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Stallings, J. L.

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- To:
1. Brandon Robinson, Chief, Analysis Division
USAID, REDSC/EA
Nairobi (ID)
Department of State
Washington, DC 20523
 2. AAO, USAID Mission
Kigali, Rwanda
Department of State
Washington, DC 20523
 3. Beverley A. Carlson, Chief, General Surveys Branch
ISPC, U.S. Bureau of Census
Department of Commerce
Washington, DC 20233
 4. Mr. Ed Smith
ARR/DR
Room 2723, New State Building
Agency for International Development
Washington, DC 20523
 5. Mr. Dan Clay
ISPC, U.S. Bureau of Census
Department of Commerce
Washington, DC 20233
 6. Dr. Alan Saalfield
ISPC, U.S. Bureau of Census
Department of Commerce
Washington, DC 20233
 7. AID Reference Center
Agency for International Development
Washington, DC 20523

From: James L. Stallings
Department of Agricultural Economics
Auburn University, AL 36849

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A STATE-OF-THE-ARTS PAPER (SOAP)
on
TECHNIQUES OF ENUMERATION
of
INTERCROPPING AND ASSOCIATED CULTIVATION
and
LIVESTOCK NUMBERS AND PRODUCTS
in
SUBSISTENCE AGRICULTURE IN LDC's

TERMS

1. Single Cropping = Growing only one crop on a plot of land within one year
2. Multiple Cropping = Growing more than one crop on the same plot of land in one year. Subheadings of multiple cropping are as follows:
 - a. Double Cropping = Growing two crops in sequence, one after the harvest of the other, within the same year.
 - b. Triple Cropping = Growing three crops in sequence, one after the harvest of the other, within the same year.
 - c. Intercropping = Growing two or more crops simultaneously in the same plot. Sub-headings of intercropping are as follows:
 - (1) Row Intercropping = Growing two or more crops simultaneously in the same plot, but in distinct, separate rows.
 - (2) Mixed Intercropping = Growing two or more crops simultaneously in the same plot with no row or other distinct arrangement by species.
 - (3) Relay or Sequence Intercropping = Growing two or more crops simultaneously, overlapping in sequence, seeding or transplanting one or more crops before the harvest of the preceding crop or crops.
3. Strip Cropping = Growing two or more crops in distinct strips or bands of multiple rows within a field, plot, or holding, with each strip or land capable of being independently cultivated or tended.
4. Sole Cropping = Growing only one crop (variety or species) alone in pure stands, either as a single cropping system or relay, or a sequence cropping system within the year.
5. Crop Rotation = A time sequence of crops following one another, either as single, sole, or multiple crops, on a particular area over a cycle of more than one year. Implies a regular cyclical pattern over time.
6. Cropping System = The set of crops making up the cropping activities of a holding, including all components required for their production, such as varieties, cultural practices, etc.

7. Livestock System = The set of different livestock and livestock products kept and produced as a part of a farm or holding, including such things as breeds, cultural practices, etc.
8. Farming System = The set of different crops and livestock kept and produced as part of a farm or holding, plus all non-crop and livestock activities necessary for operation of the farm or holding.
9. Holding = All the land farmed as one unit by one person, family, groups of persons, or an organization. This will include all the area formally included in the holding with definite boundaries plus actual or estimated equivalent area of all other land from which crops are harvested, or grazing or other agricultural benefits are derived, even if not owned or otherwise formally included within definite boundaries. This will exclude, however, communal grazing areas and areas grazed as migratory herds. The criteria is that the farmer or unit should actually have sole use of the area for at least a portion or all of the crop year.

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INTRODUCTION

This paper is the result of one item of work in a personal service contract with USAID (amended by telegram) which stated:

"The contractor will also spend two full weeks in Auburn preparing a state of the arts paper (SOAP) on techniques for measuring area and production in intercropped or associated cultivation, and the enumeration of livestock numbers and livestock products, as well as summarizing the information available in the best written material on the subject. The contractor will conduct telephone interviews with selected USDA and University personnel who have applied appropriate techniques in African countries. This paper will be delivered to AAO during the only remaining two-week trip to Kigali by the contractor who will then work with team preparing the Collaborative Survey and Analysis of Agriculture PP."

Carrying out any kind of enumeration in economies with a high subsistence agriculture, as in Rwanda, is difficult. Unlike in highly developed economies, with a high percent of commercial agriculture, enumeration of subsistence agriculture poses special problems, including: cropping systems which are complex and non-standardized; a high degree of illiteracy which precludes use of mail questionnaires; poor records, if any at all, and poor recollection of harvested amounts as crops and livestock and their products are used by the household as needed, creating difficulty in estimation of total production; poor roads, accommodations, and other aspects of logistics which makes enumeration difficult; lack of a cadre of educated personnel available to carry out the enumeration; and, many other problems. Also, there is frequently a "dual economy" in agriculture with a few large estates along with many small subsistence holdings. This paper will deal only with the subsistence type of holding.

Limiting this paper to only "...techniques for measuring area and production in intercropped or associated cultivation, and the enumeration of livestock numbers and livestock products..." as requested in the contract, was difficult. This was because these techniques are frequently determined by other decisions made concerning the overall nature of the survey and its analysis. Enumeration will, necessarily, be quite different for a complete census vs. a sample survey, for instance, and with different sampling techniques. It also will differ depending upon the objective of the census or survey and the analysis desired. These problems were avoided as far as possible, in this paper by briefly outlining, in Chapter II, an overview of how these problems fit into the whole sample survey and analysis.

Then, in subsequent chapters concerning crops and livestock, only a list of specific frequently encountered problems of enumeration are treated,

keeping in mind all the while how each fits into the overall scheme of the whole sample survey and analysis outlined in Chapter II. Each of these specific problems will be treated, in turn, according to the following outline:

- The Problem Title
- Problem Description and Alternative Solutions
- Recommendation(s) for Rwanda

Finally, it should be pointed out that all the recommendations presented in this paper are not pretested for Rwanda by the author, but are the result of review of literature and opinions of persons with experience in conducting sample surveys, including the author who lived in East Africa for a time. These recommendations then, are hypotheses for testing, and should not be taken as the chosen approach until adequately pretested. It is hoped, however, that the listing of frequently encountered problems, along with possible solutions, will be a valuable set of hypotheses for testing.

The paper written by Dr. John O'Sullivan and included as Appendix A was written separately and is presented intact as written except for his appendices which were rather bulky to include here.

II. GENERAL OUTLINE OF A SAMPLE SURVEY AND ANALYSIS

OF SUBSISTENCE AGRICULTURE IN A LDC

The following outline of a sample survey and analysis of subsistence agriculture in a LDC is not necessarily the exact outline of the work planned under the Collaborative Survey and Analysis of Agriculture Project for Rwanda. Rather, it is a gleaning of the elements of several similar surveys reviewed for writing this paper. It is intended to put the items discussed in the subsequent chapters into perspective with the overall task of planning, organizing, conducting, analyzing and using a sample survey. The reader should keep in mind, therefore, that the specific problems discussed in Chapters III and IV fall mainly under D,4 and D,5 of the following outline:

A. PLANNING THE SAMPLE SURVEY

1. Deciding on a Survey as a Complete Census--Pros and Cons
2. Determine the Objectives of the Survey
 - a. Advice from potential users (meetings, etc.)
 - b. Consult with experts
 - c. Review literature and previous surveys
3. Determine Kinds and Forms of Data Needed
 - a. Considering objectives
 - b. Considering all user needs including Government and UN guidelines and needs
 - c. Set up dummy tables with tabs, intervals, etc.
4. Determine Statistical Procedures
 - a. The sample frame--may require preliminary survey(s)
 - b. The sample size
 - c. Error control
 - d. Measurement equipment, if applicable
5. Draw Sample
6. Design Questionnaires and Other Enumeration Instruments
7. Write Training Manuals for Supervisors, Crew Leaders, and Enumerators
8. Recruit Supervisors, Crew Leaders, and Enumerators
9. Train Supervisors, Crew Leaders, and Enumerators

- B. CONDUCT PUBLIC RELATIONS CONCERNING THE SURVEY
- C. CONDUCT PRETEST OF INSTRUMENTS, PROCEDURES, ETC.
 - 1. Actual Field Enumeration Pretest with Limited Staff and Enumerators
 - 2. Return and Hold Critique of All Procedures, Instruments, Manuals, etc.
 - 3. Revise Procedures Based on Critique
 - 4. Conduct Further, More Elaborate, "Pilot Survey," if Appropriate, Before a Large, Extensive Survey
 - 5. Revise Again as Appropriate After Pilot Survey
- D. CARRY OUT GENERAL SURVEY--CONTENT MAY INCLUDE:
 - 1. Determination of Soil Types and General Land Use--Agriculture and Non-Agriculture--By Types-of-Farming Areas for Agriculture, etc.
 - 2. Nature of the Agricultural Holdings, Including Ownership Patterns
 - 3. Nature of the Family and Household
 - 4. Nature of the Cropping System(s) Including Crop Calendars
 - 5. Nature of the Livestock System(s) including Calendars
 - 6. Income Sources, Including Crops and Livestock and Their Products, Gifts and Other Exchanges, Crafts, Forest Products, Farm and Non-Farm, and Miscellaneous
 - 7. Farm Inputs, Implements, Facilities and Practices, Including Labor Use, Improved Varieties, Erosion Control, Etc.
 - 8. Prices Received, Market Channels and Methods, By Enterprises
- E. ANALYSIS OF DATA
 - 1. Receiving, Editing, Precoding, and Coding
 - 2. Data Processing, Tabulating, and Generation of Tables
 - 3. Computation of Enterprise Cost and Returns
 - 4. Computation of Measures of Farm Income
 - 5. Calories per Capita, per Hectare, etc. and other appropriate computations

- F. PUBLISH RESULTS
- G. USE THE RESULTS FOR PLANNING AND POLICY FORMULATION
- H. CRITIQUE RESULTS FOR FUTURE SURVEYS

III. ENUMERATING INTERCROPPING AND ASSOCIATED CULTIVATION

A. INTRODUCTION

The reader should refer to the Terms list in the front of this paper before continuing to note the differences in terms between single cropping, multiple cropping, double cropping, triple cropping, intercropping, and other terms. While intercropping is emphasized in this chapter, particularly "mixed intercropping" (see), many of the problems to be discussed are common to all subsistence cropping, regardless of the specific cropping system.

