming system research approach is being thought of as a new alternative. Farming system research can be defined as the application of the systematic approach to the study of whatever is defined as a farm.

Byerlee and Tripp (1981) in their paper defined a new approach of data collection method, data collection systems and methods in FSR. They argue that this data collection system covers the wide range of approaches from informal interviews to multiple visits or cost route survey--sometimes with direct field or yield measurement.

The framework of this data collection system draws on

the theory of the economics of information with these following points:

First, there is usually a time lag between expenditures of resources for generating information and the impact of the information on decisions. Part of this time lag is due to the time needed to generate information.

Second, information clearly has higher value for some variables than others. Given costs of generating information, the data collection system should be able to efficiently identify those variables about which information has most value, in order to focus research resources to obtain more valid estimates of these variables.

Third, increasing amount of information on a specific variable usually leads to diminishing returns. That is, increasing confidence in value of a specific variable such as the performance of a new variety relative to the farmers' variety may be of decreasing value to decision-makers.

Last, information generation can be sequential with data collected in one stage of the process being used to make decisions about the value of further data collection. This sequencing method is important in designing an efficient data collection system in Farming Systems Research since the ultimate objective is to narrow down from a wide array of possibilities to a few variables on which information will be transferred to the user.

Farming Systems Research may have both short-run and long-run objectives. In the short-run, providing some information quickly to farmers that allows an improvement on their existing system will usually be a priority objective. In the long-run, the Farming Systems Research program will usually consider other users of the information particularly experiment station researchers and policy makers.

Byerlee and Tripp define the characteristics of the data collection methods as follows:

(a) The degree of direct observation--that is whether a variable such as yield is measured directly or is obtained by less direct methods such as asking farmers.

(b) The degree of participation by researchers--this is measured by the extent to which researchers have first hand contact with farmers and their fields.

(c) Degree to which recording is used in the data coltion method--this range from no written recording all the way to the use of a questionnaire to record questions and answers in an interview.

(d) Degree of structure and specificity--this reflects the extent to which a given method elicits specific information in a particular sequence or is open-ended and iterative.

The FSR data collection systems and methods give a particular focus on the team and interdisciplinary approach. It also assumes experienced researchers who must have a sound

knowledge of the area of study, to be able to get meaningful information by observations, measurement and questioning the farmers.

The FSR data collection systems will be more appropriate and more complete than the traditional farm management surveys as a means of collecting information, because focusing on specific problems of a target group and aiming to solve these kinds of problems. Because of its sequential characteristic, action can be taken by farmers or policy makers after a reasonable period of time and not wait until the whole process of data collection is carried out. Where the resources, the skilled and experienced researchers are available, this approach can be successful.

As a general conclusion, it can be said that there is no unique method of data collection--one-shot surveys or multiple visit method--but a possible combination of a whole system of data collection.

The dominance of one method upon another, the degree of observations and measurement, will depend upon the objectives of the study, the kind of data needed, the resources available including the number of trained staff involved and the potential users of this information being collected.

The purpose of this review of literature was to identify some of the issues that could help guide the empirical work of this study. Attention will now be given to a description of the study area which will be followed by presentation of the statistical analysis.

III. DESCRIPTION OF THE MANDARA MOUNTAIN AREA

A. Background

1. General Characteristics

The Mandara Mountains are located in the Margui-Wandala department and the Meri Arrondissement (Diamare department) of the Northern Province of the Cameroon (Map 1). It is characterized by broken rocky mountains, modest plateaus and surrounding low land plains. The population of Margui-Wandala is approximately 500,000 and additional 50,000 people live in the Meri Arrondissement. The estimated population of Margui-Wandala is given in Table 3.1.

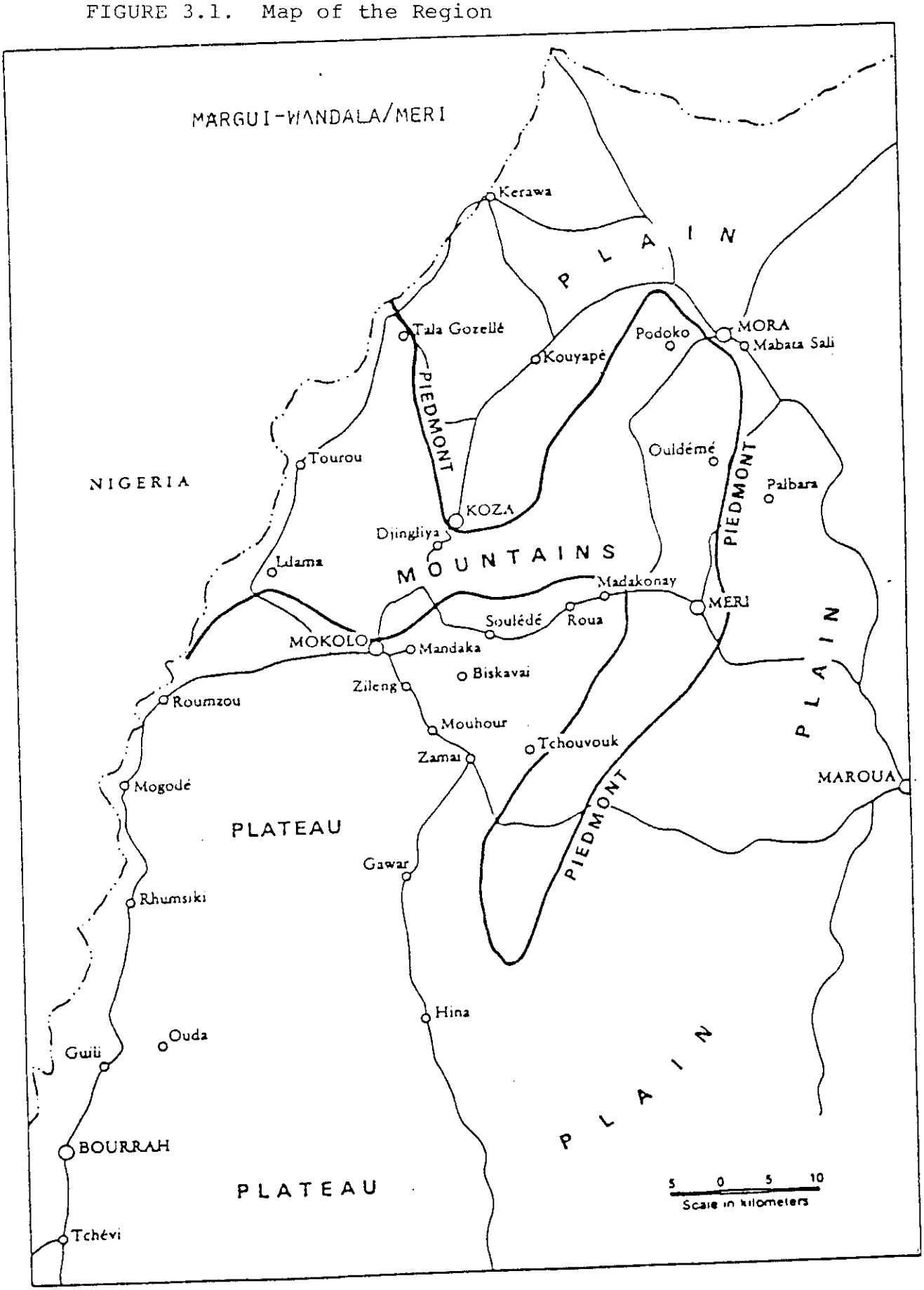
Table 3.1. Estimated Population of Margui-Wandala/ Meri in 1980 by Arrondissement

Arrondissement	Area Km^2	Population	Density/Km^2
Mokolo	3,230	224,925	69.64
Bourrah	660	30,000	45.45
Koza	637	70,000	109.89
Mora	2,408	118,141	49.06
Tokombere[a]	498	53,244	106.91
Meri	460	51,438	111.82
Total	7,893	547,748	69.40

[a]Tokombere is an Administrative District.

Source: Mahamat Chegador, 1980; Budget Communal 1979-1980. Meri Arrondissement.

FIGURE 3.1. Map of the Region



The area is the most densely populated regions in the Cameroon and one of the three major population concentrations in the country (Zalla et al, 1981).

The main non-Muslim ethnic groups of the are given below:

Matakam ou Mafa	100,000
Mofou	44,000
Podokwo	12,000
Mora	3,000
Vame-Mbreme	2,000
Ouldeme	7,000
Mouktele	11,000
Aoulgo	5,000
Guemjek	3,000
Mouyengue	8,000
Mokyo	5,000
Hourza	2,000
Mbokou	4,500
Guelebda	1,000
Mineo	3,000
Hide	7,000
Kapsiki	25,000
Bana	9,000
Djimi	2,000
Goude-Tchede	10,000
Hina	6,000
Daba	15,000
Mada	11,000

The Muslim ethnic groups of the area are:

Wandala or Mandara	17,000
Kanouri or Bornouans	10,000
Arab Chouwa or Choa	5,000
Fulbe or Peuls	4,000

(Hallaire, 1967, p. 26).

