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PROBLEMS OF MICRO-ECONOMIC
DATA COLLECTION ON FARMS
IN NORTHERN ZAIRE

by
Eric F. Tollens

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Department of Agricultural Economics
Michigan State University
East Lansing, Michigan 48824

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Eric F. Tollens, Chairman

Department of Agricultural Economics
Kisangani Campus
National University of Zaire
Yangambi, Republic of Zaire

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Introduction*

There are few African countries where the need for relevant agricultural economics research is so acute as in the Republic of Zaire.[1] Historically, development strategies and policies in Zaire have focused on the creation of an industrial, export oriented sector. Relatively minor attention has been given to agriculture and rural development. When agricultural development has been promoted in Zaire there has been a tendency to emphasize large schemes, plantation farming and educational systems from foreign countries which are incompatible with the social organization and culture of most traditional Zairean farmers. A new agricultural policy is urgently needed in Zaire in order to tackle the following problems: large imports of major foodgrains (maize, rice) and meat, rural to urban migration, urban unemployment, large urban-rural income differentials and a lack of adequate income opportunities for rural people.

The government is aware of the need to focus greater attention on agriculture and has declared "agriculture the priority of priorities".[2] The specific objectives for agricultural development are now clearly defined. Since new agricultural policies are being formulated, agricultural economics research is urgently needed in order to provide an empirical base for proposed projects and the development of specific sub-sectors such as food-

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*This is a revised version of a paper presented at an ADC conference on "Problems of Field Data Collection on Social and Economic Issues in Rural Areas in the Middle East and Africa," Beirut, Lebanon, December 8-14, 1974.

[1] The Democratic Republic of the Congo changed its name to the Republic of Zaire in October 1971.

[2] Speech by President Mobuto Sese Seko on December 5, 1972.

grains, livestock etc.[3] Priorities for agricultural economics research
are spelled out in a forthcoming paper by the author [Tollens, 1975-a].

Although agricultural development is now a top priority,[4] the country
has only a few agricultural economists to guide policy makers. The Depart-
ment of Agriculture, with the support of US/AID, recently established an
Agricultural Economics Research Bureau in the capital city of Kinshasa.
With the reorganization of higher education in Zaire in 1971, there is now
one university with three main campuses at Kinshasa, Lubumbashi and Kisan-
gani [Rideout, 1974].   The 1971 university reorganization brought about the
movement of the faculties of agronomy from Kinshasa, Lubumbashi and Kisangani
to Yangambi. Yangambi is 60 miles west of the Kisangani campus of the Na-
tional University of Zaire. Yangambi is also the headquarters of the Na-
tional Institute for Agricultural Studies and Research (INERA), known until
1970 as INEAC (National Institute for Agricultural Studies of the Congo).

At present, the Zairean capacity for agricultural economics research
and agricultural planning is very limited, with only one Zairean Ph.D. in
agricultural economics in the country. However, several Zairean students
are now undertaking overseas graduate studies in agricultural economics
at the doctoral level.

In the 1971-74 period, I was engaged in micro-economic research on
smallholder cotton and rice production in northern Zaire while at the
Department of Agricultural Economics of the National University of Zaire,

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[3] Agricultural economics was identified as a problem area requiring
urgent attention in a 1971 workshop on the role of science and technology
in the economic development of Zaire during the 1970's. The workshop was
jointly organized by the National Office for Research and Development
(O.N.R.D.) in Zaire and the U.S. National Academy of Sciences.

[4] A popular slogan is "Independance du Ventre" or "Independence of
the Belly".

first at Kinshasa and subsequently at Yangambi after the reorganization
of the university system. The emphasis of my research has been on the
collection of micro-level data in rural areas since a lack of farm level
data is a major handicap for policy analysis of rural employment and rural
development at the local, regional and national levels.

Cotton is the only major export crop which is grown solely by small-
holders. In the regions growing cotton, it is also the major cash crop.
About two-thirds of present cotton lint production is consumed by domes-
tic textile mills. However, present cotton production is only a third of
pre-independence levels. New textile mills are being built and an increase
in cotton production is a top priority for the Zairean government.

Maize and rice are the major staples in Zaire for which large quanti-
ties are imported. Maize is mainly grown and consumed in the South. Rice
is primarily consumed in urban areas and is predominantly grown in the
North. As the Faculty of Agronomy is now located in the North, it is
logical that rice production is being investigated by the Department of
Agricultural Economics.

The purpose then of this paper is to discuss some of the problems which
I have encountered in farm management and production economics research
in the Republic of Zaire. I shall devote major emphasis to a discussion
of a farm business survey and a cost route survey which I utilized over
the 1971-74 period. The farm business survey was designed to collect socio-
economic information on cotton farms in a large area with emphasis on the
range of conditions and constraints found on these traditional farms. The
survey data will be used to formulate policy prescriptions for the cotton
industry and will help to identify topics for further research [Tollens,
1975-b]. The original survey plan focused on in-depth data collection in a

small number of selected villages, using the cost route method. However, the Ministry of Agriculture preferred a study of the entire northern cotton zone with a diagnosis of the factors constraining cotton production. Thus, as only a limited research budget was available, a farm business survey was selected.

The survey area includes the cotton regions of Equator and Haut-Zaire Provinces. The distance east to west of this area is about 800 miles, while the distance from north to south is 200 miles. This area borders the equatorial rain forest to the south and includes equatorial rain forest, savannah woodland, tree savannah and shrub savannah. One-hundred and sixty farmers were selected by a two-stage sampling design. Only two visits per farmer were made to complete the survey questionnaire, one visit during planting and one visit after the crop harvest. As traditional farmers keep no written records, heavy reliance was placed on the farmer's recall.

I am using the cost route survey method in my study of rice production in Zaire. The rice study will generate input-output data on rice production and on all other crops grown on traditional farms in rice producing areas. In particular, on and off-farm labor use, incomes, expenditures and harvests are recorded twice weekly on special forms which enable the data to be keypunched without transcription on coding forms (see pages 29 through 31 for a discussion of this point). The rice survey is being conducted in the equatorial rain forest, south of the northern cotton belt and just north of the Zaire River, between Lisala and Kisangani. Bumba is the major rice production center in the area.