There are many problems associated with enumerating of intercropping and associated cultivation in subsistence agriculture. It was necessary, therefore, to choose a list to treat which seemed, from the literature review and persons contacted, to be the most frequently encountered.

B. DETERMINING CROPS GROWN AND CROP AREA

1. General Measurement Techniques for an Area

For planning purposes, it will be desirable to know both general land use for the country and other political units and area of agricultural holdings, including areas of specific plots and crops. However, general land use is quite a different problem from land use in plots or on a holding and will not be discussed here.

For areas of specific holdings, plots, or crops, there are several approaches. The most desirable, if possible, would be to simply ask the farmer, using a mailed questionnaire or by personal enumeration. This is usually not possible in subsistence economies for two reasons; a large portion of the farmers will usually be illiterate and could not read and fill out a mailed questionnaire; and, they do not have in mind a concept of area for their holdings, plots, etc. Even if a farmer did know the area of his holdings, the unit may or may not be the international or national unit being used and it will be necessary to use a conversion rate.

Other problems of getting area, in general, involve many of the subsequent problems to be discussed in this chapter. These include: distortion due to slope, undefined boundaries, non-productive areas within a plot, planting concentration and what constitutes a stand, idle and fallow lands, prepared vs planted acres, planted vs harvested acres, variety differences, intercropping, sequence cropping, wild economic production, community production, and other problems.

Other than directly asking the farmer, there are several objective measurement approaches to determining area. The most important of these is simply measuring the area in question. However, there are several approaches to measurement as follows:

- a. If fields have parallel sides, one of each of the two sets of parallel sides can be measured and area calculated as the product of the two.
- b. If there are more than three sides the area can be converted to a polygon and broken into triangles. The area of each triangle can then be determined as $\frac{1}{2}$ (base) x height to apex.
- c. Area of a polygon can also be determined by traversing the circumference, measuring the different segments, and taking bearings.
- d. Area of a polygon can also be determined by use of plotting on a map using bearings from a single point and distance measurement of two points on the polygon without traversing the circumference.
- e. Aerial photography will be mentioned as a possibility here but will not be pursued. While possibly appropriate in helping determine general land use of a political unit, it has usually been of little use on small subsistence areas having many of the problems already mentioned.

Recommendation for Rwanda: Because of the difficulties of any other approach in subsistence agriculture, it appears that a direct measurement technique would be most appropriate using two men with a measuring tape and a compass for measuring angles. Unless the fields or plots are perfect rectangles, all fields or plots should be forced into the shape of a polygon, and sides and angles should be measured by traversing around them rather than choosing a method involving cutting across plots. Cutting across plots would involve the chance of destroying crops, in some cases, and might be difficult because of obstacles in other cases. Also, measuring where to start a perpendicular line is an added problem in the triangulation approach.

2. Measuring Area on a Slope

This is a problem concerning the actual area of sloping land as the area projected on the face of the earth if the area were flat. This is a problem frequently mentioned in previous literature, but rarely is anything done about it. To quote one author, "It seems rarely to be a serious issue in practical working conditions, though adjustments are discussed occasionally. Even in a 25 per cent slope, the difference between projected area and actual area is only about 5 per cent, and this is probably among the least of the uncertainties attaching to a good deal of this work

in developing countries," (Hunt, K. E., p. 46). If the problem were in accounting for all land in general land use, slope might be an important consideration. The project under consideration, however, will be dealing with samples of "holdings" or farms. These holdings will account for only a certain percentage of all land use in Rwanda. General land use should be determined by more macro methods (aerial photos, etc.). On the other hand, actual area in holdings and in specific crops appears to be more important than area on the face of the earth in enumerating holdings and in assessing production potential in Rwanda.

Recommendation for Rwanda: Do as good a job as possible in measuring actual area planted, harvested, prepared, etc., as if the area were flat, and not be concerned with projected area. Even if the differences were great, the concept sought for this study is actual area of crops, etc., anyway. The recommendation is to forget about accounting for slope, even though the average slope in Rwanda is, no doubt, high.

3. Boundary Problems

In many cases in underdeveloped areas the specific boundary of a plot will not be clear. This is especially true of areas where clean cultivation is not practiced and crops are planted in trash and among weeds and other non-economic plants and trees.

Recommendation for Rwanda: The author found no good solution to this problem except judgement. If, in the enumerator's judgement, the land planted has essentially been cleared, and in any way cultivated as a single intact plot, the boundaries can be estimated and forced into a polygon shape for measurement. If not, treat production for area purposes as in Section 5 on Planting Concentration (see).

4. Non-Productive Areas within Plots (Roads, Ditches, Erosion Barriers, Weed Patches, etc.)

Should the area of a plot include the paths, ditches, erosion barriers, weed patches, etc. in what would otherwise be known as a separate plot; or should only the portion of land on which crops are actually grown be counted?

Recommendation for Rwanda: If the non-productive area is man-made and definitely associated with production of crops (i.e., irrigation ditches, access strips, paths or roads, erosion barriers, etc.) they should be counted as land in the plot. For other natural, non-productive areas (i.e., weed patches, bolders, etc.) judgement will have to be used by the enumerator. A rule could be made, if desired, to exclude any natural non-productive area from the plot area if it constitutes more than 5% of the total plot (or other appropriate percentage as agreed upon).

5. Planting Concentration

It is common in some areas of subsistence agriculture to scatter plantings of individual plants among trash, in wooded areas, etc. so that it is impossible to define a plot or field. These are not "wild" plants. They are actually planted by hoeing up a spot and planting a plant here and there, but not in an organized plot or field. The problem becomes one of whether or not to try to estimate an area for such production and, if so, how? Or, putting it another way, one may ask, "What concentration of plantings of a particular crop is necessary before it can be considered as a solid stand of the crop or a plot or field?"

Recommendation for Rwanda: If, in the enumerator's judgement, the area in question is not determined to be a single, intact plot for measurement purposes (See Section 2 on Boundary Problems), it is suggested that production from such areas be recorded throughout the enumeration year (keeping it separate from "wild" production) and converted to crop area later using standards for single solid stands of different crops developed for that purpose. If this production has been planted outside the boundaries of the area known as "the holding," the equivalent area should be added to the area in the holding.

6. Idle and Fallow Areas

In subsistence agriculture, as in any other agriculture, there are frequently areas in the "holding" which are being prepared during the enumeration year, or in some recent period, but are not used for agricultural purposes in the enumeration year.

Recommendation for Rwanda: If these areas are suitable for cropping (as opposed to rough, non-usable land) they should be appropriately categorized, and the area recorded, as they represent potential future production. Categories may include: cropland suitable only for pasture, further broken down into "improved" and "unimproved," cropland suitable for cultivated crops; and, any other category desired. If the land has not been prepared or cultivated or otherwise used for agricultural purposes in the enumeration year, a rule should be made that it has been used or cultivated within some reasonable recent time, say the last 5 years. All other land can be classed as "idle land," "homestead," "roads, paths, etc.," or other appropriate category, in the holding.

7. Prepared vs. Planted Areas

Should the whole of land prepared for a crop be included in the area of a crop or only that area actually planted? Because preparation of land involves labor and, perhaps, other inputs, it has been suggested that this area must be accounted for in some way, even if left fallow after prepared and not used in the enumeration year. One suggestion was that after accounting for an appropriate boundary to planted area, the rest of the area should

be recorded as "fallow" cropland. Also, fallow land for part of a year may become planted land later in the year. If so, it will eventually be included in planted and/or harvested cropland.

Recommendation for Rwanda: Any land formally prepared for planting should be measured and allocated either to fallow cropland or to planted and/or harvested area. "Formally prepared" shall mean clearing by any method and/or plowed or otherwise cultivated in any way.

8. Planted vs Harvested Areas

Should planted or harvested acres be measured and recorded or both? As with prepared vs planted areas, planting involves labor and other inputs and most sources indicate that it is valuable to record planted areas as well as harvested areas. This is particularly true if crops are planted in the enumeration year, but will not be harvested until the next year. It is also advised in order to estimate the extent of drought or other natural disaster in the enumeration year. If planted crops are destroyed or not harvested for some reason the government will have valuable information as to the extent of loss of yields and abandonment.

Recommendation for Rwanda: Both planted and harvested areas should be measured, or otherwise estimated, and recorded. Planted areas should be measured. Harvested areas may be measured or estimated as a percent of planted for some crops.

9. Different Varieties of the Same Crop

The question becomes, when are two or more varieties of what would be otherwise known as the same crop enough different to be enumerated as separate crops? For example, should the cooking and sweet varieties of bananas be enumerated simply as bananas; or, should they be separated as different crops? Should two or more types of beans be enumerated simply as beans or as separate crops.

Recommendation for Rwanda: These are judgements that this author cannot make crop by crop without more information. However, the criteria suggested is as follows: count as separate crops, any variation in varieties of what would otherwise be known as the same crop if there are either significant differences in cultural practices, yields, use, or marketing methods. Rules will have to be made for specific cases and included in the enumerator's instructions or manual.

10. Pasture and Land from Which Forage is Harvested

This category of land can vary widely from migratory ranges with sparse vegetation and not owned or controlled by any one holding, person, or persons, to improved or unimproved communal grazing in a definitely defined area, to the cutting of forages or grazing by a holding, person, or persons in areas off the formal holding, to different categories on the formal holding itself. If these types of areas are in the formal holding, there is little problem other than devising appropriate categories for enumeration. If off the holding, however, enumeration becomes more difficult.

Recommendation for Rwanda: Do not include land on which migratory herds graze and which are not owned or controlled by any one holding. Similarly, do not include definitely defined areas of communal grazing in the holding's land. Within the formal holding, enumerate different categories of pasture and forage land as desired such as: land from which hay or other forage is harvested (along with estimates of production); land used only for pasture, broken down if desired, into "improved," and "unimproved." Off the holding, enumerate equivalent areas of pasture or land from which hay or other forage is harvested. This should be estimated by standards developed and included in enumerator's instructions if the areas are not formally defined and capable of being measured (i.e., area needed for one "cow equivalent" per unit of time; areas required for harvest of a certain amount of hay or forage, etc.)