Given the high rate of birth and death and the permanent out migration, this population is estimated to be growing at the rate of 2.5 percent per year. At this growth rate, the total population of the department will reach an estimated size of 635,379 in 10 years and 813,263 in 20 years (Holtzman, 1980).

The high population density in the mountains is partially the result of historical conflicts among ethnic groups. The area has seen tensions between its ethnic groups, and some groups have withdrawn into forest-like mountains to insulate themselves from outside. In the past the government tried to develop the area by resettling people from the mountains to the plains, but disinterest and resistance were encountered.

The climate of the Mandara Mountains area is of the Sahelian Sudanic type, modified by the presence of the mountains massif. The temperatures are high through the year with a maximum in April and May and a minimum in November and December. The rainfall decreases from south to north with local variations depending on elevation and aspect. The average annual rainfall of the study area is given in Table 3.2.

Table 3.2. Average Annual Rainfall of the Study Area (in mm)

Station	Mean Rainfall	Standard Deviation	Standard Deviation as % of Mean
Bourrah[1]	1,057.03	200.15	18.9
Hina[2]	837.5	199.67	22.9
Mora[3]	725.0	168.9	23.3
Mokolo[4]	1,060.2	153.7	14.5

[1]Data based on 1954-73 with that for 1969 missing.

[2]Data based on 1957-78.

[3]Data based on 1949-1978.

[4]Data based on 1963-79.

Source: Catholic Mission Ouro-Tada for Mokolo and Service Departmental de l'Agriculture de Margui-Wandala, Rapports Annuels for the others.

2. Ecological Zones

Following Boutrais (1973), the area has been divided into four broad ecological zones, each of which has distinct social and economic characteristics: the plains, the mountains, the piedmont and the plateau lands.

(a) The Plateau - The plateau lands form the southern portion of the project area and they extend from Tcheoi and Bourrah in the south to Mokolo and Soulede in the north. It comprises almost half of the land area of Margui-Wandala department. The plateau has an undulating topography which varies in elevation from 800 meters around Mokolo to nearly 1,000

meters in the Kapsiki area before descending again 800 meters around Bourrah.

Though the majority of the plateau soils are not inherently fertile, they are increasingly being brought under cultivation. The descent of farmers from the surrounding mountains has accelerated over the past 20 years and bush clearance for cultivation has occurred.

The main ethnic groups of the plateau lands are the Kapsiki, the Bama, the Djimi, the Goude and the Baua.

(b) The Mandara Mountains - The Mandara Mountains remain the most densely populated region of the study area. The hills rise to 1,400 meters and the higher rainfall and steep slopes give rise to easy erosion of unprotected soils.

Cultivation in the steep mountain slopes is only possible under the labor intensive systems. The intensive management of the mountains soils often renders them more fertile than those adjacent valleys. The main ethnic groups of the Mandara Mountains are: The Mauktele, the Pedokiro, Mora, Wanie-Mbreme, Ouildeme Nada, Forilgo and Guernjek.

c. The Piedmont - is defined as the narrow area forming the junction between the mountains and the plain. It is an area of relatively recent settlement by people leaving the security of the mountains to settle on the plains.

d. The Plains - the Diamare Plains in the east of the study area and the Plains of Mora and Koza in the north lie

at an altitude of less than 500 meters and are a part of the wide expanse of plains and westward toward Nigeria and eastward toward the lake of Tchad Basin.

The plains receive the lowest rainfall. The low fertility and aridity of much of the area limits its potential for crop production.

B. Agricultural Production Systems

The agricultural systems in the project area have developed as mixed crop and livestock enterprises adopted to the area's diverse ecological conditions. The low level of productivity of the resource is maintained through a complex set of activities including soil conservation, crop rotation, intercropping and complementaries between crop and animal enterprises.

Boulet (1971) and Boutrais (1973) argue that the agricultural systems are founded upon complex and dynamic interactions between the environmental and socioeconomic characteristics of the area. The different agricultural systems of each ecological zone are summarized below.

B.1 The Plauteau - Until the recent descent of people from the terraced mountain areas, the Plateau lands were mainly covered in bushland which was occasionally grazed by the Fulani herds. The movement of farmers from the hills to the Plateau has resulted in widespread bush clearance for cultivation of cereals and beans for subsistence. Sweet potatoes, Irish

potatoes, vegetables, tobacco, manioc and sugar cane are the main crops which are being increasingly cultivated along the river valleys in such places as Roumzou and Mandaka. Livestock raising activity is carried out both by the area's farmers and Fulani herders. However, bush clearance for cultivation is limiting the area for grazing and conflict between herders and farmers over access to resources is occurring.

B.2. The Mandara Mountains - In the Mandara Mountains, the hillsides have been sculpted into terraces. Cultivation is only possible with intensive management of the soil resource. The relative productivity of the mountains rapidly declines in production under repeated cultivation. Crop rotation and the preservation of Acacia Albida and other trees are measures taken to maintain the fertility of the areas of Mandara Mountains. Farmers in the area, grow cereals and beans for subsistance while groundnuts are their most important cash crop. Livestock, often stall-fed within the compound during the growing season, are important component of farm income.

B.3 The Piedmont - Settlement in the area is relatively recent as Montagnards have left the security of the mountains to move to lower lands often under intensive administrative encouragement. To the dominant subsistance cereal production systems of the Mandara Mountains, is added the possibility of growing lowland crops such as cotton.

B.4 The Plains - The low fertility and aridity of much of the area limits its crop production. Farming is con-

centrated on the recent alluvirals, where cotton reproduction by Mandara farmers predominates. Around the villages, the cultivated area is expanding as immigrants from the mountains clear land but away from the streams, productivity is low.

Herding by Fulani and Arab Choa livestock owners is the dominant economic activity over much of the area.

C. Infrastructure and Other Facilities of the Area

The infrastructure of the area is poor; there are no paved roads and no railroads. There are main roads from Mokolo to Maroua, to Garoua, to Kozo. There are around 14 health centers (dispensaries) managed by Catholoic Missions or by government agencies. There are several primary schools at Mokolo, Kozo, Bourrha, Guili, Meri, Mora, Soulede, etc. Two high schools at Mokolo and Mora. The area is the poorest of the country, gauged by income, literacy, infant mortality, nutrition and education statistics.

The population of the area is primarily rural although there are some four rural towns which are taking the characteristics of urban areas and serve as centers for important economic and social services for the rural population. They are Mokolo, Mora, Koza and Meme (Holtzman, 1980). There are two different agricultural extension services in the area the Sodecotton, a parastatal, which concerns itself almost

exclusively with cotton production and the Minagri, the extension service funded by the Ministry of Agriculture and has the mandate to concern itself with crops. The poor infrastructure system isolates many areas of the region which are already removed from major markets.

IV. DATA COLLECTION METHODOLOGY OF THE MANDARA MOUNTAINS INTEGRATED DEVELOPMENT PROJECT

Traditionally farming systems research has been based upon frequent (twice weekly) interviews covering the broad range of farm family activities and enterprises. Due to financial, as well as time contraints, this approach was not suitable for the Mandara Mountains Integrated Development Project (Lev, 1980). Instead a two stage research process was followed. In the first stage, an extensive survey of 36 villages in the project area was taken followed by an intensive survey of five villages (initially six villages).

The basic task of the extensive survey was to summarize the general outlines of the farming systems present in the project area through an analysis of last year's harvest data. It was a multiple purpose interview. A more complete discussion of the statistical properties and the sampling procedures is presented in Zalla (1980).

The Intensive Survey

There were two basic goals of the intensive survey research. The first was to validate in specific villages some of the broad general conclusions which were drawn from the extensive survey. The second and more important goal was to go beyond the mere description of the farming systems, and begin to capture the dynamics of the processes taking place (Lev, 1980).

A. SAMPLING PROCEDURE

A.1 Village Selection

Based upon the results of the extensive survey six villages, which were later reduced to five, were chosen purposively on the basis of the farming systems characteristics to be studied throughout the remainder of the cropping year. The survey villages by region and ethnic group are given in Table 4.1 below.