Twenty farmers have been selected by systematic random sampling in a typical representative rice producing village, 70 miles west of Kisangani. Twice-weekly visits are made to each farmer by an enumerator over a period

of one year. A second enumerator is available on a standby basis. The twice-weekly visits are supplemented from time to time with special surveys to record inventories and to determine acreages, crop densities, weights of the standard measures and home consumption. This survey is regarded as a pilot project and will hopefully be expanded to a large size sample when adequate funding is secured. The two enumerators now employed in the survey will then act as field supervisors. I shall draw on the experience gained in the cotton and rice studies in the remainder of this paper.

Types of Farm Surveys

Spencer [1972] distinguishes four methods for collecting micro-level data from farmers: farm business survey, cost route method, model farm study and farm account books. The two most commonly used methods are the farm business survey and the cost route method. The two other methods, the model farm study and farm account books, are impractical under African conditions. The model farm study method relies on "model" farms for its source of data. However, model farms are rarely found in Africa. The farm account book method is impractical because most African farmers are illiterate and cannot keep farm accounts.

The farm business survey method is generally used for agricultural censuses and for economic surveys where relatively simple information has to be gathered over relatively large areas. The farm business survey is a quick and relatively cheap way of determining the range of conditions found on large area farms. The main drawbacks of this method are that the observational errors might be quite large because only a few visits are made

to each farmer and accurate data are not generated on alternative resource use, especially with respect to labor inputs. Thus, the farm business survey method should not be used when accurate data are needed on returns to labor and other resources and the relative profitability of different crops. Instead, the cost route method is a proven technique for generating these kinds of data.

With the cost route method, farmers are interviewed repeatedly, usually once or twice a week for at least one crop season. Precise information is gathered on resource use, costs and returns. However, only a small number (fifteen to thirty) of farmers can be interviewed by each enumerator. As a result, the sample size is generally quite small compared with samples used in farm business surveys because cost route surveys are much more expensive for a given sample size. The small sample size can produce large sampling errors. In order to reduce sampling errors it is possible to conduct a farm business survey prior to undertaking a cost route survey.

Cost route studies require prior knowledge about the production systems and their characteristics for selecting the sampling plan, questionnaire design and research method. If insufficient prior knowledge is available on these matters a preliminary survey of the farm business type can produce the necessary information. Since little micro-economic research has been done in a vast country like Zaire, farm business surveys can be very useful for organizing and planning subsequent cost route studies.

The forest areas close to the equator in Zaire have rainfall all year round and no distinct seasons. The combination of continuous cropping throughout the year, intercropping and the relatively haphazard planting and harvesting methods removes the reference points and makes it difficult

to locate farmers. Hence, if the farm business approach is used and farmers are only visited once or twice, it will be difficult to locate the farms and the fields. Frequent visits and thus a cost route type of survey are prerequisities for survey design in the forest areas [Collinson, 1972].

Definition of the Family or Household Unit

The primary sampling unit in a farm management and production economics survey is usually the farm family or household unit. Spencer [1972] defines a household as all the people eating together. Norman [1973] uses a similar definition--those people eating from one pot. These definitions imply that the consumption unit is also the production unit, i.e., that people who eat together also work together. This is the traditional concept of a family farm in Africa. Usually, it is very easy to identify the head of the family, but it is sometimes quite difficult to determine the size of the family because of the extended family system.

In Zaire, the consumption unit is often larger than the production unit. An extended family may eat together but does not necessarily work together on the same field. Often felling trees, clearing forest, burning, etc., is done by the extended family on a large piece of forest but planting, weeding and harvesting is done by smaller family units on individual plots within the large field that was claimed from the forest. Married sons or daughers usually stay for some time with their spouse at the compound of the family head. They often eat together but have their own

fields.[5/] The mutual exchange of labor without payment in cash or kind is
quite common in Zaire and, as a result, it is difficult to identify the
household unit. Most farmers have to perform certain tasks on the field
of the village chief. In addition, there is usually a communal field where
all members of the community share work tasks.[6/] This is often on a fixed
day, mostly on Saturdays, the day of "salongo".[7/] In the final analysis,
the definition of the family unit for farm management and production eco-
nomics research has to center on the definition of the production unit:
people who work together on a particular field or fields for the length
of the crop season and who distribute the proceeds from the field among
themselves. A demographic survey at the beginning of the study may be
very helpful to delineate families and record family linkages. In some
cases intensive questionning is necessary to determine the household unit
corresponding with the production unit.

I found that it was easy to identify communal labor once family re-
lationships were recorded and when the fields were clearly marked. In a
few cases, corrections had to be made on the survey forms to account for
smaller household units than at the beginning of the survey when it was

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[5/]Anthropological studies discussing extended family relationships and
land occupation rights in Zaire are the introductory volume by Vansina [1965]
a study among the Nyanga tribe by Biebuyck [1966] and the specialized eth-
nographic monographs published by the Royal Museum of Central Africa in
Tervuren, Belgium.

[6/]Prisoners usually perform most of the labor on these fields.

[7/]The Zaire government has decreed that Saturday shall be reserved for
communal projects, such as building a school or hospital or repairing roads.

discovered that the consumption unit consisted of more than one production unit.[8]

Selecting the Sample from the Population

Stratification and Area Sampling

Stratification of the population generally will reduce the variances of the statistics generated in a survey. The strata are selected so that the variation between the strata is made as large as possible and hence the variation between farms within each stratum is minimized [Upton, 1973]. It is a way of increasing the accuracy of the estimates from a sample survey and thus enables us to reduce the sample size for a given degree of accuracy of the data.

Stratification means dividing up the population according to characteristics which are important parameters in the study such as crop production systems, climate, soil type, size of farms, characteristics of the farm operators such as age, sex, tribal affinity, farm incomes, distances from marketing centers, etc.

Usually a survey is designed to yield a multitude of data. Stratification to reduce the variances of the data involves the selection of several criteria for stratification. In a country such as Zaire, data are readily available on the following: ecological areas, climate, soil types and distances to marketing centers. However, scant information is available on other characteristics, such as farming systems, crop varieties,

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[8] In the rice survey, one family consisted of twenty-three members eating together and clearing land for the rice field. At the time of planting, this family could be split up in two distinct households, each household having its own fields.

planting and harvesting dates, crop rotations and use of modern inputs, for use in stratifying the population. Therefore, a farm business survey may be needed for general data on these characteristics in order to stratify the population.