11. Forest and Land From Which Forest Products are Harvested

This category of products has caused trouble in many a survey and census throughout the world. The problem is that much of the forest products of the world are harvested from areas not traditionally thought of as "farms." Many large forest operations are owned and managed by either the government of a country or a large private company. This would cause no problem if all forest products came from operations of this type. However, there are several instances where there are forested areas or trees on "holdings" which are considered more traditionally "agriculture." For instance, a farmer who grows traditional agricultural crops, and/or raises livestock, also may harvest timber or sell firewood or charcoal. These products may come from the formal "holding" area or may be harvested off land not owned or controlled by the farmer or holding. In some instances this is handled by not considering forest products as "agricultural" products and they are simply ignored. However, in many cases, it is felt that they must be accounted for as part of the effort expended and income obtained by the farm family in the same manner as off-farm work. In other cases, they are simply counted as another farm product. In this latter case, however, the rule is usually that they must have "agricultural" operations otherwise and no "holding" would be classified as a "farm" or "holding" if it only had forest products.

If forest products are enumerated as just another agricultural product on holdings that would qualify as having "agricultural" operations otherwise, there is frequently misunderstanding by users of the data as to just what they mean. If commercial forest holdings from which forest products are harvested off formal holdings is not large, as may possibly be the case for Rwanda, users are liable to read the figures from an agricultural census or survey as all the forest products harvested in the country when, in fact, the figure represents only that amount harvested off of agricultural holdings.

Recommendation for Rwanda: In spite of conceptual difficulties, sales of forest products by agricultural holdings in Rwanda must be recorded, along with physical quantities if possible to get. Labor used for tending and harvesting forest products also must be accounted for in recording general labor use. However, it is recommended that no "holding" be classified as such wholly because of forest products, but that the holding would have been enumerated anyway without forest products. Forested area on holdings should be enumerated and recorded, but no equivalent area off the holding need be estimated and added to the area of the holding as with traditional agricultural crops. There is an exception to this which will require judgement. If the forest products are of a cultivated nature (i.e., capok trees from which capok is harvested and other forest enterprises frequently grown in rows and cultivated), they should be treated as any other crop in the holding. Wild or non-cultivated areas either on or off the holding need only be recorded. Forest area should be recorded only if well defined and on the holding--not from random trees in boundaries, in the farmstead, etc.

12. The Farmstead, Kitchen Garden, and Other Non-Crop Areas of the Holding

In agricultural areas throughout the world, there are usually areas on which the home stands, yard areas, lanes, paths, corrals or livestock holding areas, area occupied by out-buildings, etc. These are lumped into an area called the "farmstead" in the U.S. and other censuses after all other economic and idle or fallow farmlands have been accounted for.

Recommendation for Rwanda: After all other economic crops, forest area, pastures, water areas, and other areas directly associated with agricultural production have been accounted for, all other area definitely enclosed in what is considered by the operator as the "holding" can be classed as "farmstead," "homestead," or by some other appropriate term. If the home is definitely separate from all or most agricultural plots, this will be only an estimate of the living area directly contiguous to and associated with family living, processing, and otherwise working around the home. This will be a judgement in many cases.

13. Minimum Plot Size for Recording Area

This is a definitional problem. It should be determined by the purpose of the survey and/or nature of the crop(s) being enumerated. For instance, if the enumeration was primarily in range land, one hectare may be the minimum necessary to be enumerated, or even a larger area. However, if the crop were an intensive, high value type, such as a vegetable crop, even 1/10 of a hectare may not be small enough to be significant. Not enumerating areas smaller than 1/10 hectare may result in missing a significant or valuable amount of a crop. While some sources might advocate different minimums for different crops, that, too, causes a problem and may not be worth the extra effort. Before the minimum is set for Rwanda, some preliminary study should be made as to how much, of what crops, and of what value would be missed at decreasing minimum sizes. Then, a decision should be made commensurate with the budget and trouble involved with enumerating increasingly smaller sizes. It may not be worth it, or appropriate, for instance, to enumerate area of any crop grown as an herb in the yard or farmstead, although production may be recorded. However, if a crop with small area per holding is widespread throughout the country, a significant area may not be recorded for the country as a whole by setting the minimum too high per holding.

Recommendation for Rwanda: Considering that many holdings in Rwanda are small, and areas of many crops are even smaller, with high value per unit of area, the recommendation is to enumerate and record area of any plot of any one crop or mixture if the area is as much as 5 square meters. Production should be recorded, but area should be designated by *, or some other symbol, with a footnote "less than 5 square meters or .0005 hectare " if the areas less than 5 square meters.

14. Multiple Cropping--Double and Triple Cropping

In cases where the mixture of crops in any one enumeration year on the same plot of land follows in a definite sequence with one crop harvested before the other is planted (or, with only a minimum of overlap as in the case where the new crop is planted in the rows or other area of the previous crop just before harvest) there is little problem of enumeration. The only requirement is that the areas and production of each crop in the sequence be recorded. There is another figure which is useful, however, and that is the area within an enumeration year which is double or triple cropped. These areas, along with all single cropped and other areas, are necessary to account for total area in the holding. Otherwise, if all areas of crops in double or triple cropped sequences were simply added up, double and triple counting would occur and the total area in the "holding" would be distorted.

Recommendation for Rwanda: Record all individual areas of crops double or triple cropped along with the area double or triple cropped in total to avoid double or triple counting.

15. Multiple Cropping--Row or Sub-Plot Intercropping

In cases where the mixture of crops in multiple cropping is planted in definite rows or sub-plots there is usually little problem involved in estimating area other than deciding on the boundary between them. If sub-plots are of a similar type and size of crop the sub-plots can be measured as separate plots and the boundaries can reasonably become half the distance between the definite plots. In the case of equally spaced rows, the whole area can be measured and allocated to each crop by counting rows.

If rows are not equally spaced, areas of row-planted crops may become more of a problem, especially between crops of widely different growth patterns, heights, etc. This is equally true of boundaries between sub-plots of widely differing plant types. (For example, wheat in narrow rows or planted solid abutting maize planted in rows of two or three feet; or, fruit trees fifteen to twenty feet apart next to the wheat.) In cases of tree crops, an estimated point below the last outer branches can reasonably be taken as a point of measurement to the next crop such as wheat. If wheat or cotton extends somewhat under the branches of a tree crop, the judgement decision will have to be made as to when it becomes mixed intercropping (see). Otherwise the boundary can be at some average of the overlapping area where the two crops meet.

Recommendation for Rwanda: If areas are capable of being definitely separated and are not judged to fall under the classification of "Mixed Intercropping" (see), determine boundaries between areas planted as half the distance between the last plants of each sub-plot, or at the average of the overlapped area, if minor. This will require judgement in many cases. Area harvested would then be a separate concept (see Section 8, Planted vs Harvested Area).

16. Multiple Cropping--Mixed Intercropping

In subsistence agriculture in tropical areas, multiple cropping frequently consists of interplanting the various crops by a scattering of the plants of one crop among the plants of another. Sometimes these mixtures consist of one crop which is quite clearly dominant, with a few scattered plants of one or more others. In other cases there are mixtures of two or more crops which are part of a regular and established pattern of cropping in the neighborhood. In other cases there appears to be no definite pattern among farmers in an area and the plant mixture is non-homogeneous between farms, with no one species dominant in all cases.

Assuming that areas of individual crops in a mixture could somehow be estimated, there is the initial question as to whether or not it would make sense to aggregate data from pure stands of a crop with that from a mixture. However, if it is assumed, for the sake of analysis, that the total area of the plot containing a mixture of crops must be allocated

among the different crops, there are several approaches which have been suggested in different references as follows:

- a. The "Pure Stand Approach": This approach requires development of a set of standards for the different plants contained in the mixtures for their density in some "average pure stand." This may be difficult if one or more of the crops in a mixture are seldom or never grown in pure stands in the area. However, some estimate of the number of plants in a "pure stand" must be estimated in some way. The number of the plants of each variety in the plot must then be actually counted or estimated in some way and the areas determined for each, assuming they were in a pure stand. If the total areas of the different plants add to more or less than the area of the plot, the area of the plot can then be allocated in proportion to the areas of individual crops in the added total. This can be done in the office after enumeration is completed.
- b. The "Proportion of the Area Occupied Approach": This is similar to the pure stand approach, but is only applicable if it is possible to estimate the proportion of the ground covered by each crop. It would not work well in cases where one or more crops are grown in the shade of other crops. This approach requires "judgement" on the part of the observer as to the proportion of the area occupied by the respective crops. With practice, this approach may be accurate enough for some mixtures.
- c. The "Each Crop Occupying the Whole Area Approach": This is applicable if there is no one dominant crop and the concept of total acres of crops grown adding to more than total land area can be accepted as with double or triple cropping (see). This may be more applicable in cases where only one crop is being studied in a survey. It poses problems, however, for a general survey of all agricultural operations where there is a need to have a count of specific acres of specific crops at any one time adding up to total cropland.
- d. The "Mixed Crop Approach": This approach is particularly applicable when there are certain well-defined mixtures grown by many farmers in an area and the proportion of each crop in the typical mixture is about the same among many farms (for example, bananas shading coffee, with sweet potatoes planted under these in some areas of East Africa). In this approach, the familiar mixture may be given a name and counted as a single crop such as "Banana-Coffee-Sweetpotato Mixture." Unfortunately, there usually comes a time when a national government, the U.N., etc. wants area of individual crops for a particular use. This approach would then break down and area would have to be estimated in some way. This could be done after the fact in the same manner as in any of the three approaches in a, b, or c above.

- e. The "Area from Harvested Production" Approach: This approach is much like the "Pure Stand Approach" in that it requires development of standards for average production per unit of area from a pure stand for the area and year of enumeration. In this approach, area is determined for the whole field plot at anytime, but it is not allocated to specific crops in the mixture until harvest of all crops is complete. Then the standards are applied to estimate area which would have been required to produce this amount from a "pure stand" with "average yields" given the weather conditions, cultural practices, etc. of the particular year of enumeration. As in the "Pure Stand Approach" if total estimated area of individual crops adds to more or less than the area of the plot, the area of the plot can then be allocated in proportion to the areas of individual crops in the added total. This can be done in the office after enumeration is completed.
- f. The "Seeding Rate" Approach: If it is possible to know how many seeds or plants were planted in a mixed stand, standards for planting rates for "typical" plantings could be used to allocate area to each crop in the mixture. This is frequently not possible, however, and seems applicable only to special cases. It would be much better to be able to pretest each of these methods for various kinds of mixtures which include tree crops, row crops, and solid plantings before making a recommendation. However, this writer will not have this luxury and a recommendation will have to be made at this point. The approach chosen should be pretested, however, before final adoption. In fact, it may be found from pretest that different methods should be applied to different types of mixtures if they can be well defined.