Table 4.1. Survey Villages by Region and Ethnic Composition

Village	Canton/Arrondissement		Principal Ethnic Group Served
	Mountain Region		
1. Dkingliya	Koza	Koza	Mafa
2. Mazai	Kova	Koza	Mafa
3. Tala Gozelle	Meskota	Koza	Mafa
°4. Ldama	Matakam-Sud	Mokolo	Mafa
5. Ldamtsai	Matakam-Sud	Mokolo	Mafa
6. Mokola	Matakam-Sud	Mokolo	Mafa
°7. Madakonay	Matakam-Sud	Mokolo	Mafa
8. Magoumaz	Matakam-Sud	Mokolo	Mafa
°9. Manguirda	Douroum	Meri	Mofou
10. Menguer	Doulek	Meri	Mofou
11. Gamnaga	Zouleva	Mora	Mouktele
	Piedmont Region		
1. Djeleng	Mofu-Sud	Mokolo	Mofu
2. Goudour	Moknong	Mokolo	Goudour/Mofu
3. Mada	Mada	Mora	Mada
4. Makoulahe	Podoko-Nord	Mora	Podoko
5. Mabata Sali	Mora Massif	Mora	Mada/Mandara
6. Maltamaya	Gaboua	Koza	Mafa
°°7. Palbara	Palbara	Mora	Mouyengue

Table 4.1 (cont'd.)

Village	Canton/Arrondissement		Principal Ethnic Group Served
	Plateau Region		
1. Djeki	Tehevi	Bourrah	Tchevi
°2. Ouda	Guili	Bourrah	Bana
°3. Rhumzou	Mogode	Mokolo	Kapsiki
4. Kila	Mogode	Mokolo	Kapsiki
5. Rhumsiki	Mogode	Mokolo	Kapsiki
6. Taifara	Hina	Mokolo	Bana
	Plains Region		
1. Hina Marabak	Hina	Mokolo	Hina
2. Zamalao	Boula	Mokolo	Guiziga
3. Ouro Sissi	Godola	Meri	Fulbe/Guiziga
4. Mbozo	Mbozo	Meri	Mandara/Fulbe
5. Kidji Kerawa	Kerawa	Mora	Mandara
6. Klissawa	Kossa	Mora	Fulbe/Ouldeme Boenouan
7. Makalingay	Makalingay	Mora	Mandara
8. Tamballam	Kolofata	Mora	Arabe Choa
9. Warba	Warba	Mora	Mandara
10. Quartier-Wagaouma	Meme	Mora	Mandara/Toupo Houza
11. Serawa	Serawa	Mora	Zoulgwa
12. Mgetchewe	Mozogo	Koza	Mafa/Mandara

°Intensive Survey Sites

°°Intensive Survey Site, later dropped

Farming Systems Characteristics of Selected Villages

In the extensive survey, the survey area was divided in terms of four broad ecological systems. The mountains represent the most traditional and least market-oriented of those zones. Few purchased inputs are brought in and few outputs flow out. Although many mountain families produce seven or more different crops, the vast majority of land and labor

time is reserved for sorghum/millet, peanuts and cowpeas. Three of the sites were selected for the intensive survey. Ldama, a Mafu village which lies to the east of Mokolo, is the southern most extreme of the mountain areas around Mokolo. Ldama represents a relatively rich village having diversified cropping patterns and a fair amount of livestock.

Manguirda, a Mofou village in Meri arrondissement, presents a stark contrast to Ldama. The village, according to the interviewing suffers a substantial yearly deficit in food crops. Livestock holdings, which play an important role throughout the region as insurance when crops fail, are small in Manguirda and the majority of farmers are forced to migrate in search of wage labor on a regular basis in order to alleviate their food deficit.

A similar situation exists in Madakonay, a Mafa village situated on the road between Mokolo and Meri. Although placed in the mountains in the extensive survey, Madakonay should be placed in the "Northern" Plateau. The farmers in Madakonay cultivate the flat land at the foot of the mountains in which their fathers lived.

The area termed the Plateau in the extensive survey has since been renamed the "Southern" Plateau. The farmers in this region, while still using very limited quantities of purchased inputs differ remarkedly from their counterparts to the immediate north. Having more and in many cases, better land at their disposal, the farmers on the Southern Plateau

produce and sell a more diverse range of crops. Peanuts, sweet potatoes, and white potatoes are the three most important market-oriented crops which complement the basic cereal crops. The diversity of the Southern Plateau systems enable the farmers there to display a greater resiliency and flexibility in response to external shocks. Even if one or two major crops fail, there are others to fall back upon.

Two of the intensive survey sites, Ouda and Rhumzou, are located in the Southern Plateau. Both have high food and cash crop production as well as substantial numbers of small and large ruminants. They, thus, offer marked contrast to the poorer sites mentioned above. The two other broad ecological zones, the Plains and the Piedmont, lie largely within the sphere of influence of Sodecotton and, thus, are not in the primary project area. The Plains agricultural system has undergone the greatest degree of transformation in recent years. Farmers in the region, induced by the expansion of cotton production, purchase more inputs, consult agricultural extension agents more frequently, and exhibit the clearest market orientation of any farmers in the survey area. The emphasis on cotton production in the rainy season has also resulted in the expansion of dry season sorghum in this zone. Agricultural activities has thus taken on a year-long scope. The influence of cotton growing may also be seen in the other cropping enterprises in the Plains. Whereas, according to the extensive survey, more than 80 percent of the farmers in

the three other regions continue to practice intercropping, it was found that more than 70 percent of the farmers in the Plains sole cropped exclusively. Use of manure also dropped off markedly in this zone. Whereas, 96 percent of the farmers in the mountains, 88 percent in the Piedmont and 79 percent in the Plateau used manure on their fields; only 55 percent of Plains farmers reported using manure.

The Piedmont region represents the interface of the mountains and the Plains systems in more than just the physical sense. Many similarities can be drawn with the Northern Plateau in that the Piedmont farmers have only recently moved off their terraces. Although Sodecotton is represented in the region, in most Piedmont villages only one-third to one-half of the farmers are engaged in cotton production. The other farmers continue to depend upon sorghum, cowpeas, and peanuts.

Palbara, the sixth intensive survey was an example of such a village. Midway through the second series of interviews, the decision was taken to drop Palbara for logistical reasons. Although Manguirda is a mountain village, it was felt that the key aspects of the Piedmont system could be captured there since a third of the farmers of Manguirda descend to cultivate cotton fields in the surrounding plains.

A.2 Farmer Selection

After selecting the six villages, a listing

of all households in each village was used to choose twenty-four (24) farmers, selected at random from the list for each village. This yielded a sample of 120 farmers, but eight dropouts reduced that figure to 112. Poor cooperation was given as the reason for the dropouts.

A.3. Enumerator Training and Supervision

Five enumerators were selected and trained. They were all high school leavers with elementary certificates (CEPE), except for one person who had a high school diploma (BEPC). All these enumerators participated in training for both the extensive and intensive surveys. Training for administering the surveys was given in three two-week sessions from April through July 1980. Initial training in April 1980 was focused on survey instruments other than those used in the intensive survey. Another two-week training period in early June emphasized the intensive survey, and focused on the techniques of interviewing. A final two-week training program in late July 1980 dealt with the questionnaire for the intensive survey, the refinement of methodology and the practice of interviewing. There was one enumerator per village and at any given time, one to three supervisors (usually two). Three villages retained the same enumerators throughout the extensive and intensive surveys; one village received an experienced enumerator, transferred from another village when theirs quit and one village was provided a new job-

trained enumerator midway through the intensive survey.

Supervision was very close. Both supervisors and the research worker interviewed every farmer at least once. The research worker took final responsibility for the quality of the data.

In the field judgments were made as to which data were correct and would be retained. Thus, it is somewhat difficult to tell if the actual data recorded came from the enumerator, supervisor or research workers.

B. QUESTIONNAIRE

The questionnaires were administered every two weeks and the questions were almost entirely pre-coded. The interview schedules were field-checked frequently by supervisors and scrutinized carefully by the research worker before key punching. The key punching was done in the States. Simple error checks were carried out on punched data by the research worker

C. UNIT OF ANALYSIS

The sample population was approached from two separate perspectives--the whole farm including the farm household and the enterprise. An enterprise, for the purpose of the project, was a sole or mixed crop associated with a particular field.* The criterion for selecting an enterprise for the in-

*A field is an area devoted to one or multiple crops which is considered by the farmer to be a single unit. Contiguous

tensive survey was:

(1) It occurs on a large proportion of farms in the project area; or

(2) It appears to possess considerable potential for raising incomes through its expansion and improvement. The main enterprises selected were pure sorghum (rainy season and dry season), sorghum/cowpeas, sorghum/millet, millet, millet/cowpeas, maize, sweet potatoes, white potatoes, souchet, peanuts, peanuts/sesame and cotton. For the enterprises involved in intercropping, only fields which had proportions of each crop similar to the standard proportional mix defined for that enterprise were selected.