If a lack of time precludes the selection of a stratified random sample, post-stratification of the data is still possible during the data analysis phase. For example, Norman has stratified by village and by land-per-resident ratios [Norman, 1973].

In Zaire, because of low population densities in rural areas and consequent low degrees of land occupation, agricultural production is spread over very large areas.9/ Clustered or area sampling may help to reduce the travel time of enumerators. This involves at least a two-stage random sampling procedure: in the first stage, villages or clusters are randomly chosen from a frame of all villages and in the second stage, the household units within each chosen village are randomly selected from a list of all household heads in the village.

A shortcut to this procedure is to select representative villages in the population using subjective judgments and to use random sampling in these villages. This technique assumes a good prior knowledge of the population and small inter-village variability relative to the intra-village variability. However, in a system of shifting cultivation with modest capital being used by farmers, wise variations in resource use and product combinations do not occur. As a result, it is relatively easy to choose a representative village [Clayton, 1964].

9/Only about 2 percent of the arable land in Zaire is presently occupied. The average overall population density is 9.2 persons per square km. with about 30 percent of the population in urban areas.

Sampling Frame

A sampling frame is a list with the names of all the households or household chiefs in a particular area. The frame is used to select the families which will be included in the sample survey. Under African conditions, it is usually difficult to find a reliable frame.

Norman [1973] reports that researchers have used the following frames with varying degrees of success: tax lists and members of cooperative societies and sellers of particular crops to marketing boards or under contract to processing plants, etc. However, tax lists, according to Norman, are usually unreliable.

In my cotton study, I utilized a list of the farmers who were under "crop imposition"[10]/ and a list of farmers who had to pay a personal minimum tax.[11]/

In 1970, the Ministry of Agriculture with the aid of FAO drew up a frame of all farmers in Zaire for the 1970 World Agricultural Census. I used that list but discovered that it contained the same errors as the "crop imposition" list from which it was probably derived.[12]/ For example, some farmers were not included in the list, others appeared more than once

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[10]/ The imposition system requires old able-bodied adult males who are unemployed in a rural area to grow particular crops as prescribed by the regional authorities. Failure to comply may result in prison terms or payment of fines.

[11]/ The personal minimum tax for each able-bodied adult male is fixed at 2 Zaires per year or $4 per year. The tax list is usually prepared on the basis of the list of able-bodied adult males. The government agronomist in each zone with the aid of the extension agents and the village chiefs draw up the list of all able-bodied adult males.

[12]/ The frame for the 1970 World Agricultural Census was also prepared under the responsibility of the government agronomist in each zone. It is likely that this frame was somewhat out of date for the 1973 cotton survey.

but under different names and still others could not be traced in the village. As time was pressing to start the survey, I used the census frame and accepted its inaccuracy.[13]/

Most researchers will have to derive their own frame of farm families if they want a reliable frame. This is a costly and time-consuming operation. Often, because of budgetary and time constraints, frames based on tax lists or other listings will be used. If an area sampling technique is adopted, then only farmers in the selected areas have to be listed.

Sample Size

Statistical theory helps us determine the sample size for a particular survey in a universe provided we specify the variance of the variables and the degree of accuracy of the estimates we want to derive [Yang, 1965]. This system works very well for problems where only one variable is handled. However, in production economics and farm management research, we always deal with problems where several important variables have to be quantified such as labor utilization for different crops, yields of the crops, prices received capital used, age of the farmers, wage rates for hired labor, etc. This complicates the application of our statistical theory. Moreover, we usually ignore estimates of the variances of the variables we want to estimate in the survey. This makes it impossible to apply formal statistical procedures and to achieve statistical representativeness of the sample.

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[13]/Using an inaccurate frame introduces a bias in the survey. I judged that the bias was acceptable after taking into consideration the cost of drawing up my own frame.

Upton [1973] states that, "... it is sample size and not the fraction of the population sampled which almost entirely determines the precision of estimation for a given population. For most purposes a sample size of thirty farms in each independent stratum is probably adequate."

I am not aware of any field surveys in Africa using the cost accounting method where the sample size was arrived at by applying statistical formulas. Since cost route surveys are expensive and time consuming, the budget constraint usually determines how many farmers are interviewed.[14]

The number of farmers each enumerator can handle depends on how many visits are to be made to each farmer per week, the dispersion of the farmers, the type of transport available to the enumerators and the size of the enumeration area.[15] If each enumerator can be expected to interview y

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[14]My cotton farm business survey cost $48.00 per farm record. This includes salaries, transportation and equipment of field enumerators and supervisors and in-country transport, equipment and other expenses of the project leader, excluding his salary. The relatively high cost of my farm business survey was caused by the dispersion of cotton farmers and the extensive traveling by enumerators, supervisors and the project leader on poor roads. Travel expenses, depreciation and maintenance of a landrover and three motorcycles and a bicycle accounted for just over half the research budget. Some comparative data on the cost of cost route surveys is as follows: Spencer [1972] incurred a cost of $41.40 per farm record in Sierra Leone; Norman [1973] incurred a cost of $139 per farm record in Nigeria and Zuckerman (quoted by Spencer) incurred a cost of $150 per farm in his research in Western Nigeria.

[15]In my cost route survey of rice production in Zaire where hours of labor input are recorded on a daily basis, I have found that one enumerator can handle fifteen farmers. Enumerator travel time is reduced as an area sample is used and each enumerator lives in the village where he collects his data. Farmers are interviewed twice a week, mostly in late afternoons or in the evenings because farmers are at work in the morning and do not like to be disturbed. The enumerator visits each farmer on Monday or Tuesday evenings and on Thursday or Friday evenings. The mornings and all of Wednesday is used for field measurements and for coding the questionnaires. Each enumerator has a bicycle at his disposal.

farmers per week, then the sample size is x χ y.[16/] Hence, it is difficult to determine how representative the sample is of the universe. However, the researcher is often requested to generalize his findings to a particular geographical area even though his sample has often been chosen on the basis of budget and time constraints rather than statistical reliability.