It is also anticipated that, for some uses, there will eventually be a need for allocating area in mixed intercropping to individual crops, even though the area in mixed crops themselves may be the most useful figure from an area standpoint and will be obtained in the original measurement in any case.

Recommendation for Rwanda: Considering ease of enumeration and the eventual need for area of individual crops, no matter how artificial the concept, the following approach is recommended for mixed intercropping in Rwanda: Get area of the overall plot early in the year of enumeration. Get production from all the different crops throughout the enumeration or harvest period, keeping the record separate for that plot or plots. Then allocate the plot(s) area to individual crops using the "Area from Harvested Production" approach (e) using standards to be developed for that purpose. Standards can be developed as detailed as needed by areas, elevation, soil types, etc. from measured pure stands in the enumeration year or estimated from mixed stands for crops seldom occurring in pure stands. Actual computations of areas of individual crops can be done after the enumeration is over in the office.

17. Multiple Cropping--Relay or Sequence Intercropping

Rwanda is typical of certain tropical areas without great variations in rainfall and growing seasons where crops tend to be planted and harvested in overlapping sequences rather than planted and harvested all at once. For example, bananas may be planted a few at a time almost constantly throughout the year with maturity and harvest occurring accordingly. Beans, maize, potatoes, cassava, and other crops may be planted in the same way. This makes it extremely difficult for field staff to keep track of sizes of plots and areas of specific crops throughout the enumeration year.

Complicating the problem is the fact that certain annual crops may be planted in sequence among perennial tree and other crops which continue on year after year. Recording areas of individual crops, then, will result in more area of crops per year than there is of actual land area. This should cause no problem as long as data are published for both land area in general and area of multiple cropping. The concept is not difficult--only the carrying out of the enumeration.

Recommendation for Rwanda: Whenever this type of production occurs, and it appears very common in Rwanda, there appears to be no possibility for complete enumeration at only one time of the year, or even at a few times a year. The only solution appears to be intensively enumerate a manageable sample of farms, commensurate with the budget, so that the enumerators can keep detailed track of this almost constant planting and harvesting. Ideally, where this practice is very prevalent, the enumerator should visit each sampled holding once a week to note new plantings and to record harvesting. If this is not possible within the budget, two-week or one-month intervals may be sufficient, but the time interval should probably be no more than one month between visits at the most. In short, there needs to be an accounting for area of each crop at points of time during the year with areas of individual crops grown determined for the year at the end of the year.

If the particular case is too complicated, the whole area may be treated as Mixed Intercropping (see Section 16) and area estimated from production at the end of the year.

18. Changing Area and Location of Plots in Holding Within the Year

It is common in subsistence agricultural areas to change areas where plots are located within the enumeration year. For instance, all harvesting may be concluded on a certain plot at some time during a year, but one or more plots started somewhere else later in that year. This may be some distance away and the farmer may not think to mention the fact to the enumerator. This is particularly bothersome considering that the enumerator must go out early in the enumeration year and initially get area of all plots in the holding. Considerable area and production by a farmer and his family on a particular holding may be missed unless the

enumerator constantly is alert to increased cultivation being started during the year and other plots being finished and abandoned.

This general problem may take the form of intermittent additions to the area of existing plots around their perimeter or actually clearing and planting in new areas.

Recommendation for Rwanda: As with the relay or sequence problem the only solution to the above problem appears to be to visit each sampled holding as often as possible, preferably once a week or, at least, no less than once a month, making sure each time to ask the farmer for any action concerning new planting, proceeding to measure this area and adding it to the existing plot areas. Any areas either prepared, planted, or harvested during the enumeration year should be included in the total crop area in the holding at the finish of the enumeration year even if it was not cleared and planted until near the end of the year or was harvested and abandoned early in the year. Judgement will have to be used when preparation or harvesting is occurring at the beginning or end of an enumeration year as to whether or not to include the area in the holding.

19. Wild Economic Production Areas

In subsistence agriculture it is common for local people to harvest the production from trees and plants in certain areas not contained in formal holdings, without having any formal rights in them. These may represent a significant amount of food consumption at times of the year, in some cases, and products sold for cash in others. This is similar to certain areas in the Western U.S., particularly the Sand Hills of Nebraska, where hay is harvested by farmers from roadsides and railroad right-of-ways. If not accounted for in "area in this farm" it can seriously distort average yield figures, if allocated to only area in the farm owned or formally controlled by the farmer. This also is true of pecan production in some southeastern U.S. states where certain pecan producers have pecan routes and pick up and add production bought from other people to their production for selling in one lot or for processing. This production may be from trees on city lots and from other people not ordinarily classed as farmers.

Production of the type illustrated above is certainly agricultural production and should be accounted for if significant to an area or the nation. The question then becomes one of whether or not to account for it in formal holdings or in general in some way.

Recommendation for Rwanda: The enumerator should specifically ask if any agricultural products are harvested and consumed from areas not in his "holding" during the enumeration year. This should be done weekly, or once a month at the most, so that seasonal consumption of certain plants, fruits, and other products can be accounted for. The "Area from Harvested

"Production" approach should then be used (see Section 16 for Mixed Intercropping) to estimate equivalent land area necessary to grow that production and this area added to area in the formal "holding" as if it were a part of it. This is similar to the hay cut off of roads or railroad rights-of-way mentioned above. It may be very difficult in the case of seasonal browsing of the family from mango trees, etc. to determine the amount consumed or picked. Also, a typical mango tree and production would be difficult to determine as would be the area it occupies if in a pure stand, which is usually not the case. A lot of judgement will be involved in these cases. The author is certainly not sure of this recommendation and would like to pretest this and other methods for specific crops before a final decision is made.

20. Community, Multiple-Person Partnership and Other Tenure and Ownership Arrangements (Including Rights to Tree Production not in Holding)

Tenure and ownership arrangements listed in the title are not uncommon in developing countries; and, may result in under or spurious enumeration if not handled properly. For instance, a farmer may, quite honestly, forget to tell an enumerator about an interest he has in a crop with another farmer on another hill or ownership or harvest rights he has retained in perennial tree production from an area where he has lived before.

Somewhat different from the partnership and ownership rights mentioned above is community or tribal areas farmed in common and the production allocated in some way not necessarily according to labor or other inputs supplied, and in which the farmer or his family have no direct rights--only the obligation to supply labor or other inputs. In this case, they may receive output from this area, or they may not, and the amount received may have no relationship to labor or other inputs supplied.

Recommendation for Rwanda: If the area is farmed in partnership and/or if the farmer has some definite proportional right to the production from an area or trees, etc., the area can be estimated using the "Area from Harvested Production" approach (see Section 16 for Mixed Intercropping) and added to the area of the formal holding. If the farmer and his family is only supplying labor or other inputs to a communal operation, this area should not be included in the holding and any benefits received should be accounted for as "Other Income," as with off-farm work and income, when accounting for income of the farm family as a whole; or, in consumption figures if these details are obtained in the survey.

21. Ponds, Lakes, and Other Water Areas in the Holding

Normally, in the past, such areas would not be included in areas in a holding. They would, however, be accounted for in general land area for the whole nation or other political unit. Increasingly, however, there is

an interest in water area available on a holding for various purposes, including for stock watering, for drinking and other home uses, and, increasingly for confined fish production. Increasingly, man-made or other water areas, are being stocked with fish and fish harvested and consumed or sold.

Recommendation for Rwanda: Areas of water on a formal holding, or controlled by the farmer, should be measured or estimated as the area which would normally never go dry during a year. This would include all non-flowing lakes and ponds controlled or on the holding, but only flowing streams if within the holding.

22. Special Crops and Farming Areas (Game Preserves, City Lots, Prisons, and Crops Grown by Only a Few Farmers)

These are all categories of holdings and crops for which sampling is not appropriate. For such holdings as game preserves or prisons, there may be only one or a few holdings in a country with production quite important for a political unit. Sampling also may be inappropriate in accounting for certain crops grown by only a few farmers, even if the area or value is small. However, while area or value may be small, the consequence of missing a significant amount of such a crop in a sample may have a highly unfavorable effect on the user's confidence in the data in general. If it is well known, for instance, that only 3 farmers in a political unit grow orange trees, but only one is recorded when the data are published, the user's confidence in the data may be undermined, even though data for more widely distributed crops is quite accurate.

The method of handling game preserves, prisons, and other institutional producers would not normally be treated here, as this paper deals only with subsistence agriculture. However, the procedure for handling such cases is the same as for special sparsely distributed crops or subsistence holdings.

Recommendation for Rwanda: For such cases as above, where sampling is inappropriate, a system of Special Farms Cards is recommended, compiled from whatever lists, or in whatever manner available or appropriate. These would then be given to the enumerators for the areas involved and they would be required to include them in their enumeration. The enumerators, in each case, should ask the respondent of each Special Farm for names of similar institutions or of others who grow the same special crop. The list of special farms should be continuously updated until no more are found.

C. DETERMINING CROP PRODUCTION, CONSUMPTION AND SALES

1. A Common Unit for Measuring Production

Most sources caution that units known locally must be used in obtaining production rather than international or national units desired by the final users of the data. The information collected from farmers can then

be converted to the desired unit using conversion rates supplied, either to the enumerators in the field; or, the work can be done after the data reaches the processing point.