The data collected on two cropping enterprises (fields) per household are:

(1) field composition

(2) labor

(3) yield

(4) other inputs

Other data collected include total number of fields, income, purchases, livestock, crop problems. Gifts received and given, and a complete list of activities for one day per month, for selected households, were also collected.

D. CARRYING OUT THE SURVEY

The 1979 data were collected during the last two weeks

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parcels may or may not be considered to make up a single field. Non-contiguous parcels of the same or mixed crops are regarded as a separate fields. The farmers had some discretion in deciding how to demarcate their fields.

of June 1980 on a memory recall basis. It was a one-shot survey. The 1980 data collection began in July and continued through February 1981 on a bi-weekly basis.

V. HYPOTHESES AND RESULTS OF COMPARISON

Year to year seasonal variation makes it difficult to examine methodological issues using data from two different cropping seasons. We have sought to minimize this difficulty by examining aspects of the cropping system which should vary relatively less on a year to year basis than would, for example, crop yields. Although the null hypothesis that the two years would be identical for the variables considered is not totally satisfactory, it constitutes an essential assumption for our research.

A summary of results is given in Table 5.1 to show the diversity in the area of study. The general objective in looking at these hypotheses is to estimate the magnitude and types of differences between two sets of estimates. For each hypothesis, we will look at five villages taken together, and then individually at the two villages which had the worst (Rhumzou) and the best (Madakonay) enumerators, respectively, for the collection of 1979 survey data.

The underlying reason for the selection of Rhumzou and Madakonay is that the inter-seasonal factors are the same for the two villages. Therefore, the only reasons for divergent changes between the 1979 and 1980 data is a difference in enumerator quality.

Table 5.1 Table of Results

Variables	Number of fields		Proportion owned by HHH *		Total Area for household		Average Area per field		No. of different crops grown	
Villages	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980
Total sample (N=112)	6.00	10.44	.67	.58	30.75	41.49	5.23	4.16	7.71	10.69
Ouda (N=24)	6.04	11.54	.81	.79	55.44	71.57	9.28	6.03	6.96	11.62
Rhumzou (N=19)	6.37	17.16	.70	.54	31.63	57.20	4.86	3.17	7.21	9.21
Ldama (N=23)	7.09	8.83	.59	.56	32.75	31.27	4.49	4.41	8.78	10.69
Madakonay (N=23)	6.48	8.96	.53	.47	9.1	11.30	1.41	1.33	10.56	10.74
Manguirda (N=23)	4.09	6.83	.73	.69	23.91	37.55	5.85	5.61	4.96	10.83

HHH* = Head of household

The hypothesis is that the poor enumerator's data will be more divergent and the good enumerator's data will be less divergent from the 1980 data. The detailed differences between 1979 and 1980 are discussed in the following section. A pairwise comparison statistical t-test is carried out for all the different hypotheses.

A. Hypothesis 1: Number of Fields

We do not believe that, on a year to year basis, the number of fields will vary greatly. Thus, if the 1980 average number of fields per household is much greater than the 1979 number of fields per household, we would feel justified in arguing that more frequent interviewing identified more fields.

Table 5.2. Results of Comparison of Number of Fields

$N = 112$ $\quad \bar{N}_o$: 1979 average number of fields per household

$H_o: \overline{N_{oi} - N_{1i}} = 0$ $\quad \bar{N}_1$ 1980 average number of fields per household

$H_a: \overline{N_{1i} - N_{oi}} > 0$ $\quad i = 1, 2 \ldots 112$

$\bar{N}_o$	$\bar{N}_1$	(Difference) Mean	t- Value	Probability	Significance*
6.0 (2.254)[1]	10.44 (6.391)	4.44 (5.854)	(8.02)	.000	S

*S: Significant at the .05 level

**Standard deviation for the series of the mean is given in parentheses

The results of the comparison indicate that the 1980 average number of fields per household is much greater than the 1979 average number of fields per household, 1.74 times the 1979 data. The high standard deviation of the 1980 average number of fields per household, given in parentheses, is caused by variability in farming systems and family size in the different villages. This is an accurate reflection of the diversity of the region but was not adequately captured by the one-interview format. In sum, we can conclude that a substantial number of fields were missed in the 1979 survey.

Hypothesis 1(a): Number of fields per household on a village by village basis.

Table 5.2(a). Results of Comparison of Number of Fields per Household at Rhumzou

$N = 19$

$H_o: \overline{N_{oi} - N_{1i}} = 0$

$H_a: \overline{N_{1i} - N_{oi}} > 0$

$\bar{N}_o$: 1979 average number of fields per household at Rhumzou

$\bar{N}_1$: 1980 average number of fields per household at Rhumzou

i : 1.2 -- 19

$\bar{N}_o$	$\bar{N}_1$	(Difference) Mean	t- Value	Probability	Significance*
6.37 (2.314)	17.16 (8.153)	10.79 (6.917)	6.80	.000	S

*S: Significant at the .05 level

Table 5.2(b). Results of Comparison of Number of Fields per Household at Madakonay

$N = 23$

$H_o: \overline{N_{oi} - N_{1i}} = 0$

$H_a: \overline{N_{1i} - N_{oi}} > 0$

$\bar{N}_o$: 1979 average number of fields per household at Madakonay

$\bar{N}_1$: 1980 average number of fields per household at Madakonay

$i = 1, 2 \text{ --- } 23$

$\bar{N}_o$	$\bar{N}_1$	(Difference) Mean	t-Value	Probability	Significance*
6.48 (1.702)	8.96 (4.446)	2.48 3.703	3.21	.002	S

*S: Significant at the 0.50 level.

Results of the test indicate that for both villages the tests are significant. As was expected, the Rhumzou figures show inconsistent results for the two years (the 1980 data is 2.69 bigger than the 1979) while the Madakonay figures seem consistent (the 1980 data is 1.38 bigger than the 1979). Rhumzou's data increase, therefore upholds our expectation that changes will be greater in Rhumzou than in Madakonay data.

B. Hypothesis 2: Percentage of Distribution of Ownership of Fields

We would not expect percentage of ownership of fields to vary from year to year. Our hypothesis would be that in 1980 a higher percentage of fields would be owned

by members of the household other than the head of the household.

Table 5.3. Results of Comparison of Percentage of Distribution of Ownership of Fields

$N = 112$		$\bar{P}_o$: 1979 average proportion of fields owned by the head of the household			
$H_o: \overline{P_{oi} - P_{1i}} = 0$		$\bar{P}_1$: 1980 average proportion of fields owned by the head of the household			
$H_a: \overline{P_{oi} - P_{1i}} > 0$		$i = 1, 2 \text{ --- } 112$			
$\bar{P}_o$	$\bar{P}_1$	(Difference) Mean	t-value	Probability	Significance*
.67 (.216)	.58 (.238)	.09 (.227)	4.14	.000	S

*S: Significant at the .05 level

The results of the test are significant and showed that more frequent visits did identify more fields owned by household members other than the head of the household.

Hypothesis 2(a): Percentage distribution of ownership of fields on a village by village basis.

Table 5.3(a). Results of Comparison by Percentage Distribution of Ownership of Fields at Rhumzou

N = 19

H_o: $\overline{P_{oi} - P_{1i}} = 0$

H_a: $\overline{P_{oi} - P_{1i}} > 0$

$\bar{P}_o$: 1979 average proportion of fields owned by the head of the household

$\bar{P}_1$: 1980 average proportion of fields owned by the head of the household at Rhumzou.

i = 1,2 --- 19

$\bar{P}_o$	$\bar{P}_1$	(Difference) Mean	t-value	Probability	Significance*
.70 (.254)	.54 (.247)	.16 (.245)	2.76	.0065	S

*S: Significant at the .05 level

Table 5.3(b). Results of Comparison of Percentage Distribution of Ownership of Fields at Madakonay

N = 23

H_o: $\overline{P_{oi} - P_{1i}} = 0$

H_a: $\overline{P_{oi} - P_{1i}} > 0$

$\bar{P}_o$: 1979 average proportion of fields owned by the head of the household at Madakonay

$\bar{P}_o$: 1980 average proportion of fields owned by the head of the household at Madakonay

i = 1 --- 23

$\bar{P}_o$	$\bar{P}_1$	(Difference) Mean	t-value	Probability	Significance*
.53 (.127)	.47 (.177)	.06 (.166)	1.71	.051	NS

*NS: Not significant at the .05 level

For Rhumzou, the test is significant at the .05 level while for Madakonay, it is not significant at the .05 level. This could be explained by the fact that the good enumerator needed only the one-shot survey to identify the fields owned by the different members of the household, while the poor enumerator needed more frequent visits in order to collect this data adequately. The figures show that the change between 1979 and 1980 is greater in Rhumzou than in Madakonay.