Measuring the Land Input

Measuring the size of the farmer's fields is a necessity as African farmers generally do not have any concept of acreage. In most Zairean agriculture, shifting cultivation (shifting of cultivated land around the habitat of the farmer in search of fertile land) is practiced [Jurion and Henry, 1969]. Each year, farmers claim a new parcel of land from the forest by felling trees, slashing and burning. The shape of the field is generally irregular and can best be approximated with a polygonal. Sometimes it is very difficult to determine the boundaries of the field as fields fade into the forest and vice-versa. Usually there is no clear boundary to the field. In savannah areas under shifting cultivation, a new plot of savannah is turned into a field by cutting and burning savannah grasses each year.

Fields should preferably be measured after planting and before the crop is fully matured or just after harvesting in order to minimize crop

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[16/] In my cotton farm business survey my field research budget enabled me to hire four field enumerators to cover the northern cotton zone—an area of 800 miles from east to west and 200 miles from north to south. Since each enumerator could only interview forty farmers during planting and harvesting periods, I ended up with a sample of 160 farmers.

damage as a result of walking through the field. In the central basin of
Zaire (equatorial rain forest), seasons are not well defined. There is
no pronounced wet or dry season. With intercropping on most fields,
planting as well as harvesting is often a continuous activity until the
field is abandoned and returned to fallow, usually after two to four years
of cultivation. What complicates matters is that once a piece of forest
is burned and cleared, often only part of it is planted. Some of the land
may be planted six months to a year later as the need arises. Thus, the
field size is variable over time. In these cases we were forced to measure
field size just before the harvest of the major crop or crops. Some fields
had to be measured twice during my cotton survey.

Norman [1967-72] used aerial photographs to calculate crop acreage in
the savannah area in northern Nigeria. He found that aerial photographs
were useful because the field boundaries were clear and remained unchanged
for at least one crop season. However, in rain forest areas, it is doubt-
ful if aerial photographs can be used to delineate fields because of the
dense vegetation cover. The cost of aerial photographs, if this service
is available, may also be prohibitive.

My experience has been mostly in forest areas in Zaire. In my survey,
fields were measured by using measuring tapes (20 m. in length) and field
compasses.[17] Measuring tapes are easier to use than measuring chains.
In a savannah area with flat topography, a measuring wheel could be used
instead of measuring tapes. Measuring wheels could not be used in forest
areas because of forest debris and the tree stumps.

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[17] Suunto field compasses were used, type OY KB-14, tropicalised. The
sum of all the angles measured can be compared with (n-2) 180 where n equals
the number of sides of the field. Theoretically, the two figures should be
equal.

It is sometimes difficult to determine the ownership of fields as several fields may have the same cropping patterns.[18/] Norman [1973] used different colors and combinations of colors to identify fields as field numbers are not remembered by farmers. In measuring fields, the enumerator needs the help of an aide. In Zaire, the local agricultural extension worker is useful for this purpose. The fields are then plotted on graph paper to an appropriate scale. A 360 degree protractor is used to report the azimuths. Graph paper facilitates the drawing of azimuths as the vertical or northern direction is always indicated by the vertical lines on the paper. The acreage is then determined with the aid of a planimeter. At the beginning of the survey, my field enumerators struggled to find an appropriate scale to draw the fields to scale, but this problem was resolved with experience. Measuring and drawing errors were easily checked by looking at the "closing gap" of the polygonal. If the closing gap exceeds 5 percent of the perimeter, fields have to be remeasured.[19/]

Land is not a homogeneous input because of differences in soil fertility. Therefore, it might be useful to take a soil sample when measuring fields. In Zaire, fairly detailed soil survey maps are available for several regions although these maps may be too general and/or inaccurate for village level studies.[20/]

[18/] In the Yangambi area of Zaire it is rare to find fields with only one crop growing. Most fields are interplanted with manioc, maize and bananas.

[19/] Several methods exist to measure fields. They are described by Collinson [1972], Hunt [1969] and Zarkovich [1966].

[20/] Although climatic conditions are not considered in most farm management research studies, they might be important in explaining certain findings. It might be useful to provide each enumerator with a pluviometer to record rainfall in his enumeration area. The amount and distribution of rainfall can be an important variable affecting crop yields.

Measuring the Labor Input

Since the land input usually only needs to be measured once and the capital input is very low in traditional African farming, labor is by far the most important productive factor to measure in a cost route survey. The collection of specific disaggregate labor information on the basis of field activity, age, sex and family on a daily basis is one of the main features of cost route surveys. Although all hired labor is paid by the man-day, the man-hours of hired labor is recorded for the different work activities during the day. It is also one of the main reasons why these surveys are expensive. All members of the family, excluding children below the age of eight, have to account for their time utilization between 6 a.m. and 6 p.m. every day of the week. This time interval corresponds with daylight time as the enumeration areas are close to the equator. In my cost route survey on rice production in Zaire, hours of work are being recorded for family labor, communal labor and hired labor.

Since farmers in my rice survey generally do not have watches, the enumerator has to estimate the hours of labor worked on a particular task. With two interviews per week, the memory recall of time worked is never more than four days. Several farmers have their children record work information on a diary provided by the enumerator.

Most fields are some distance from the farmer's home and traveling to and from the field is an important activity.[21] This time is counted as

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[21] In the cotton survey, fields were an average of 2.0 km. from the house of the farmer. This can be explained partly by the fact that the colonial administration forced all people to live along the roads. Most farmers, however, keep some fields in the area where they or their parents lived before.

part of the farmer's labor input.[22/] Travel time is relatively more important for small plots than for large fields and it introduces an upward bias for the type of crops located in fields further from the house.

In aggregating man-, woman- and child-work hours, there is a problem of determining how to weigh the different labor inputs by age and sex. Obviously, age and sex are important variables in measuring the labor input as well as the task being performed.[23/] Work studies or time and motion studies are needed to determine the common denominator and the real weights to use in aggregating different labor inputs. These studies, however, are generally not available in Africa.[24/]

In Zaire, there is a customary division of labor between sexes. For example, land clearing, felling trees, burning, hunting and fishing are reserved for males and weeding and crop maintenance for females and children. Planting and harvesting is usually done by both sexes.