Another problem, in addition to the final unit itself, is that the output may not be harvested at the time or in the form which is chosen as the standard unit. Again, the recommendation is usually to get production at the time and in the form harvested and convert to the standard unit using prepared conversion factors. Some examples of these are as follows (taken from Morris, W. H. M.):

- a. Bananas: Beer is 40% of the weight of fruit in the bunch.
- b. Caffé: Marchand (market coffee) is 20% of ripe berry weight.
- c. Caffé: Marchand (market coffee) is 74% of caffé parché (parchment coffee).
- d. Cotton: Fiber is 38% of the weight of seed cotton (fiber with seeds still in it).
- e. Manioc: Peleé is 32% of fresh roots; dry roots are 45% of fresh roots; cossettes are 33% of fresh roots; and flour is 31% of fresh roots weight.
- f. Peanuts: Shelled weight is 70% of weight in the shell; oil is 50% of shelled weight; and cake and other is 50% of shelled weight.
- g. Pyrethrum: Dry flowers are 20% of the weight of fresh flowers.
- h. Quinine bark: Dry bark is 35% of fresh bark.
- i. Rice: dry grain is 68% of paddy weight consisting of--
- whole grain, 46%
- broken grain, 22%
- j. Soybeans: Dry beans are 72% of weight in pod; of the dry beans, 18% is oil and 82% is cake.
- k. Sugarcane: Averages 11% sugar.
- l. Tea: Dry leaves are 22% of fresh leaves.
- m. Tobacco: Dry leaves are 17% of fresh leaves by weight; dry processed tobacco is 92% of dry leaf weight.
- n. Yams: Edible portion is 86% of fresh tuber weight.

Recommendation for Rwanda: Determine the unit used locally for each crop being enumerated and the form in which it is usually harvested. Develop conversion tables for the enumerator to use for each crop and farm likely to be encountered. Enumerate in the common unit and form and convert to the standard unit and form by the enumerator in the field before sending the data in to the processing point.

2. Techniques for Physically Measuring or Obtaining Production Data (Method and Frequency)

The actual physical measurement of production is a problem in itself and will probably vary with the crop being recorded and the nature of its production, consumption, and sales. Alternatives for measuring, or otherwise determining physical output include:

- a. Ask the farmer
- b. The actual weighing or counting units of crops harvested at some point
- c. Eye judgement by experienced reporters
- d. Crop sampling and cutting or harvesting by the enumerator
- e. Utilization tables

In the above, asking the farmer, eye judgement by experienced reporters, and utilization tables are commonly used in advanced economies; but, most sources seem to feel they have little place in subsistence agriculture. This leaves only the crop sampling and actual weighing or counting. While the methods a, c, and e may be appropriate for the sophisticated plantation-type agriculture in developing countries, it should be pointed out that this paper is dealing only with subsistence type agriculture. The crop sampling technique (cutting or harvesting small clearly defined, sampled areas by the enumerator) also has its drawbacks because of the practice of starting harvest before maturity for many crops.

Recommendation for Rwanda: It seems that actual weighing or counting of crop output will be the only appropriate method for most crops in Rwanda. This usually must be done at the time of actual harvesting by the farmer because of the practice of harvesting piecemeal at different stages of maturity. It also must be done at sufficiently frequent intervals so that accurate recall is no problem. Standard sized measuring containers must be provided for some crops. It would be desirable to have some technique for the farmer or family to record small lot harvesting between visits of the enumerator, such as a form with pictures on it for making marks or tallys, etc.

3. Non-Homogeneous Production (Varieties, Size, Etc.)

This problem is related to Section 1, A Common Unit for Measuring Production. It results from the practice of harvesting at various stages of production, as well as from different sizes and weights of units such

as tubers of cassava, sweet potatoes, etc., making counting irrelevant. It also results from different varieties of what would otherwise be thought of as the same crop, having different characteristics such as cooking and sweet bananas.

Recommendation for Rwanda: This problem will have to be handled generally as recommended for the Common Unit Problem (Section 1). The common form in which the crop is usually harvested locally will have to be determined and conversion factors devised, when appropriate. When not appropriate, as in the case of cassava, sweet potatoes, bananas, etc. which are non-homogeneous and other crops such as beans where counting is not applicable, some form of weighing procedure or common sized plastic or metal containers will have to be devised and used for each crop. Conversion factors will then have to be devised and applied, preferably by the enumerator in the field before sending the data for processing.

4. Stage of Maturity and Intermittent Harvesting, Consumption and Sales

Quantity, and even the nature and quality, of a crop will differ greatly depending upon whether it is harvested early, shortly after formation of the grain, fruit, root, etc.; whether it is harvested at some consensus as to what is accepted as "maturity;" or whether it is harvested and enumerated after this sometimes theoretical point called "maturity." The point of harvest or enumeration will affect such aspects of the product as:

- a. The carbohydrate, protein, and vitamin content
- b. The water content and, therefore, density or weight of the output per cubic volume
- c. Pest damage before harvest from birds, insects, etc.
- d. Field losses at harvest due to shattering; transport to storage; and, bird, monkey and other pest loss from foraging in the field or from products stacked in the field
- e. Losses in storage from pests, rot, etc.
- f. Losses of quality due to drying or respiration in storage

For example, maize eaten as green corn before harvest is quite a different product from mature maize; so much so that President Nyerere of Tanzania, in the 1960's, felt it a necessity to discourage the practice of pulling and eating green maize before maturity, in that total food value was more at maturity and the practice reduced the country's food supply. Similarly, the people may dig and start eating the immature cassava roots as early as 9 months after planting and continue digging up to as much as 2 years or more. Obviously the young tubers have a different nutrient, fiber, and water content from the older tubers. Also, total food yield from an area will be less if harvest occurs too early before total maturity. The question becomes, then, one of definition. Is the desired figure for production the actual weight of the product harvested regardless of the stage

of maturity; or, is it potential amount at some chosen point of harvest or maturity; or, is it some amount actually reaching consumption after allowing for losses in storage, etc.?

If there were no complications due to harvest and consumption before "maturity," most sources in developed countries opt for the concept of production reaching the initial storage point immediately after harvest and before any appreciable loss due to storage occurs.

Recommendation for Rwanda: Because Rwanda agriculture is, to a large extent, subsistence, and harvest and consumption may occur often before maturity, the recommendation is to record production as at the first point of storage just after harvest, plus amounts harvested before maturity, if the product is defined as the same. In cases where the product is quite different (i.e., green maize vs. mature dry maize) judgement will have to be used as to whether they should be defined as two different products (i.e., a vegetable vs a field crop). If defined differently the areas of each will have to be allocated accordingly for reporting purposes.

5. Production from Intercropped Areas

Production from intercropped areas should cause no particular problem except that associated with units, form, and time of production already mentioned.

Recommendation for Rwanda: Record as recommended in Sections 1 through 4, but keep production amounts by specific plot of intercropped area, especially mixed intercropping and sequence intercropping, in order to be able to estimate area to be allocated to each crop in the plot later.

6. Unharvested and Incompletely Harvested Production

For various reasons certain crops may reach maturity and remain unharvested or incompletely harvested for some reason. These crops may have taken the same amount of labor and other inputs to grow as in other areas which are completely harvested. A good example of this is cassava, which is frequently planted as a "reserve" crop in case of a drought and not harvested, or incompletely harvested, if not needed. The problem is a conceptual one. Are we interested in actual production or only that harvested?

Recommendation for Rwanda: While estimation of potential production is done in some countries for some purposes, only production actually harvested in the enumeration year should be recorded. Area prepared, planted, and harvested in the enumeration year will have been recorded, however, as will areas simply carried over from previous years as with tree crops, etc.

7. Production in Progress but not Mature in Survey Year

This is the same problem as in Section 6, and is common for such crops as tree crops, pineapples, bananas, and many other crops. It is also common because of the nature of year-round production in tropical areas.

Recommendation for Rwanda: Handle as in Section 6. Record production when it occurs and not "potential" production. Account for area, however.

8. Wild Production

As stated in the chapter on area, this is very important in some areas and in some seasons of the year in many LDC's.

Recommendation for Rwanda: The enumerator should visit the holding frequently taking care to ask each time about this type of production. He should anticipate it also from his knowledge of the area. This is an argument for picking local enumerators as far as possible.

9. Production from Community, Multiple-Person, or Partnership Holdings

This may account for a large amount of the nutrients consumed or sold and would be an important omission if missed in many cases.

Recommendation for Rwanda: If area can be allocated as part of the holding (see Chapter on Area) count as production from the holding. If the farmer and his family do not have a definite exclusive right to the output but receive output in some manner not related to labor or other inputs, consider anything received as other income. Account for it in family consumption, if applicable.

10. Production From the Farmstead, Kitchen Garden, and Other Non-Crop Areas of the Holding

It may be that some production does not come from areas identifiable as area of cultivated crops because the area falls below the minimum area to record. Also, important production may come from small "kitchen gardens," tree crops from random trees in the farmstead, along boundaries, etc., and from vines on roofs, in trees, etc. All of this production may be very important or it may be insignificant. The question becomes one of choosing a criteria for deciding when it is important enough to record and how to record it.

Recommendation for Rwanda: In many countries, if this production is all for home consumption, it is not recorded. However, in Rwanda, where production for home consumption is the most important category for disposal of production, the recommendation is to record productions of specific crops if it meets one of two criteria: (1) It would convert to the minimum area to be recorded from an area standpoint (will need to develop minimums for each crop in the enumerator's instructions) or (2) it is a special crop grown by only a few holdings, or having high value, and to miss it would result in lack of confidence in the survey by users (these crops also will have to be listed in the enumerator's instructions). If converts to less than minimum area, record production anyway with appropriate symbol in area box.

11. Accounting for Home Consumption vs. Sales, vs. Manufacturing, vs. Kept for Seed

This is a matter of design of the questionnaire or other recording instrument.

Recommendation for Rwanda: Design columns opposite each crop in each section to reflect the above breakdowns of use of output. Tailor each section for different types of crops to their particular characteristics.

12. Production from Multiple Product Crops (Greens and Roots from Cassava, etc.)

It is common in parts of Africa to harvest the leaves of the cassava plant for greens several times during the life of the plant and then harvest the tubers. There may be other crops of this nature.

Recommendation for Rwanda: If pretesting indicates that a second product from the same plant is important the questionnaire will have to be designed to reflect the harvest of two products. However, if it is necessary to estimate area from production, estimates should be made from the most important product of the two, perhaps from a value standpoint if sold.

13. Production of Forage Crops

This is usually not an important activity in most tropical LDC's. However, if it occurs, area and production should be handled as for any other crop.

Recommendation for Rwanda: Design a question on the questionnaire as for any other crop if pretest indicates that it is important enough to warrant it. Otherwise, record in an area on the questionnaire designed for "Other Field Crops."

14. Production of Forest Products

Many kinds of forest products, such as firewood, poles, etc. will not be formally given on a holding but will usually be gathered off the farm in "wild" areas. Other products such as capok, timber, etc. may be sold and may constitute an important economic product, where grown.