C. Hypothesis 3:

Total area per household and average area per field per household as measured using a proxy variable for field size (seed planted).

This proxy variable would be expected to be consistent from year to year. The hypothesis would be that total area would be greater (more fields) but that average area per field would be less (the additional fields would be smaller).

Table 5.4. Results of Comparison of Total Area Per Household and Average Area per Field

N = 112

H_o: $\overline{TA_{oi} - TA_{1i}} = 0$

H_a: $\overline{TA_{1i} - TA_{oi}} > 0$

$\bar{\bar{TA}}_o$: 1979 mean total area for household

$\bar{\bar{TA}}_1$: 1980 total area for household

i = 1,2 --- 112

$\bar{\bar{TA}}_o$	$\bar{\bar{TA}}_1$	(Difference) Mean	t-value	Probability	Significance*
30.75 (24.156)	41.49 (39.705)	10.74 (29.150)	3.90	.000	S

N = 112

H_o: $\overline{\bar{AA}_{oi} - \bar{AA}_{1i}} = 0$

H_a: $\overline{\bar{AA}_{oi} - \bar{AA}_{1i}} > 0$

$\bar{\bar{AA}}_o$: 1979 mean total area for household

$\bar{\bar{AA}}_1$: 1980 average area per field per household

i = 1, 2 --- 112

$\bar{\bar{AA}}$	$\bar{\bar{AA}}$	(Difference) Mean	t-value	Probability	Significance*
5.23 (3.589)	4.16 (3.363)	1.07 (3.265)	3.45	.0005	S

*S : Significant at the .05 level.

The results are significant at the .05 level. The more frequent visits did pick up more total area and smaller fields. The size of new fields is 2.421 compared to the 1980 average area of fields (i.e., 4.1636) and the 1979 average area per field (i.e., 5.2276).

Hypothesis 3(a): Total area per household and average per field on a village by village basis.

Table 5.4(a). Results of Comparison of Total Area per Household and Average Area per Field at Rhumzou

N = 19

H_o: $\overline{TA_{oi} - TA_1} = 0$

H_a: $\overline{TA_{1i} - TA_{oi}} > 0$

$\bar{\bar{TA}}_o$: 1979 mean total area for household in Rhumzou

$\bar{\bar{TA}}_1$: 1980 mean total area for household in Rhumzou

i = 1,2 --- 19

$\bar{\bar{TA}}_o$	$\bar{\bar{TA}}_1$	(Difference) Mean	t-value	Probability	Significance*
31.63 (19.565)	57.20 (38.918)	25.57 (41.651)	3.53	.001	S

*S : Significant at the .05 level

N = 19

H_o: $\overline{AA_{oi} - AA_{1i}} = 0$

H_a: $\overline{AA_{oi} - AA_{1i}} > 0$

$\bar{\bar{AA}}_o$: 1979 mean average area per field in Rhumzou

$\bar{\bar{AA}}_1$: 1980 mean average area per field in Rhumzou

i = 1, 2 --- 19

$\bar{\bar{AA}}_o$	$\bar{\bar{AA}}_1$	(Difference) Mean	t-value	Probability	Significance*
4.86 (1.558)	3.17 (1.081)	1.69 (1.787)	4.12	.0005	S

*S : Significant at the 0.50 level

Table 5.4(b). Results of Comparison of Total Area per Household and Average Area per Field at Madakonay

N = 23

H_o: $\overline{TA_{oi} - TA_{1i}} = 0$

H_a: $\overline{TA_{1i} - TA_{oi}} > 0$

$\bar{\bar{TA}}_o$: 1979 total area per field in Madakonay

$\bar{\bar{TA}}_1$: 1980 total area per field in Madakonay

i = 1,2 --- 23

$\bar{\bar{TA}}_o$	$\bar{\bar{TA}}_1$	(Difference) Mean	t-value	Probability	Significance
9.1 (5.551)	11.30 (6.139)	2.19 (5.646)	1.86	.038	S

*S : Significant at the .05 level

N = 23

H_o: $\overline{AA_o - AA_1} = 0$

H_a: $\overline{AA_{oi} - AA_{1i}} \geq 0$

$\bar{\bar{AA}}_o$: 1979 average area per field in Madakonay

$\bar{\bar{AA}}_1$: 1980 average area per field in Madakonay

i = 1,2 --- 23

$\bar{\bar{AA}}_o$	$\bar{\bar{AA}}_1$	(Difference) Mean	t-value	Probability	Significance*
1.41 (.735)	1.33 (.453)	.08 (.865)	.43	.334	NS

*NS : Not significant at the .05 level

The results of the comparison indicate that for Rhumzou, the tests are significant, while for Madakonay, the test on average area per field is not significant. One reason for this lack of significance of the average field area in Madakonay might be that, although there was a difference in the number of fields in Madakonay (1979 number of fields was 6.478 versus the 1980 average number of 8.956), the data in Madakonay were more consistent because of the skills of the enumerator and this makes the test on average area per field in Madakonay not significant. For Rhumzou, there was an inconsistency in the 1979 and 1980 data due to slip-shod data gathering and reporting by the enumerator which could be the reason why the test on the average area per field is significant.

The assumption concerning the test on a village by

village basis was that the difference between the 1979 and 1980 data for Rhumzou would be greater than the difference between the 1979 and 1980 data for Madakonay because of the quality of the enumerator.

Our conclusion is that the expectations were confirmed. In fact, for the total area per household in Rhumzou the difference between 1979 and 1980 is 25.57 versus 2.19 for Madakonay; for the average area per field, we have for Rhumzou a difference between 1979 and 1980 data of 1.69, versus .08 for Madakonay.

D. Hypothesis 4: Number of different crops grown by households

The hypothesis would be that larger number of crops in 1980 is due to greater enumerator accuracy.

Table 5.5. Results of Comparison of Number of Different Crops Grown by Households

$N = 12$

$H_o: \overline{N_{oi} - N_{1i}} = 0$

$H_a: \overline{N_{1i} - N_{oi}} > 0$

$\bar{N}_o$: 1979 average number of crops grown by households

$\bar{N}_1$: 1980 average number of crops grown by households

$i : 1, 2 \text{ --- } 112$

$\bar{N}_o$	$\bar{N}_1$	(Difference) Mean	t-value	Probability	Significance*
7.71 (2.629)	10.6 (2.417)	2.97 (3.483)	9.03	.000	S

*S : Significant at the .05 level

The results of the comparison are significant at the .05 level and indicate that the more frequent visit did pick up more crops grown by the household.

The results of the comparison did indicate that the difference is significant for Rhumzou and not significant for Madakonay. The 1980 data is 1.27 greater than the 1979 data for Rhumzou which is 1.01. Again, the change between the 1980 and 1979 is greater for Rhumzou than for Madakonay. The implication of this analysis might be that, for a good enumerator, the one-shot survey is sufficient to collect the number of crops grown by households, while more frequent visits are necessary for the poor enumerator to come up with an acceptable estimate of the number of crops.

The number of principal crops in the field is given in Table 5.6 to complete the information on the number of crops grown by households. From Table 5.6, it may be seen that principal crops in the field did increase in absolute number although some principal crops such as sorghum, peanuts, corn, and rub decreased as percentage of total. Principal crops such as cotton, potatoes and sugar remain the same in terms of percentage while principal crops such as beans, sweet potatoes, bambara groundnuts and rice increased in terms of percentage of total. The 1980 data seem to locate more principal crops grown by women in the household such as bambara groundnuts.

Table 5.6 Principal Crops in Field

Principal Crop in Field	1979 Absolute Number	1979 % Of Total	1980 Absolute Number	1980 % Of Total
Sorghum	223	33	360	31
Beans	8	1	22	2
Peanuts	140	21	210	18
Cotton	7	1	9	1
Sweet Potatoes	50	7	118	10
Potatoes	13	2	20	2
Corn	37	6	58	5
Rub	69	10	103	9
Bambara groundnuts	59	9	170	14
Rice	26	4	55	5
Sugar cane	7	1	9	1
Other	33	5	39	3
Total	672	100	1,173	100

E. Conclusions

The overall results of the tests of different hypotheses indicate that the more frequent visits gave better estimates than the one-shot survey. They also point up the importance of the quality of the enumerator in the collection of data. As a matter of fact, the results of Rhumzou and Madakonay on these different variables show that even in one-shot surveys that a good enumerator can come up with relatively accurate data. The implications of this analysis in survey design are that the one-shot survey with well-trained enumerators and reference periods matching the agricultural seasons, can give accurate enough estimates for variables such as the number of fields, the number of crops grown. Another implication is that it would be difficult to have accurate estimates for field size and crop planted and harvest in a one-shot survey and more frequent visits are needed with close supervision and field measurement of fields planted and harvested to have relatively accurate estimates of field area.