In the final analysis, any conversion of female and child labor to man labor units is arbitrary. I utilized Spencer's conversion scale, whereby children from 7 to 5 years have a 0.5 weight and women have a 1.0 weight because I believe that women are as efficient as men in the types of farm work performed by women in Zaire.

[22/] In RERU studies, this time was not included in labor estimates of crops [Norman, 1973].

[23/] Hecq, et. al. [1963] proposed a scale of production units for the Bashi's in the Kivu region of Zaire.

[24/] de Schlippe [1956, 1957] was probably the first agricultural economist to undertake work studies in Zaire during the colonial period. His approach to the study of the agricultural economy was strongly influenced by social anthropology. His study method was direct observation. He measured the labor input with the aid of a stopwatch on customary fields and on cotton fields of the Zanda in the northern savannah of Zaire and Sudan.

Measuring Crop Yields

In my farm business survey of cotton production the total production was easily determined by verifying the sales slips kept by farmers from the sale of their cotton to the national cotton marketing office or by weighing the total harvest of cotton if the farmer's crop was unsold. For cash crops that are already sold, such as cotton and coffee, it is easy to determine the yield if there is a record of the sale and the acreage is known.[25/] For other crops, either a yield plot method or some other sampling method must be used as it is usually impossible to record the total harvest from a field. Usually, there is an upward bias to yields derived by the field plot method. Also, if fields are heterogeneous, no accurate yield data will be derived and this method cannot be utilized. In Zaire, most of the fields were quite heterogeneous and the yield plot method was not used.

In my rice survey in Zaire, all products that are harvested from the fields or from any other locations (forest, rivers, etc.) are recorded in local measures by the enumerator during his twice-weekly visits. The standard weights of local measures for different products are determined by the researcher. For recording of home consumption, product exchanges, gifts, storage and waste of produce, other methods must be used. A short term survey with high visiting frequency (direct observation) is one method of determining the amount of produce regularly consumed by the farm family.

[25/] This assumes that the sales weight equals the actual weight of the crop. Cross-checking is needed to verify this.

Norman [1973] used the five unit method extensively. In this method, five units of the crop (e.g., bundles, baskets) were drawn at random from those harvested from the field and weighted to determine the average weight of a unit of a crop. After harvest, the farmer was asked how many units of the crop he harvested and the total production was then calculated by multiplying the average weight of one unit by the number of units harvested.

Crop density counts also help to estimate yields. The crop density count, usually done in the yield plot, indicates the number of plants of each crop in the plot. [26/] By comparing the density counts with average crop densities for pure or one crop fields, the proportion of land devoted to any one crop in intercropping can be determined.[27/] Crop density counts also help to define objectively the type of intercropping in a field. If different crop enterprises are grown on different parts of the field, the field is split up in plots whereby each plot has a homogeneous cropping pattern. Crop densities are then determined in each plot of the field.

In Zaire, it is often difficult to find single crop fields in the northern region because intercropping is so widely practiced. Density counts from single crop plots in experiment station fields can be obtained if no pure stands are available in the region.

[26/] Only the bunches of plants from the same plant materials are counted and not the individual plant stalks.

[27/] In my cost survey of rice production, I determined the crop densities by counting the number of plants in density squares of 9 m^2 for rice, 25 m^2 for maize, groundnuts and other annual food crops and 200 m^2 for pluri-annual crops, including manioc, bananas, cocoa, coffee, pineapples and sugar.

Analysis of Crop Mixtures in Intercropping

Intercropping is a widely used practice in African agriculture[28]
and it poses some analytical problems in determining the land and labor
inputs and crop yields for the individual crops in fields with crop mix-
tures. Most farm management studies of intercropping systems in tropical
agriculture consider the mix of crops in a field as an enterprise, defined
by the density of the different crops. The crop enterprise is handled as
a unit, just as if it were a single crop field. Data are then collected
and analyzed for the crop enterprise and not for each crop. This makes
it analytically easy to handle mixed crops. This approach is only satis-
factory when there is some standardization of crop mixtures [Upton, 1973].
In Zaire, I found an almost infinite variety of crop mixtures between farms
and, as a result, I did not use this method.

One might treat each component crop in the mixture as though it occu-
pied the whole area [Upton, 1973]. The total area of three crops mixed
in a field is then three times the area of the field. Each crop in the
field has the same yield as in a pure stand. It is assumed that there is
little variation in crop densities. Clearly, this method is not accep-
table.

Another approach is to allocate the resource inputs for each crop in
the mixture on the basis of the ratio of the crop density in the mixture
to the average density in a pure stand. The ratio is used as a measure of
the relative importance of a crop in a field with mixed cropping. Ideally,
the sum of the ratios for the different crops in the mixture is equal to

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[28] For an excellent discussion of intercropping in Africa, see Norman
[1971].

one. However, this will rarely be the case and, as a result, a correction factor must be used. This approach ignores interactions between the different crops in the mixture. It is likely that labor requirements for a crop in intercropping are different from the requirements in a pure stand, after adjusting for different crop densities.

Norman [1973] has published a method for determining labor requirements for crop enterprises in fields with more than one crop enterprise. The ratio of labor requirements per acre of crop enterprise i and j which could be measured directly was taken as the ratio of labor requirements per acre for the same crop enterprises in fields where they could not be determined directly. He also presents a method for estimating yields of individual crops in crop enterprises that could not be measured directly. Again, he assumes that the ratio of the yield per acre of crop x in crop enterprise i to the yield of crop x in crop enterprise j which could be measured directly is the same for crop x in crop enterprises i and j which could not be measured directly. This enables us to calculate individual crop yields of crop x in crop enterprise i.

Cooperation with Government Officials and Farmers

It is very important that government officials and local, regional and national authorities are fully briefed on the purpose and scope of the survey. One way of securing their cooperation is to ask them to prepare a letter of recommendation for the survey and to visit the survey area.