Recommendation for Rwanda: Record only forest products that are sold, either from the holding or from wild production. Area will be accounted for only on the holding. For certain forest products such as capok, treat as any other tree fruit or product if the tree is not destroyed in harvesting.

15. Production from Ponds, Lakes and Other Water Areas on the Holding

This would be fish or any other water-living aquatic product.

Recommendation for Rwanda: Have a screening question if there is water area on the holding to ask if there are fish or other aquatic products. If so, record in an area of the questionnaire designed for these products.

16. Crops Grazed by Humans (Eaten Off the Trees or in the Field)

This is a very difficult problem. While it may constitute an important source of nutrients during certain times of the year there is usually no way to estimate amounts. For instance, where the author lived in East Africa, mangoes were grazed off the tree in large amounts during the season and constituted an important part of the diet.

Recommendation for Rwanda: The author has no recommendation for such production other than to estimate it in some way other than from the sample survey. Perhaps this information would be obtained in more "in-depth" anthropologic studies which recorded activities, food eaten, etc. of families. More study should be made of this problem.

IV. ENUMERATING LIVESTOCK NUMBERS AND PRODUCTS

A. INTRODUCTION

There are many livestock systems in LDC's, some of which are easy to enumerate and some which are not. If livestock are confined on the holding, or if the holding is the base to which the livestock are brought at night, there is usually little problem of enumeration. The problem becomes one of questionnaire design and technique of asking the questions. If the livestock system is nomadic, however, and the economic value of livestock is secondary to the social or prestige value, enumeration becomes more of a problem. Not the least of the problems of nomadic herders is that there is no home base or holding which can be located on a map and enumerated. Also, unlike with crops, there are many taboos and fears of revealing livestock numbers.

This chapter will not be as long as the chapters on crops and their problems of enumeration, not because the problems of enumeration of livestock and their products are not difficult, but because the difficult problems can be summarized in fewer categories. Also, for this paper, no attempt will be made to break out the specific problems of specific livestock in most cases where the problem is the same for all.

B. DETERMINING LIVESTOCK NUMBERS AND OWNERSHIP

1. Determining Kinds of Livestock, Ownership, Numbers, and Disposition--Large Animals (Cows, Goats, Sheep, etc.)

The items enumerated in the title of this section may seem like different problems and they are. However, most of this information must be determined at the same time in order to have cross-checks as to the accuracy of the information.

Recommendation for Rwanda: Regardless of the nature of production of large animals (confined or migratory) the following information is needed on the questionnaire, or other instrument, in order to cross-check accuracy and to obtain information usually desired by users for each type of livestock:

- Inventory at beginning of year
- Number born during the year
- Number killed for home consumption
- Number bought (or obtained in some way)
- Number sold
- Number died, lost or stolen during the year
- Inventory at end of year

In addition, age and sex groupings as well as a distinction as to work stock, breeding stock, etc. may be obtained.

2. Migratory Herds

Obtaining any kind of information on migratory herds is one of the more difficult of the problems associated with enumeration of livestock. In addition to being difficult to find, there are superstitions concerning giving livestock numbers as well as fear of the tax collector. It may be that traditional enumeration of "holdings" will not be appropriate for these herds and some other method may be necessary. Aerial photos may help, but they have the disadvantage of not being able to determine ownership and other characteristics of a herd. Government veterinary programs to control different pests may also give fair estimates of numbers in some cases as most migratory people love their animals and frequently participate in such programs. Also, special enumerators may be needed for this type of livestock production and, possibly, all livestock production. Most references indicated that it took a special type of person, interested in livestock, to be a good livestock enumerator. Also, most references indicated that enquiries about migratory herds should be an entirely separate activity from enumeration of holdings.

Recommendation for Rwanda: Migratory herds are not now as important as they once were many years ago in Rwanda. However, to the extent that they exist, they should be considered as "Special Farms" much in the manner of prison farms, large plantations, etc., and not sampled as with small holdings. Rather, a livestock "expert" should be assigned to the enumeration for all of Rwanda for this class of livestock, determining the sample frame from whatever sources are possible, and proceeding with a complete enumeration of these herds at intervals of, as near as possible: (1) beginning of the year, (2) April 1, (3) July 1, (4) October 1, and (5) end of year. Otherwise, the information collected should be the same as for livestock on holdings.

3. Owners of Livestock Herded by Someone Else

At times there are people in cities who have interest in or own livestock which are kept on holdings by someone else or are kept in migratory herds.

Recommendation for Rwanda: Enumerate livestock as "on this holding" or "in this herd" regardless of ownership. The key should be, who has active control over the animals as to husbandry, etc. Ownership may be an item obtained on a questionnaire, but the livestock should be considered a part of the holding or herd.

4. Frequency and Time of Enumeration

This will vary by type of livestock and whether or not there are livestock products to enumerate such as milk and eggs, etc. It will also vary by holdings and by migratory herds.

Recommendations for Rwanda: Livestock and products raised on, or associated with, a "holding," which also produces crops, should be enumerated in much the same manner at the same time as the crop enumeration--about every week or two or, at the most, no less than once a month. For migratory herds, they should be treated as "Special Farms" and be enumerated by an "expert" separately. Any products from these operations should be estimated at time of interview which should be approximately quarterly (January 1, April 1, July 1, October 1, and December 31).

5. Enumeration of Numbers of Poultry and Small Animals

Unlike the large animals, such as cattle, goats, and sheep, poultry, and small animal production have different characteristics. While inventory at even one time may give a good indication of the relative importance or numbers of large animals throughout the year, it may not adequately characterize small animals numbers raised, because more than one batch may be born, raised, and consumed or sold between the beginning and end of the year.

Recommendation for Rwanda: Enumerate poultry and small animals numbers at one or two week intervals at the same time as crops are enumerated, obtaining:

- Inventory January 1 by categories desired
- Numbers every two or three weeks including:
 - Numbers on hand by categories
 - Numbers born or hatched
 - Numbers consumed by categories
 - Numbers sold by categories
 - Numbers died, lost, or stolen, by categories
- Inventory December 31 by categories

6. Animal Products (Milk, Eggs, Meat, Skins, Dried Fish, Honey, etc.)

These should cause some problem on subsistence farms because they are usually for home consumption and the farmer and his family may have no idea as to quantities.

Recommendation for Rwanda: The important thing is to enumerate frequently (every one or two weeks) to facilitate recall. Production should be in the units known, if possible, or standard measures should be provided for milk, honey, etc., with provisions for the farmer to record amounts in some way between visits. Eggs and skins can be counted. Meat and fish can be weighed but this could be very difficult and could only be determined easily if sold. If used for home consumption amounts would probably need to be estimated for fish. The whole animals used for home consumption would, otherwise, be recorded only by number.

C. CONCLUSION ON LIVESTOCK AND LIVESTOCK PRODUCTS ENUMERATION

The author does not feel that he found very much on livestock and products. The authors which treated the subject also felt frustrated at the inadequacy of livestock and livestock product enumeration in developing countries. To quote one "These are not very satisfying proposals for handling livestock statistics, but to judge from reports of statistical work in this field in various developing countries, satisfaction is rare" (Hunt, K. E., p. 81). On another page Hunt states, "Collection of livestock statistics in developing countries is usually either a reasonably straightforward process or an intensely difficult one" (p. 77). In another case he states, "The history of work in this field suggests that in any but straightforward cases, where the herds are part of the regular system of a settled agriculture, the prospects of initial success are small" (p. 78). While Hunt may seem unduly pessimistic, he represents most authors, except for a very few.

It seems that this author's initial ideas on the subject of livestock and livestock products enumeration in LDC's, or subsistence agriculture, were confirmed by the review of literature and contacts. It seems that, except for straightforward cases on settled holdings, enumeration of livestock and products takes a special enumerator with special knowledge of the livestock systems in the country. While this is also true of crops it is true to a much greater extent with livestock. One author went so far as to infer that livestock people were a "special breed" with a "special knack" and if the enumerator did not have this "feel" for livestock, he was doomed to failure from the start. This author tends to agree.

One major conclusion did seem to emerge from the study, however, and that is that, except for livestock and products in settled agriculture, all other migratory herds should be handled by an "expert" and separately from a sample survey.

The author recommends more study and pretesting on the subject of enumeration of livestock and products in Rwanda, which is not possible without actually being there.

APPENDICES

APPENDIX A

AGRICULTURAL SURVEY METHODS IN LESS DEVELOPED COUNTRIES
and
Recommendations for the Agricultural Census Project of
Rwanda, sponsored by USAID

John M. O'Sullivan
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Department of Ag Econ/ Auburn University
Center for Rural Dev./ Tuskegee Institute

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I. THE PROBLEM

The Agency for International Development (AID) has been asked by the Government of Rwanda to assist its Ministry of Agriculture in setting up an Agricultural Statistics and Analysis Unit. AID has agreed to participate in this project and has developed it as the Collaborative Survey and Analysis of Agriculture Project, #698-0135. The Project Identification Paper (PID) was written in November, 1979 and the project is scheduled to run from 1979 until 1984. There are two phases of the project; the pilot phase lasting through February, 1982 and the complete implementation phase scheduled to run from March, 1982 until February, 1984. The goals of the project are:

- 1) "to provide findings of immediate utility for the formulation of policy;"
- 2) "to strengthen the capabilities of the Ministry of Agriculture in data collection, data processing and analytical interpretation as a basis for the formulation of policy" (PID:1).

Rwanda does not now collect information about agriculture in any systematic way and data used in planning and decision making is based on rough "guesstimates". There is no reliable data on acreage, production yields or even types of crops. The lack of data base obviously makes it impossible to evaluate development projects (or even to plan them intelligently). This problem compounds an already critical situation since Rwanda, one of the poorest countries in Africa, also has the highest population density in Africa with 173 people per Km² or 340 people per Km² of cultivable land (Annuaire Jeune Afrique, 1979 - 479). Fed by subsistence agriculture, this population pressure on the rugged terrain of Rwanda has led agriculture experts to conclude that "...if current trends in population growth and deterioration of Rwanda's land base are not retarded, a full scale food crisis will occur no later than 1990..." (PID:10, See Appendix I for some information on this problem).

The solution to the problem at hand might seem obvious at first glance. Rwanda has only to administer an agricultural census patterned on that which is carried out periodically in the United States, for example. Such a gathering of data from the entire population (Bailey: 72; definition of a census) would then provide the base of systematized quantitative data against which specific projects could then be measured.