The summary of the results of the different hypotheses are given in Tables 5.7 through 5.9.

As a matter of fact, the multiple visits method picked up fields that were planted but not harvested and also fields discovered by field measuring teams (approximately forty percent of all households in the survey). The results also

Table 5.7. Summary of Results of the Different Hypotheses of the Overall Sample

Hypothesis / N = 112	Hypothesis 1: No. of Fields/ household	Hypothesis 2: Proportion of fields owned by head of household	Hypothesis 3: Total Area/ Hsehld & Average Area/ field		Hypothesis 4: No. of Different crops grown per household
			Total Area/ household	Average Area per field	
Value in 1979	6.00	.67	30.75	5.23	7.71
SD*	2.254	.276	24.156	3.589	2.629
SE*	.604	.020	2.283	.339	.248
Value in 1980	10.44	.58	41.49	4.16	10.68
SD	6.391	2.38	39.705	3.363	2.417
SE	.213	.022	3.752	.318	.228
(Difference) Mean	4.44	.09	10.74	1.07	2.97
SD	5.854	.227	29.150	3.265	3.483
SE	.553	.021	2.754	.309	.329
t-value	8.02	4.14	3.90	3.45	9.03
Probability level of significance	.000	.000	.000	.000	.000
	Significant at α = .05	Significant at α = .05	Significant at α = .05	Significant at α = .05	Significant at α = .05

*SD: Standard Deviation

**SE: Standard Error

Table 5.8. Summary of Results of the Different Hypotheses **for** Rhoumzou

Hypothesis / N = 19	Hypothesis 1: No. of Fields/ household	Hypothesis 2: Proportion of fields owned by head of household	Hypothesis 3: Total Area/ Hsehld & Average Area/ field		Hypothesis 4: No. of Different crops grown per household
			Total Area/ household	Average Area per field	
Value in 1979	6.37	.70	31.63	4.86	7.21
SD*	2.314	.254	19.565	1.558	2.250
SE*	.531	.058	4.489	.358	5.16
Value in 1980	17.16	.54	57.20	3.17	9.21
SD	8.153	.247	38.918	1.081	2.347
SE	1.870	.057	8.928	.248	.538
(Difference) Mean	10.19	.16	25.57	1.69	2.00
SD	6.917	.245	31.541	1.787	3.03
SE	1.587	.056	7.236	.410	.697
t-value	6.80	2.76	3.53	4.12	2.87
Probability level of significance	.000	.0065	.001	.005	.005
	Significant at $\alpha = .05$	Significant at $\alpha = .05$	Significant at $\alpha = .05$	Significant at $\alpha = .05$	Significant at $\alpha = .05$

*SD: Standard Deviation
**SE: Standard Error

Table 5.9. Summary of Results of the Different Hypotheses for Madakonay

Hypothesis / N = 23	Hypothesis 1 No. of Fields/ household	Hypothesis 2 Proportion of fields owned by head of household	Hypothesis 3 Total Area/ Hsehld & Average Area/ field		Hypothesis 4 No. of Different crops grown per household
			Total Area/ household	Average Area per field	
Value in 1979	6.48	.53	9.11	1.41	10.56
SD *	1.702	.127	5.551	.135	1.308
SE *	.355	.026			.273
Value in 1980	8.96	.47	11.30	1.33	10.74
SD	4.446	.177	6.139	.453	1.484
SE	.927	.037			.309
(Difference) Mean	2.48	.06	2.19	.08	.11
SD	3.703	.166	5.646	.865	1.723
SE	.772	.035			.359
t-value	3.21	1.71	1.86	.43	.48
Probability level of significance	.002	.051	.038	.334	.316
	Significant at α = .05	Not Significant at α = .05	Not Significant at α = .05	Not Significant at α = .05	Not Significant at α = .05

*SD: Standard Deviation
**SE: Standard Error

showed the importance of the reference period, the number of interviews and close supervision in survey design.

VI. CONCLUSIONS AND SUGGESTED FUTURE STUDY

A. Conclusions

One of the objectives of this paper was to compare the accuracy of data obtained by two methods of data collection (i.e. one-shot survey and bi-weekly frequency visit) carried out in the Mandara Mountains Integrated Development Project. Variables such as number of fields, distribution of ownership of fields, number of principal crops grown, total area per household and average area per fields were used in the comparison of these two methods of data collection. Although the results of the analysis did indicate that the more frequent visit method provided more accurate estimates of these variables, it would not be wise to conclude that the bi-weekly frequency visit method is more appropriate than the one-shot survey to collect input-output data in the Mandara Mountains Integrated Development Project.

One reason among others is that the survey of the project was not designed to carry out these comparisons. Another reason is that the variables considered in the analysis, although important, are not the ones with first priority for economic planning purpose and decision-making process by the host country. Variables, such as quantity produced, harvested and consumed, labor input would have been more intersting for testing the accuracy of data col-

lection methods. For these different reasons, it would be important to give some suggestions on how to design surveys to test the accuracy of data collection methods.

Clear definition of variables to be studied is essential to research design. For the purpose of this exercise, focus will be on the yield and area estimates for principal crops grown by farmers of the project area. Data on yields are used for many purposes and most attempts at improving agricultural production are aimed at yields. Without adequate data on yields, a judgment is hardly possible on the efficiency and usefulness of the measures taken. Coupled with data on areas, information on yields appears to have primary importance in economic planning. The rate of yield multiplied by the area harvested of a given crop represents the production of that particular crop, and production figures represent a basis for the preparation and formulation of many economic measures.

B. Suggested Future Study

B.1 - Objectives of the Study

The study will be an exercise to design a research undertaking which will compare the accuracy of data obtained by one-shot survey and multiple visit method. In order to carry out this exercise we will maintain the same project area.

Yield and area estimates of principal crops will be

variables of interest. Yield will be defined as the crop output obtained at the time of harvest per hectare. Land area will be defined as harvested area. Principal crops are defined as the top four crops in an array from high to low according to land area occupied on individual farms for a single growing season. This information will be obtained from an informal survey to be discussed later.

B.2 - The Sample Size and Selection of Farmers

The sample size influences the accuracy of data collected. Collinson (1974) stated that the central issue is to keep investigation costs within the resources available while getting information at a level of accuracy to meet the objectives of the study. The accuracy is influenced by the sampling errors and the measurement/observation errors. Sampling errors as described by Moser and Kalton (1972) reflect fluctuation of the sample or population estimates around their expected values. The standard error is the measurement of fluctuation. Boruch (1972) defines measurement errors or response errors as the difference between the recorded response to the inquiry and potentially measurable time, condition associated with that inquiry. It is believed that the one-shot survey reduces the sampling error by increasing the sample size while the more frequent visit method reduces the measurement/observation errors by frequent visits to the farmers. Norman (1973) puts the argument succinctly:

"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 require high visiting frequency and under ceteris paribus conditions. This approach would result in relative high sampling errors." Collison (1974) illustrates the cost involved in these two different methods in the following table.

Table 6.1. The Cost of Increasing Accuracy under given Data Variance and Survey Design Characteristics.

Level of Precision % and of standard error	Sample size	Cost per Area covered (£)	
		Single Unit	Daily Visit
10	100	2,000	12,750
7.5	180	2,900	20,700
5	400	5,600	112,400

The area of the study is given in the following table (6.2). From this table we can distinguish difficult ecological zones: the plains, the mountains, the Piedmont and the plateau. For the selection of village and farm households, these steps will be followed. Also, sample size may be affected by research methodology and extended use of data.