In Zaire, security officials should be contacted and briefed before the survey starts and they should be kept informed about its progress. It is always advisable to include the village head in the survey to ensure

his cooperation, but he does not have to be included in data analysis. It is questionable whether material rewards should be offered to farmers in the survey. If they receive something for their cooperation, it easily leads to expectations for more and it builds tensions with farmers who are not included in the survey.[29]

My initial survey questionnaire in the cotton study required an average of more than two hours of interviewing. This was too much to expect from the farmer. Interviewing should take a maximum of an hour because fatigue sets in. When the questionnaire could not be completed in a one hour session, then additional sessions were held on different days. This proved to be a satisfactory solution.

In the rice study, farmers are currently being visited twice a week. Some farmers are annoyed with the frequent visits and they have demanded compensation for their information, such as cigarettes, beer, farm tools, salt, clothing, etc.

Collecting Sensitive Information

Spencer [1972] argues that sensitive information should only be gathered at the end of the cost route survey when there is a well established rapport between enumerator and respondent. However, in a farm business survey with one or two visits, it is very difficult, if not impossible, to collect this type of information. The challenge is to determine the amount of sensitive information that can be effectively

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[29] In the rice survey enumerators are asked to share cigarettes with farmers to promote closer rapport. Surveying also brings on certain responsibilities. When a village chief became sick, I had the moral obligation to drive him and his family to the nearest hospital.

secured in limited visits. In the cotton study, some questions which
were judged too sensitive for the respondent were dropped from the ques-
tionnaire after the survey had started.

The purpose and scope of sensitive questions should be made quite clear
to the respondent. A letter of recommendation from well known local or
regional authorities will help to assure farmer cooperation. However,
some data should not be collected because it is too personal and answers
will most likely be unreliable. Examples are information which will help
determine the farmer's net worth such as data on loans, debts and cash
savings and the number of suits, shirts, shoes, etc. Also, it is unwise
to try to collect information on the possession of guns or other illegal
weapons and information about illegal activities such as distilling alcohol
or hunting protected animals.

Organization of the Survey and Logistical Problems

The organization of a field survey involves the coordination of sev-
eral different activities over time. Most farm management surveys focused
on a particular crop have to start at a specific time, usually before land
clearing, and they will be operated for at least one crop season. If
several crops are considered, the survey usually lasts at least for a full
year. The training of the field enumerators usually takes from two weeks
to a month. In addition, a lead time of two weeks to a month is necessary
to familiarize enumerators with the survey operation before accurate data
are forthcoming.

The following activities are involved in most field surveys:

1. getting official government and/or university clearance for the research project,

2. contact with local and regional authorities,

3. development of the data collection instrument--drawing up survey questionnaires and forms,

4. ordering of materials and equipment for the survey,

5. hiring of field supervisors and/or survey assistants,

6. development of a sampling plan, including stratification of the population and a sampling frame,

7. drawing the sample,

8. hiring of field enumerators,

9. training of field enumerators,

10. receiving materials and equipment,

11. organization and running of a pilot survey,

12. contacting the selected farmers,

13. posting the field enumerators,

14. operating the survey,

15. supervision--checking the survey results,

16. termination of the survey,

17. contract termination with enumerators and/or survey assistants,

18. compilation and handling of the survey data,

19. analysis of the survey data,

20. write-up of the research report,

21. publishing of the research report,

22. distribution of the research results,

23. final report to the research sponsor.

For large sample surveys, a PERT program may be helpful in planning and organizing the survey.[30/] For this purpose, three time estimates are also needed for each activity: an optimistic, a pessimistic and a normal time estimate. The main advantage of such a PERT plan is that the critical activities which determine the length of the survey are known and that probability statements about the completion time of the survey can be made.

Before a survey can start, all materials and equipment needed for the field work have to be on hand. Most of the equipment needed for field surveys in Africa is imported and sufficient time must be given to order and receive materials and equipment. If some vehicle or equipment is imported duty free, the delays are usually long.[31/]

In a cost route survey, field enumerators have to interview farmers without interruption, once or twice a week, for at least one crop season or for a full year. Therefore, arrangements must be made in advance to ensure the continuity of the survey and to minimize incomplete data collection. If an enumerator gets sick, needs to see his family or abandons his work, a standby enumerator must be ready to take his place. A field su-

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[30/] In a PERT (Program Evaluation and Review Technique) program, all the activities of a project are depicted in a graphic display called a network. The network shows the essential relationships between various activities. Special attention is placed on the activities which control the time required to complete the project. The "critical path", the principal analytical tool of PERT, identifies these pacing activities. Any delay or speeding up of these pacing activities will directly affect the completion date of the project. Thus, PERT helps to organize and coordinate the different activities of a project. It is especially helpful for projects involving a large number of complex activities [Baker and Eris, 1964] [PERT/CPM/LOB, US/AID].

[31/] In Zaire, duty free importation of scientific equipment may take from four months to two years between the time of ordering and clearing of customs.

pervisor, a surveying aide or a reserve enumerator can be hired for this purpose.

The employment of enumerators for a long period of time has to be consistent with the existing labor legislation and the cultural habits of the people. Problems of this nature should be recognized at the onset and steps should be taken to overcome these difficulties. In the cotton survey, enumerators were required to sign a labor contract which stipulated the terms of employment and the contract was approved by the government labor inspection service. In the rice survey, a standby enumerator is available to fill in when necessary.

In order to retain field enumerators throughout the survey, a number of incentives should be provided. The following incentives may be used: (a) deferring part of the salary to the end of the survey with a promise to pay only if the enumerator stays on the job and (b) offering bonuses in the form of material and equipment such as raincoats, boots, watches, bicycles, etc. which can be kept by the enumerators at the completion of the survey. Needless to say, enumerators should be paid an attractive salary.[32] Since enumerators have to travel, it is usually desirable to hire single enumerators as married ones might be reluctant to stay away from home

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[32] In the cotton survey, field enumerators were paid between 30 to 40 Zaires a month (1 Zaire = 2 U.S. dollars) depending on their performance during the month. They were paid a fixed monthly salary of 30 Zaires and a variable bonus of up to 10 Zaires per month, depending upon the quality of their work. The enumerators were secondary school leavers and were only hired for the cotton survey. No assurances were given for work after the survey ended. However, from the four enumerators hired, immediate employment was secured for two in the cotton marketing office and for one in a private coffee plantation; the fourth enumerator could not be recommended for employment. In the rice survey, the enumerators were hired by the university on a permanent basis and were paid about 25 Zaires a month.

for extended periods of time. Proper maintenance and repair of transport vehicles (bicycle, motorbike) should be taught during the enumerator training sessions.