As is so often the case, however, the obvious solution is not feasible in practice. Budgetary constraints (both in terms of data collection and analysis) make a Rwandan census an impossible task. The problems of data collection alone (about which more will be said later) lead to the realization that the census would contain more errors than a well thought out sample survey.

With the above idea in mind, it would be easy to pick up off the shelf such excellent guides to survey design as Bailey (1978), Miller (1977), or such hands-on work as the U.S. Bureau of Census Agricultural Census Enumerators Handbook. These works provide the theoretically sound framework for sample design based on the random selection of participants in the survey, permitting the application of the laws of probability to the study.

Since conditions are so different, much of the information contained in the studies focusing on the situation here in the U.S. is irrelevant to such countries as Rwanda. Neither mail nor telephone sampling methods could be used there because there is no general mail delivery or telephone service. In addition, with a population which is over 75% illiterate, important sources of information such as written farm records are non-existent.

Thus only survey methods based on actual interviews and enumeration by the surveyor himself will provide any data at all, and methods of such data collection must be tailored to the environment of LDC's (Lesser Developed Countries). Since analysis of the data is only as good as the data collected at best, the bottom line in this project is the development of sound procedures which assure good data collection. Otherwise we are back at the guesstimate stage (because of the "garbage in-garbage out" principle).

If the problems indicated above were the only ones then sound planning and careful survey design could minimize them. Unfortunately, this is not the case. Data collection and agricultural enumeration in LDC's involve a series of problems--socio-economic, historical, definitional, measuremental--which have so far defied solution throughout the world. Crops are intercropped, multicropped, sequence cropped, planted around irregular fields, planted and not harvested, and harvested and consumed by the farmers. Livestock are frequently herded in common and numbers of animals are not even divulged within the farm family. Small animals like goats and chickens wander around scavenging for themselves.

Dr. Stallings has identified the following areas of concern in enumeration in Rwanda:

- 1) How to measure fields which are not rectangular, not planted in single crops, nor in rows, nor solidly throughout the field or which happen to be on steeply sloping land.
- 2) How to evaluate crops which are multicropped (including bananas, coffee, sweet potatoes, etc.). Should typical mixtures be identified? Should each crop be allocated an area? How can fields cultivated in common be measured?
- 3) How to enumerate livestock when herds are held in common and when livestock products are consumed on the farm and do not enter the money economy.

- 4) How to enumerate on a certain date for animals and crops which are produced throughout the year (Stallings, Trip report: 3).

Beyond the above enumeration problems, there are socio-economic factors to be considered as well. Rwanda experienced half a century of colonial government with its frequently heavy-handed rule and hence Rwandans view any government interest in them and their possessions with suspicion. Furthermore, agricultural activities in Rwanda are divided by sex. Food production is largely in the hands of the women. While interest in food production is of major concern to planners, it might not be possible to obtain information from the women (particularly if male surveyors are the only data collectors). My own experience in West Africa confirms this problem. In all probability, without women enumerators, information cannot be collected from women.

It is a fact that such problems are not unique to Rwanda; they plague data collection throughout the lesser developed world. Since this is the case, it is important to consider what is being done elsewhere. AID, FAO, the UN, other donor countries, LDC's, and the International Agriculture Research Centers (CIAT, IITA, ICRISAT and IRRI) have all had to face these issues and propose solutions. Frequently these solutions are ad-hoc and turn out to be less than adequate, but on the other hand, there is no need to re-invent the wheel. If adequate procedures have been developed in a particular country, then it might be applicable elsewhere--if communications linkages can be established so that we learn from the experience(s) of others.

The purpose of this paper is to begin to explore these linkages. Literature searches, computer data bases and personal communications have all been explored as much as possible within the time constraints of my work schedule. The establishment of these linkages is a laborious process. Everyone involved in international development and economic analysis of LDC's recognizes the problem and can give examples of the problem, but few people have answers to offer.

It would seem logical to pursue the problem of data collection not only comparatively (in the sense of seeing what is being done elsewhere), but also longitudinally (in the sense of building on what the Belgian colonial administration did). I do not have access to such material and can only recommend that they be consulted.

The Bulletin Agricole du Congo Belge has been recommended to me as a valuable source of such material and that the "Rapport de la Mission Anti-Erosive" by M. Philippe Leurquin be consulted in particular. Projects which have been implemented in Rwanda by AID, World Bank and other donor agencies should be surveyed for information and methodological insights. Obviously this can only be done in Kigali.

By the same token, recommendations must be made on a realistic level. Budgetary constraints, manpower limitations, computer systems and goals

of the government set the basic operational framework within which work can be done. People directly connected with the project can most accurately assess this aspect of the problem and can tailor recommendations to the working context.

II. PROJECT OBJECTIVES

While the PID identifies various goals of the project--the two most specific of which I quoted earlier, I think it worthwhile to develop a conceptual framework and objectives in that framework for this paper. As I shall argue, I think that the development of the ASAU system of Rwanda should be done within the paradigm of what is presently known as farming systems research. Within that overall frame of reference, I recommend that the goals of the work be as follows:

- 1) To understand the land, climate and socio-economic environment;
- 2) To evaluate existing farming systems and to improve understanding of the farmer;
- 3) To improve problem identification (target areas, bottlenecks, etc.);
- 4) To enhance the capacity of research to design new systems and/or to improve existing ones; and,
- 5) To tie together:
 - a) Base Data Analysis
 - b) On-Farm Studies
 - c) Research Station Studies (Farm Systems Research, 1978: 21-24).

If project personnel could keep in mind these very broad objectives while working on specific aspects of the problem, then it would come together. Quantification without a purpose is meaningless and will only serve to further alienate the farmers.

Not only should those goals be kept in mind but some of the broader questions of development might also be raised with profit. So often it seems that AID personnel get trapped into the details of project implementation while university types wax eloquent on theoretical issues and ignore political and economic reality. I think that cross-fertilization would be useful for both.

III. AGRICULTURAL DEVELOPMENT: THE BROADER THEMES

I have personally found the following four books to be very thought-provoking in their analysis of agriculture in Africa and recommend that

they be part of any AID Mission Library (if they are not already there). They are:

- 1) The Design of Rural Development: Lessons from Africa (Uma lele).
- b) Agricultural Development in Tropical Africa (John de Wilde).
- c) Farming Systems in the Tropics (Hans Ruthenburg).
- d) Small Farm Development (Richard Harwood).

Any efforts at agricultural development must have assumptions and theoretical underpinnings even when they are not explicit. But if the assumptions are not made overt there are serious potential dangers; not just of incoherency, but of irrelevance. It is striking that most African countries have been independent for approximately two decades and millions of dollars have been spent on so-called development projects by dozens of donor countries and organizations. But what is to show for these efforts? The countrysides are littered with rusting carcasses of broken down Soviet and American heavy equipment. Concrete and steel feeder lot corrals stand buried in weeds because they were never economically feasible. Farmers are seen as being obstinate obstacles to development. It reminds one of the "Wizard of Oz" if only the farmers would put on the green-colored sunglasses, then they too could see Emerald City.

Fortunately there is an awareness of the problem and people now recognize that mega projects and showpiece modern state farms are not going to solve the problem. As Jeune Afrique (the weekly French language magazine focusing on Africa) reported in a special presentation on African Agriculture:

"...one no longer speaks of the increase in agricultural production, but of intergrated rural development and of the participation of the population in the process of development...The directors (of the World Bank) with Mr. McNamara in the lead, insist that the well-being of the rural populations has become one of their principal criterion in assessing aid for agriculture" (J.S., May 79:33).

And as William Foote Whyte wrote:

"Robert McNamara, president of the World Bank, has pointed out that in many countries in the developing world, the poorest segment of the population (some 40% of the lower income levels) has not improved its income despite very satisfactory percentage increases in total GNP from year to year.

"The McNamara doctrine is now so well established that it is the official policy of AID to limit its projects for rural

and agricultural development to those which are designed to have a favorable impact on the small farmer" (Whyte, 1975:4).

The books referred to above recognize that development has to be built on the cooperation of the farmer and must take a view from the bottom up if it is to stimulate change. Since valid data can be collected only with the full cooperation of the farmers--both men and women, a major component of the Ag Census Project should be educational. Radio time, posters, meetings led by personnel who are not seen in any way as having police functions should be arranged and the viewpoint of the farmers should be taken into consideration in the implementation of the project. Uma Lele, Harwood and de Wilde deal with these issues in very thought provoking ways; Lele's and de Wilde's are classics in the field.

Ruthenberg's book is the best study of farm classification in the tropics. With it as a base, the project can fit its efforts into the international data collection base while tailoring its survey data collection methods to the Rwandese situation. Research such as my own clearly indicates the pressing need for data and research methods which are comparable and have some consistency.

IV. DATA BASE DEVELOPMENT - FARMING SYSTEMS RESEARCH

A survey of the literature on research methodology of agricultural systems in LDC's (the unifying objective of this paper) reveals the consensus that a broad holistic approach known as Farming Systems Research (FSR) is the most useful paradigm presently available. FSR is being actively pursued by AID, the international agricultural research centers such as Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Maize and Wheat Improvement Center (CIMMY), and the Food and Agriculture Organization (FAO).

FSR is a multidisciplinary research activity. It involves ecological, agronomic and socioeconomic analysis and includes all of the factors relevant to agricultural production and consumption. AID has funded a project, "Farming Systems R&D Methodology" (130-254) to review the literature about FSR and produce relevant publications. This project is being handled by the Office of Agriculture, Technical Assistance Bureau and Dr. Willis Shaner of Colorado State University at Fort Collins is coordinating the research and distribution of results. The International Agricultural Research Centers held a conference in May, 1978 in Nairobi. "Farming Systems Research at the International Agricultural Research Centers" is a published proceedings of the meeting.

In "Farming Systems Research," a farming system is defined as:

"...a collection of distinct functional units such as crop, livestock, processing, investment and marketing activities

which interact because of the joint use of inputs they receive from the environment which delivers their outputs to the environment and which have the common objective of satisfying the farmers' (decision makers) aims" (Ruthenberg:333).

The AID project paper on farming systems research states:

"The small farm household firm system is the farm family with its values and aspirations, its supply of human resources, its stock of other resources (land and non-land) and its variety of activities (economic farm, economic non-farm and non economic)...