Table 6.2. Survey Area by Region and Ethnic Composition

Village	Canton	Arrondissement	Principal Ethnic Group Surveyed
Mountain Region			
1. Djingliya	Koza	Koza	Mafa
2. Mazai	Koza	Koza	Mafa
3. Tala Gozelle	Moskota	Koza	Mafa
4. Ldama	Matakam-Sud	Mokolo	Mafa
5. Ldamtsai	Matakam-Sud	Mokolo	Mafa
6. Mokola	Matakam-Sud	Mokolo	Mafa
7. Madakonai	Matakam-Sud	Mokolo	Mafa
8. Magoumaz	Matakam-Sud	Mokolo	Mafa
9. Manguirda	Bouroum	Meri	Mofou
10. Menguer	Doulek	Meri	Mofou
11. Gamnaga	Zouleva	Mora	Mouktele
Piedmont Region			
1. Djelong	Mofou-Sud	Mokolo	Mofou
2. Goudour	Mokong	Mokolo	Goudour/Mofou
3. Mada	Mada	Mora	Mada
4. Makoulahe	Podoko-Nord	Mora	Podoko
5. Mabata Sali	Mora Massif	Mora	Mada/Mandara
6. Maltamaya	Gaboua	Koza	Mouyengue
Plateau Region			
1. Djeki	Tohevi	Bourrah	Tohevi
2. Ouda	Guili	Bourrah	Bana
3. Rhumzou	Mogode	Mokolo	Kapsiki
4. Kila	Mogode	Mokolo	Kapsiki
5. Rhumsiki	Mogode	Mokolo	Kapsiki
6. Taifara	Hina	Mokolo	Bana
Plains Region			
1. Hina Marabak	Hina	Mokolo	Hina
2. Zamalao	Boula	Mokolo	Guiziga
3. Ouro Sissi	Godola	Meri	Fulbe/Guiziga
4. Mbozo	Mbozo	Meri	Mandara/Fulbe
5. Kidji Kerawa	Kerawa	Mora	Mandara
6. Klissawa	Kossa	Mora	Fulbe/Ouldeme/Bornouan
7. Makalingay	Makalingay	Mora	Mandara
8. Tamballam	Kolofata	Mora	Arabe Choa
9. Warba	Warba	Mora	Mandara
10. Quartier-Wadouma	Meme	Mora	Mandara/Toubouri/Houza
11. Serawa	Serawa	Mora	Zoulgwa
12. Ngetchewe	Mozogo	Koza	Mafa/Mandara

-- Exploratory (informal) Survey. This exploratory survey is necessary in order to have a better knowledge of the area of study. During the pre-survey investigation, information on the farming system patterns, on agronomic background of the area, on the rainfall patterns, on socioeconomic characteristics of the population, on infrastructure facilities of the area will be collected from secondary sources and from informal interview with persons knowledgeable about the study area.

-- Section of Villages and Farm Households. Once the results of the pre-survey investigation are available, a stratified two-stage sampling method will be used for the selection of respondent units. The strata will be the four well-defined regions of the country. They are assumed to be markedly different among regions but relatively homogeneous within region.

The first stage of sampling will be the geographical/ecological zones. Villages will be selected with probability proportional to the size of the strata. A list of all the villages in each ecological zones are available.

The interpenetrating subsamples concept* will be used

*Replicated or interpenetrating sampling is a flexible

to choose 12 villages at random for each subsample. Once the villages are selected, a listing of all the households will be done to provide the sampling frame for the study. From this sampling frame, a constant size k (i.e.; k = 12) sample for each village will be drawn.

The distribution of villages and households for each subsample will be:

Mountains	4 villages	48 households
Piedmont	2 villages	24 households
Plateau	2 villages	24 households
Plains	4 villages	48 households
Total	12	144

Alternate households drawn will constitute the sub-sample for the one-shot survey method and the remaining group will be for the multiple visit method. Excess households will be drawn to provide for possible refusals or drop-outs.

B.3 - The Questionnaire

The questionnaire design is critical to the accuracy of data being collected. Collinison (1974) finds that the structure of the questionnaire is important in the one-shot survey for the following reasons:

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approach of survey design which consistes of selecting a number of sub-samples rather than one full sample from the population. For further details, See Deming, W.E. (1960). Sample Design in Business Search - Wiley, New York and Mahalnobis, P.C. (1946): Recent experiments in statistical sampling in the Indian Statistical Institute, Journal of the Royal Statistical Society, 109, 326-378.

-- to prompt the enumerators to cover all facts of the farm which required investigation;

-- to carry the farmer through a logical sequence of events interconnected in his mind and, therefore, better remembered in association at the same time avoiding repetition of subjects the farmers must recall;

-- to avoid unnecessary physical effort in covering ground on the farm, particularly any repetition in visit to field;

-- to allow checks on the consistency of farmers' answers and awareness and reliability of enumerators.

The questionnaire will be translated to the main local languages of the area of study; the questions will be precoded with some internal consistency

B.4 - Selection and Training of Enumerators Supervision

Enumerators are the link between the farmers and the research worker; for this reason their function is fundamental in the accuracy of data.

Six enumerators will be selected, one for each 12 respondents in the multiple visit method and the same enumerators will interview the other 12 households drawn for the village sample of one-shot survey cooperation. Since the enumerators will make no contact with the farmers reserved for

the one-shot survey until the end of the study period, it is assumed that the conditioning effect will be little or zero.

Criteria for the enumerator selection will be:

-- sound knowledge at least one of the main local languages of the area of study;

-- sound background experience in farming in the region;

-- acceptable level of school education (minimum of an elementary school certificate);

-- pleasant and enthusiastic personality;

-- availability for the duration of the study. The training of the enumerator will take two to three weeks duration and will focus on:

-- the details of the objectives and conduct of the survey;

-- enumeration techniques;

-- familiarity with filling in of questionnaires.

-- training in plot area and field measurement techniques;

-- analysis of cropping patterns;

-- collection of market and weight information.

There will be three supervisors, one for every two enumerators.

B.5 - Data Collection

For both surveys the focus of data collection will be on area and yield of the top four principal crops grown by farmers.

B.5.1: The Multiple Visit Survey. The survey duration will be from the planting time to the completion of harvest for all selected principal crops.

Field identification: the field identification issue is very important both for the farmer and the enumerator in order to have a common understanding on the questions being asked and the answers expected on a particular field. We will use identification by location, by crops. Farmers will be asked to give names for their field of interest, also color marking on the tree trunks will be used to identify fields (Norman 1972; Ogunfowora, 1974). For the yield estimates, yield plots will be used supplemented by questions on production, consumption and quantities stored of principal crops . . . yield. A plot will be marked out in the field of interest of the farmer between the planting and harvesting time of the principal crop. Yield plots will be laid out using some random method and will have a dimension of 5m x 5m.

On a bi-weekly basis, beginning with the maturation of the principal crop, data on home consumption, quantity sold, given, paid for different reasons will be collected.

One enumerator will be employed full time from shortly after crop planting to completion of the assignment to work with tapes and field compasses to measure the fields. For crops such as sorghum and millet, the measurement will be done between the planting time and before the crop gets too high to impede the measurement by tapes and field compasses. For other crops, like peanuts, cow peas, the field measurement will be done just before the harvest time. The field measurement will be supplemented by question on quantity of seed equivalent asked after the planting is completed.

B.5.2: For the one-shot survey. The one-shot survey will occur two to three weeks after the harvest is completed. On a recall basis, information or yield and harvested areawill be collected for the principal crop at the field level. Questions on production and quantity harvested by field will be asked of the head of the household. The women of the household will be interviewed for information on consumption and gifts to others. As a further check on estimates of area planted, the quantity of seed planted will be asked of farmers; which by appropriate conversion can be used to compute an estimate of area of field.

All the questions concerning yield and area of field of principal crops will be asked on local units of measure and weights, these local units will be converted in standard units (i.e.; kg, lb).

C. Data Processing and Analysis

In order to carry out the analysis the card punching, the error checking during the editing process will be closely supervised by the research worker and one or two supervisors. The unit of analysis will be the field level and household or farm level. The household principal crop production will be the summation of individual fields of that particular principal crop. The analysis of data will consist on testing some hypotheses concerning the data collected by these two different methods (i.e., the one-shot survey and the multiple visit survey). Our main assumption is that the multiple visit survey estimates will be more accurate than the one-shot survey estimates for one particular variable.

A 95 percent confidence interval* for the mean of the paired differences (i.e., estimate obtained by the multiple visit method minus estimate obtained by the one-shot survey method) for each variable of interest will be calculated. In situations were there is a doubt that the distribution of the paired differences is all close to normal, we will use the sign test and the signed-rank test to carry out the analysis.

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*We chose the confidence interval concept because a confidence interval statement is regarded as a more comprehensive inference procedure than testing a single null hypothesis. In fact a confidence interval statement tests many null hypotheses at the same time.

D. Concluding Comments

The purpose of this paper was to provide empirical evidence of accuracy of data collected by different data collection methods. The variables used in the testing of the different hypotheses did not allow us to reach conclusive evidence of the superiority of one method of data collection on another. As a matter of fact, various questions have to be considered before the selection of one method of data collection or another, or the combination of various methods. These issues can be:

-- the time frame the data is required for use; the risk involved in taking wrong decisions based upon the data collected; this is closely linked to the accuracy of data;

-- the availability of resources, either financial or human;

-- the availability of secondary data;

-- the needs of the potential users of data;

Added to all these issues is the fact that in most developing countries, particularly the west African ones, any type of data collection is based on the memory data recall of the different respondents.