It is very important that field enumerators receive regular and surprise visits by the field supervisor or project leader in order to review and cross-check. During these visits, instructions are given and any problems which may have occurred are handled. In my opinion, enumerators should be visited at least once every two weeks. Supervision is the key to successful field research, in my judgment.

Enumerators for a farm business survey with limited visits normally need more years of formal schooling and should be more mature than for a survey technique which utilizes twice weekly visits. In the latter type of survey, enumerators frequently meet with a small number of the same farmers and repeat the same set of questions, requiring less originality, initiative and adaptation than in a limited visit survey on a large number of farms.

My best experiences have been with young, single, secondary school leavers with a rural background who were looking for a job and who like to work in rural areas. They were the best motivated. It is important that the enumerators are properly motivated and supported. They have to realize the importance of their work and should never feel neglected.

Not all logistical problems can be handled in this paper. Principles and guidelines for selecting, training and supervising enumerators and for assuring farmer cooperation have not been dealt with adequately. These topics are sufficiently covered by Zarkovich [1966], MacArthur [1968], Collinson [1972], Spencer [1972], Norman [1973] and Upton [1973].

I do realize that these topics are very important in determining the quality of data collection.

Handling and Storing Data

When unexperienced researchers engage in field survey, few will realize the sheer bulk of data they will have to handle. This is especially true in cost route surveys where each farm is visited at least twice a week and information of the following type is gathered on each visit:

1. the amount of time all active family members devote to labor and nonlabor activities during twelve daylight hours a day, for 365 days,

2. use of hired or nonfamily labor,

3. amount of crops harvested or sold in quantities and prices received,

4. amount of all purchases in quantities and prices paid,

5. input use, especially fertilizers, pesticides, credit, improved seeds, machinery.

Even for a small sample, say less than thirty farms, it soon becomes impossible to handle all the data that is being generated through manual tabulation.[33/] Therefore, storage of the data on punched cards or better, on magnetic tape and computation by a computer is a necessity. Even then, the time involved in tabulation and in transcription of the data on coding forms is frightening.[34/] Some researchers might be tempted to drop some of the data of lesser importance. There exists, however, a time saving

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[33/]A pilot survey of a very small sample is useful to estimate the quantity of data that will be collected.

[34/]Collinson [1972] reports one clerk for tabulation to every three enumerators.

solution to this problem--the use of enumeration forms from which the punching can be done directly.[35/] This eliminates the manual transfer of data. The enumeration form being used in the rice cost route survey records all the types of information listed above. The information which has to be punched on cards appears in brightly colored columns and rows and is written in a distinctive red ink. Each column on the form corresponds with a column on the punch card. Each row on the form corresponds with one punch card. All activities, fields, crop compositions and units of measure are coded on the form. Hence, only numbers appear in the brightly colored columns. A photo reduction of such a form is added in annex 1. For each family member and other laborers there is a column in which labor use is recorded. The two extreme right hand side columns record entry and exist of products and money in their respective units. In the top rows, all activities of the members of the family and outside workers are recorded, indicating respectively the individual field, crop composition in the field, coding, kind of activity and hours spent on each activity. The bottom rows record money and product flows, such as buying, selling, harvesting, home consumption, gifts, lending and borrowing. First the coding of the activity is indicated and the kind of activity, then the coding of the product, the product description and the units of measure and the coding of the units of measure. In the extreme right hand side columns, the quantities involved are noted under the appropriate column. On the

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[35/] Information recording forms from which keypunching can be done directly are nothing new. Several years ago, the U.S. agricultural census forms were designed with this purpose in mind. To my knowledge, Kenneth H. Shapiro was the first researcher to use this kind of form for field research in African agriculture [Shapiro, 1973]. Paul Perrault also used the same type of forms for field research on the economics of plantain (banana) production in the Kisangani area of Zaire.

top left side of the form, information regarding the farm and the week and
day of interviewing is recorded and coded. On the rest of the top of the
form, age, sex and names of the family members and outside workers are
recorded and coded.

The enumeration form that I am using on the rice survey can record data
for a maximum of eight persons on the farm and for a maximum of four days.
If more people are involved, then two or more forms must be used. Inter-
viewers quickly became familiar with this form and had no problems using
it. At the start of the survey, several codes had to be added or changed.

A main drawback of this form is that it requires higher quality enum-
erators and there is poor space utilization resulting in a large number of
cards to be punched.[36] Only fifty-one columns out of a potential eighty
were used on the punch cards (see annex 2). A suggested improvement of
this form is presented in annex 3. With the revision all eighty columns
on the punch cards can be utilized. The form used is somewhat inconven-
ient to use because of its size and shape. I do not have experience with the
the improved form.

The forms are easy to check for errors. Some farmers may even be able
to fill out the form themselves. The coding manual which accompanies these
forms enables anyone to understand the nature of the data recorded. Thus
the data recorded in this way can be easily retrieved by any
without much explanation.

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[36] In the rice survey each interview results in 25 rows to be filled
out on the form and thus 25 punch cards. With two visits per week and for
a survey lasting a full year, this adds up to 25 x 2 x 52 = 2,600 punch
cards per farm. A sample of 100 farms will thus require about 260,000
punch cards!

Summary

This paper highlights the major problems encountered in farm management and production economics research which I undertook on smallholder cotton and rice production in the Republic of Zaire over the 1971-74 period. This paper is based on my experience working in two distinct ecological areas, forest and savannah areas, and in using two different methods of data collection, a farm business survey and a cost route survey. In this paper I first discussed the special problems of collecting data under forest conditions followed by a discussion of the problems encountered in the use of the farm business survey and then a discussion of the methodological problems encountered in using the cost route survey method.

Cotton is the only major export crop which is grown solely by smallholders. Present production is only one-third of pre-independence levels. The main objective of the cotton study as set forth by the Ministry of Agriculture was an analysis of constraints on cotton production in the northern cotton belt. The east to west distance of this area is about 800 miles while the distance from north to south is 200 miles. The northern cotton belt is north of the central basin equatorial rain forest and includes equatorial rain forest, savannah woodland, tree savannah and shrub savannah. Because of a limited research budget, I used the farm business survey method to study smallholder cotton production. Four field enumerators were used. Each enumerator interviewed forty farms twice a year, once during planting and once during harvesting seasons.