Researchers involved in LDC's should give high priority to developing data collection methodologies which fit the local realities of these countries. Attention should be de-

voted to the conceptual and operational definitions of different respondent units (i.e. household) and conversion of local units of measure and weight to standard units in order to make any comparison of survey results possible.

APPENDIX A

CAMEROON QUESTIONNAIRE SURVEYS

Survey	Sampling	Frequency	Contents
Extensive Base-line Survey	8 households in 36 census E.A.'s Random (288)	Once	Livestock holdings previous year's harvest migration, marketing,family size, etc.
Intensive Farm Budget Survey	24 randomly selected households in 5 purposively selected E.A.'s (120)	Once every two weeks by enumerator with a small number visited repeatedly by researcher	Field composition purchases, income, harvest, livestock holdings, input-output data on two crop fields and one livestock enterprise
Marketing Surveys	Ad hoc in selected markets by enumerator	Varied	Market transactions, volume, movements, reasons for buying and selling
Stall Fed Livestock	52 farmers in three purposively selected villages	Bi-weekly visits by enumerator with a small number visited repeatedly by researcher	Input-output data credit program involvement, history with stall feeding
Extensive Livestock	Sample of selected livestock producers	Once	Livestock holdings, livestock movements, and transactions, interactions with sedentary farmers
Nutrition/ Consumption	20 households in three of the E.A.'s followed by farm budget survey (60)	Three per day for four consecutive days	Food consumption, anthropometric, role of women, somen's economic status, coping with food shortages
Survey of Extension Agents	Judgment sample of about 40% of department's agents	Once	Training, work satisfaction and problems

BIBLIOGRAPHY

Barnard, C.S. (1975) Data in Agriculture: A Review with Special Reference to Farm Management Research Policy and Advice in Britain. Journal of Agricultural Economics, Vol. XXVI No. 3, September 1975. Department of Agricultural Economics, The University, Reading, England.

Boulet, J. (1971) "Magomex: etudes d'un terroir de montagne en pays Mafa." ORSTOM, YAOUNDE.

Boutrais, J. (1973) "La Colonisation des Plaines par Les Montgnards Au Nord Du Cameroun (Monts Mandara)," Travaux et Documents De L'ORSTOM, 24. Paris.

Byerlee D. and Tripp, R. (1981) Data Collection Systems and Methods in - On Farm/Farming Systems Research: A Critical Review. October 1981. Unpublished paper. CIMMYT, Mexico.

Casley, D. J. (1975) "Problems in Estimating of Crop Areas and Crop Yields," Bulletin of the Intnational Statistical Institute, Vol. 46, Part 2.

Casley, D.J. and Lury, D.A. (1981) Data Collection in Developing Countries." Clarendon Press Oxford.

Catt, C.C. (1966) Surveying Peasant Farmers - Some Experiences. Journal of Agricultural Economics. Vol. XVIII, No. 1, May 1966.

Collinson, M. P. (1972) Farm Management in Peasant Agriculture: A Handbook for Rural Development Planning in Africa. Praeger Publishers, New York.

_____ (1974) Some Guidelines for Farm Economic Data Collection in Rural Areas of Africa. Agricultural Development Council Seminar, Beirut, December 1974.

_____ (1975) The Role of the Agricul-Economics in Regional Planning. Development Studies No. 16, 1975. University of Reading, Department of Agricultural Economics and Management.

Connell, J. and Lifton M. (1977) "Assessing Village Labour Situations in Developing Countries." Oxford University Press, 1977.

Deming, W. E. (1960), "Sample Design in Business Research," John Wiley & Sons, Inc., New York, London.

Farrington, J. (1975) "Farm Surveys in Malawi: The Collection and Analysis of Labour Data." Development Studies No. 16, 1975. University of Reading, Department of Agricultural Economics and Management.

Fox, D. J. (1979). The Research Process in Education, Holt, Rinehart and Winston, Inc., New York.

Friedrich, J. H. (1974) "The Collection and Analysis of Micro-Economics Data in Developing Countries." FAO, Rome, November 1974.

George, A. (1980) "Farm level surveys of West African Agriculture: A critique of conventional Methodology," Paper presented for workshop on Sahelian Agriculture; Department of Agricultural Economics, Purdue University.

Gilroy, M. (1981) "Labour Data Collection in African Traditional Agricultural Systems: A Methodological Review and Examination of Some Nigerian Data." School of Development Studies. University of East Anglia.

Hall, M. (1970) "A Review of Farm Management Research in East Africa." ECA/FAO Agricultural Economics Bulletin for Africa, 12:11-24.

Hallaire, A. et al. (1967) "Atlas Regional Mandara Logone." ORSTOM, YAOUNDE.

Hansen, R.H., Hurwitz, W.M. and Bershad, M.A., (1961), "Measurement Erros in Censuses and Surveys," Bulletin of the International Statistical Institute, Vol. 38, Part 2.

Hansen, R.H., Hurwitz, W.M. and Gurney, M. (1953) "Sample Survey and Methods and Theory," Vols. I and II John Wiley and Sons, New York.

Hansen, R.H. and Marks, E.S. (1958) "Influence of the Interviewer on the Accuracy of Survey Results," Journal of the American Statistical Association, Vol. 53.

Lipton, M. and Moore M. (1972) "The Methodology of Village Studies in Less Developed Countries." IDS Discussion, Paper No. 10.

Lynch, S.G. (1980) "An Analysis of Interview Frequency and Reference Period in Rural Consumption Expenditure Surveys. A Case Study from Sierra Leone." Working paper No. 10, Michigan State University, East Lansing, MI.

MacArthur, J.D. (1968) "The Economic Study of African Small Farms: Some Kenya Experiences." Journal of Agricultural Economics, Vol. XIX, No. 2, May 1968. University of Reading, Department of Agricultural Economics.

Mahalanobis, P.C. (1944) "On Large-Scale Sample Surveys," Philosophical Transactions of the Royal Society, Series B 231. London.

_____ (1946) "Recent Experiments in Statistical Sampling in the Indian Statistical Institute," Journal of the Royal Statistical Society, Vol. 109, London.

_____ (1950) "Cost and Accuracy of Results in Sampling and Complete Enumeration," Bulletin of the International Statistical Institute, Vol. 34, Part 2.

Mahalanobis, P.C. and Sen, S.B. (1954) "On Some Aspects of the Indian National Sample Survey," Bulletin of the International Statistical Institute, Vol. 34, Part 2.

Mahalanobis, P.C. and Sengupta, J.M. (1951) "On the Size of Sample Cuts in Crop-cutting Experiments in the Indian Statistical Institute, Bulletin of the International Statistical Institute, Vol. 33, Part 2.

Mahamat, Chegador. (1980) "Elements sur le deficit alimentaire dans les Margui-Wandala." Mokolo, Typescript.

Moser, C.A. and Kalton, G. (1972) "Survey Methods in Social Investigation" 2nd edition. Basic Books, Inc. Publishers, New York.

Murthy, M.N. (1974) "Evaluation of Multi-subject Sample Surveys," International Statistical Review, 42.

Muthiah, C. (1965) Agro-Economic Research Centre, University of Madras. Private Communication.

Norman, D.W. (January 1973) "Economic Analysis of Agricultural Production and Labour Utilization Among the Hausa in the North of Nigeria." African Rural Economy No. 4, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

_____. (April 1973) "Methodology and Problems of Farm Management Investigations: Experiences from Northern Nigeria. Rural Economy Research Unit Ahmadu Bello University, Zaria, Nigeria.

_____. (1974) "Data Collection in Farm Management Studies: The Case of Northern Nigeria.: Workshop on Field Collection of Socioeconomic Data in Developing Countries. Beirut, December 1974.

Ogunfowora, O. (1974 "Farm Survey as a Data Base of Analysis and Planning: Experiences from Kawara State of Nigeria," Development Paper No. 14, Nigerian Rural Development Study, University of Ibadan, Nigeria.

Panse, V.G. (1954) "Estimation of Crop Yields," FAO Rome 1954.

Schultz, W.M. (1978) "On Accuracy and Precision in Statistical Estimates." Canadian Journal of Agricultural Economics 26 (4), 1978.

Spencer, D.S.C. (1972) "Micro-level Farm Management and Production Economics Research among Traditional African Farmers: Lessons from Sierra Leone," African Rural Employment Study Rural Employment Paper No. 3, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

Zarcovich, S.S. (1962) "Agricultural Statistics and Multisubject Household Surveys," FAO Studies in Agricultural Economics and Statistics, 1952-1977, Vol. 11 (5), Rome 1978.

Zarcovich, S.S. (1966) "Quality of Sample Statistics," FAO.