Rice is a major staple in Zaire and is primarily grown in the North. Rice imports are increasing. I am currently carrying out a pilot cost route survey of smallholder rice production in a representative village

close to Yangambi in the equatorial rain forest in northern Zaire. Twenty
farmers are being interviewed twice a week by one enumerator. A second
enumerator is available on a standby basis. The purpose of this pilot
survey is to collect reliable input-output data over a period of one year
and to extend this survey to other villages when adequate funding is
secured.

Much of the literature on micro-economic research in rural Africa is
based on farming in savannah areas. Although this literature was a val-
uable guide for my micro research in forest areas, I introduced several
modifications in order to collect more reliable data in the forest region.
The problems are underlined below and the solutions to the problems follow.

1. Measuring the land input when fields are nearly inaccessable
   and very irregular in shape with loose boundaries. I could not
   use a measuring wheel. Instead, measuring tapes and field com-
   passes were used and the fields were plotted to scale on graph
   paper using a protractor. The acreage was then determined with
   the aid of a planimeter.

2. Measuring the land input when field size is variable over time.
   Fields were measured just before the harvest of the major crop or
   crops. Some fields had to be measured twice--once per major
   crop.

3. Long traveling distances. Since farmers had to walk long dis-
   tances from their home to the fields, I included travel time as
   part of the farmer's labor input.

4. <u>Determining yields under variable plant densities and heterogeneous crop mixtures with a mixture of annual and pluri-annual crops and no well established planting and harvesting dates</u>. Since the rice plant density was so variable, I could not use the yield plot method to determine reliable yields. Instead, all products harvested from the fields were recorded in local measures on a twice weekly basis.

5. <u>Analysis of single crops in crop mixtures (intercropping)</u>. An almost infinite variety of different crop mixtures is found in Zaire on farms in the forsst areas. Although this problem is mentioned in the literature, there is no satisfactory methodological basis for the analysis of single crops in crop mixtures. Most texts consider the mixture of crops in a field as one enterprise, defined by the density count of the individual crops. This by-passes the problem but does not solve it. This problem becomes very relevant, especially when annual or perennial crops (e.g., coffee) are grown along with annual food crops. More research attention should be devoted to this topic.

Turning to the farm business survey method, I found this method useful in identifying the cotton production systems, the production environment and the major constaints in cotton production in a large geographical area. With a fixed budget constraint, the sample size in farm business surveys is usually much larger than in the cost route surveys. When little is known about a large agricultural area, farm business surveys will be very useful for organizing and planning subsequent cost route studies.

Through the process of trial and error, I devised alternative methods to deal with the following problems in the farm business study on cotton.

1. <u>Time required to complete questionnaires</u>. Since it took more than two hours to complete the questionnaires, I solved this problem through repeated visits on successive days, each visit not taking more than one hour.

2. <u>Collecting sensitive information</u>. Since the farm business survey allowed only two visits per farm, I found that sensitive information could not be collected in this type of survey. Therefore, I deleted questions dealing with sensitive information.

3. <u>Sampling frame</u>. Since the research budget did not allow me to derive my own frame, I utilized an existing frame of all farmers and accepted its inaccuracies.

4. <u>Sample size</u>. A statistical formula was not used to arrive at the number of farmers to be interviewed. Instead, budget and time considerations determined the sample size.

I found that when reliable data is needed on labor inputs, incomes and cash flows, I turned to a cost route survey. Since labor is the most important factor of production in smallholder farming in Zaire, cost route surveys are needed to generate data on labor utilization and labor substitution. In forest areas close to the equator, frequent visit type surveys are needed because of continuous intercropping with haphazard planting and harvesting dates.

Common problems encountered in both types of surveys, cost route and farm business surveys, and ways of overcoming these problems are:

1. <u>Definition of the primary sampling unit</u>. In Zaire, the consumption unit is often larger than the production unit. Thus, the usual definition of a household unit in Africa, all the people eating out of the same pot, is not satisfactory. Each household head should be interviewed at the beginning of the survey to record family linkages and to determine what unit in the household corresponds to a production unit.

2. <u>Organization and timing of the survey</u>. Timing is very important as the survey schedule is tied to the growing season of the major crop under study. Careful planning is necessary in order to match the survey with the growing season.

3. <u>Enumerator drop-out</u>. I used the following incentives to reduce enumerator drop-out: deferring part of the salary to the end of the survey, awarding bonuses at the end of the survey, providing an attractive salary and using a labor contract which stipulated the terms of employment.

4. <u>Breakdown of transportation</u>. Part of the enumerator training should be on repair and maintenance of bicycles or motorcycles.

One of the most frustrating problems in my cotton survey was the handling, tabulation and transcription of the mass of data. These activities are time consuming and are cumbersome. In order to overcome this problem, I developed an enumeration form from which the punching can be done directly. I am using this form in my rice survey and I have discussed it in the text. All activities, fields, crop composition and units of measure are coded on this form. These forms are easy to check for errors. The recorded data can be easily retrieved by any researcher without much explanation and the

techniques promote an exchange of data between interested researchers and facilitates inter-country comparisons. However, this form has several major drawbacks--poor space utilization and a resultant proliferation of punch cards and better quality enumerators. An improved form is proposed which provides for better space utilization. However, this form is large and somewhat inconvenient to use.

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Annex 1.

| MAIS - S. | HARICOTS - H | MANIOC - M | PATATE DOUCE - P | ARACHIDES - A | ELAEIS - E | BANANES - B | COTON - C | RIZ - R |

Annex 2.

Void Area in the Survey Form

	John	Bob	Ann								Entry	Exit
Description of Time Utilization				Time Utilization in Hours							V O I D	
Product and Money Flow Description				V O I D							Units of Product and Money Flow	

Annex 3.

Proposed New Form

	John	Bob	Ann							Entry	Exit
Description of Time Utiliza-tion				Time Utilization in Hours					Units of Products and Money Flow		Product and Money Flow