"Within the household firm as a system, there is a production system...(this is) the principal dependent variable.

"The production system is defined as that part of the household-firm combining land, capital, technology, and the human resource (labor and management) for the purpose of producing crop and animal products for home use and sale..." (AID PP "Farming Systems R&D Methodology": 5).

These extended quotes fit well within the definition supplied by the FAO for the 1980 world census. This is important since it has been decided that the project in Rwanda fits within those guidelines. The FAO asks that data be collected around the basic unit of the holding. "A holding, for agricultural census purposes, is a techno-economic unit of agricultural production comprising all livestock kept and all land used wholly or partly for agricultural purposes and operated under the management of one person or more, without regard to title, legal form size or location" (FAO: 16).

Thus, the emphasis in present data collection is neither on crops nor livestock but rather a wholistic farming systems one. The farm unit is viewed within its environment (interacting with it and its socio-economic situation. The approach is a systems approach and requires a multidisciplinary input and analysis in order to understand the various component elements.

Each farming unit is a microcosm linked with other similar units in its milieu. Some are more successful (though for such value words we must carefully inquire the meaning in the local context), others less so. Some are better endowed in terms of natural resources, others have made farm management decisions which have brought larger harvests. The danger in the recognition of this situation is a methodological one. How can one generalize to relevant scale, and on the other hand, how detailed and microscopic must one's data be in order to accurately inform the analyst?

The work done by M. P. Collinson gives some answers. His book, Farm Management and his several articles deal with farm management in East Africa. The methodological problems of agricultural census and surveying in LDC's are vast in scope; the answers come from in-depth knowledge of the local context.

K. E. Hunt's Agricultural Statistics for Developing Countries has been on the scene for quite a while, but is still useful since it too was written by someone deeply aware of the problems with a wide experience of the attempted answers. He points out the many problems of data collection, field measurement, computation of production (when the crop could be consumed before the final stages of marketing), and timing estimation. He refers to the multicropping problem and such things as the cassava problem where a crop is planted which will only be harvested if there is need, otherwise it will be ignored and left in the ground. Other problems of costs of research, prices on non-marketed inputs and outputs are all indicated. He has several appendices giving sample frame and means of measurements.

Hunt's book is a good example of the attempt to apply standard data collection methods to the developing world. When all is said and done, those methods are too expensive, too threatening to the farmers or do not provide relevant data. It is for these reasons that scientists are looking for new and useful approaches to agricultural statistics. Obviously, an agricultural census is not possible in the Rwandan situation. What then is a research methodology which could be used to collect data?

Since there are adequate aerial maps made recently of Rwanda, they could provide a good starting point. A grid could then be created and numbered, and then randomly selected. This would provide the base for statistical analysis.

I would suggest that approximately seventy-five (75) grid units be chosen since we are talking about one hundred and forty-one (141) enumerators. I would insist that these grids be drawn up without any correlation with political boundaries (to avoid political pressure and to reassure the farmer that the data collected is not being used for police and/or tax purposes). As underscored above, farmer cooperation is essential to this kind of work. By limiting the grid units to approximately 75, then half the enumerators can be women who would focus on the feminine agricultural sector.

Within the grid, the transect methodology mentioned in the Farming Systems R&D PP (21) should be considered as a way of making the whole problem manageable. Transect sampling is a specialized sampling technique used in range management and other ecological sciences. It provides a sampling frame which permits a limited number of observations.

To begin, the researcher might lay out transect lines which diagonally cut across the random chosen grid zones (randomly, this should provide

manageable quantities of data across the main ecological zones of climate, altitude, soil and social organization).

"The transect methodology is especially relevant in an R&D process that aims to include the farm and the farmer. Since it involves a straight line that cuts across variations, it can mark the boundaries where the variable changes. With a small number of transects to provide the second dimension, it is relatively easy to locate or identify an area homogeneous for an important variable. It is also relatively easy to identify and measure non-contiguous areas having the same characteristics, a factor quite important in transferability of technology. Further, since the transect operates from straight lines, a great deal of information on the area can be produced from a relatively very small number of observations compared to other types of sampling. When the number of observations needed is significantly reduced, resources are freed to observe more variables or the same variables over a range of time. All of the above pertains to the complete range of data in which the farming system is interested, and it pertains equally to data generated autonomously on the site or to data generated by purposive experimentation" (Farming Systems: 27).

See Appendix II for a suggested list of sample topics used by ICRISAT in their farming systems research (Farming Systems Research at the International Agricultural Research Centers: annex 4). Such a list or others like it, are useful for focusing on the types of data one could collect. Since Data collection resources are limited, information collection must be selective and useful.

V. SUBSYSTEMS IN FSR

Within FSR and the ecological data base approach which I have recommended above, obviously agricultural productivity (both crops and livestock) are of main concern to development planners. With that in mind, the two principle production systems are considered here as subsystems of FSR. The fact that they are subsystems of farming systems must be underscored. The integrated approach is the only one which ties together the whole system as it is in reality. Harwood, for example, notes the contributions of animals to mixed systems.

AGRICULTURE - CROPS

In tropical areas over much of the world, farmers have developed complex cropping patterns rather than the agricultural patterns familiar to European-style agriculture of regular fields of monoculture. While these cropping systems more efficiently meet the environmental constraints of the tropics, they are an enumerator's nightmare. Crops are interplanted, tiered, broad-strewn around trees and boulders in irregular patterns in

irregular fields. Other crops are planted in mounds which have been created throughout the fields.

Furthermore, many of the crops--particularly food crops, are consumed on the farm after being stored in on-farm granaries. Thus there is no easy access point nor is it easy to generalize even if one goes to the trouble of measuring any given field or its yield.

Dana Dalrymple tried to deal with this problem in his well-known study for the USDA, Survey of Multiple Cropping in Lesser Developed Nations, but he defined away the problem by only treating regular sequences of pure stands of crops. He excluded the whole intercropping problem (though he did emphasize the point that production may take place throughout the year and include different crops throughout that cycle--a further problem for the unwary researcher).

See Appendix 3 for the International Agricultural Research Center's report definitions of the various configurations that intercropping can take. By adapting these terms, some standardized analysis of the problem could begin to take place.

Bill Morris made a very interesting point when he compared Rwandese agriculture to gardening. He noted the small size of the average farm--normally about 2 hectares farmed year around, at least in the Masalea paysannat perimeter for which there is data (Morris: 40). In another paysannat the family averaged 6.6 people (Morris: 34). See Appendix 4 for the annual calendar of farm work following Leurquin cited by Morris (114).

The reason I stress the above is because a further area of research focus is relevant here. This is the research being done by such people as John Jeavons at Ecology Action of the Mid-Peninsula, Palo Alto, California and Alan Chadwick (Mother Earth News, 62:16-22). These people are studying intensive "biodynamic" gardening. This involves deep digging, organic fertilizers, companion planting, interplanting and the like. Jeavons is looking for self sufficiency in 2,800 sq. ft. with this approach.

These people are on the track that Rwandese agricultural research should pursue. For much of Rwanda, the problem is intensifying the gardening system that is a component part of the farm system. Jeavons is a systems analyst who has been pursuing scientific investigation of improved inexpensive gardening. Such gardening systems research could play a very important part in improving Rwandese agricultural productivity without technological inputs.

Richard Harwood's book Small Farm Development is of special interest on this point as well, because of its focus on small farms. He has a chapter which discusses the farm yard as a center of production that is particularly good. He writes there: "A well developed farmyard planting essentially mimics the tropical forest ecosystem, replacing the native plant types with economically useful species" (Harwood: 102). Farming systems research which pursues this logic and the above gardening systems

research could be of real use to Rwanda. Morris suggests that such research is being done on two small farms (fermettes) near the Rubona station of the Rwandan Institute of Agricultural Research (ISAR) (Morris: 97). While such work is a beginning, it must be pursued on-farm, as argued by Richard Goldman, since valid research must include "...the farmer's decision making environment" (Goldman, 1979: 3).

Some of the reports I read had to deal with these problems in gathering data. Christopher Delgado studied farming systems in West Africa and completed a dissertation entitled Livestock vs Foodgrain Production in Southeast Upper Volta: A Resource Allocation Analysis. He approached the problem following Norman (1973) and Collinson (esp. pp. 278-283). Enumerators were issued standardized metal bowls to measure grain. They also had standardized baskets (3 sizes: small, medium, large) to measure harvested but unwinnowed crops. Some grain was obtained from farmers randomly, dried and weighed to obtain conversion factors.

The problem of field measurement was one of the most difficult Delgado faced. He tried tape measures and scale drawings, but found this to be too time consuming and settled for pacing the fields (pp. 55-60).

It is obvious that the combination of multicropping and field irregularity (both in terms of shape and internal characteristics) make this a major problem. A very useful book on many of the topics considered in this paper is the Agricultural Development Council's Field Data Collection in the Social Sciences: Experiences in Africa and the Middle East. They note that there are many problems; even such basic ones as field identification and field changes due to shifting agriculture. Furthermore, farmers are frequently reluctant to indicate how many fields they have and do not know acre or hectare size. The conclusion drawn in this report is that there are few alternatives to direct measurement.

Thus the problems of intercropping, field measurement and yield measurement are very nuts-and-bolts questions about which there is no consensus except that they are very difficult questions to deal with. Direct measurement seems to be the only sure method of data collection, though it is the most expensive approach. Because of problems of intercropping, local weights and shifting agriculture, it may not provide definitive data. Repeated contact by the enumerators might keep the Census Unit up to date on the scope of the problem so that decisions can be made as the project develops. On site information (based on pretesting) will indicate the best approaches for Rwanda.

There are other types of data which need to be collected in the agricultural subsystem as well. These include farm management, socio-economic aspects of production, types of inputs available to the farmer and types of inputs used. Furthermore, farmer goals need to be understood and government policy about food and cash crops have to be included.

In evaluating these problems, even more complex difficulties surface. As the ADC report notes, "managerial ability is an input for which no

satisfactory way of measurement has been discovered" (p. 113). Richard Harwood wrote: "Because so many small farmers operate entirely outside the commercial sector, or very nearly so, the standards commonly applied to evaluate farm management--income, return on investment, cash flow and the like--are inappropriate or misleading" (p. 27).

John Lewis has written a very interesting disertation about village farmer agricultural production in Mali and argues therein that the production focus is the long term maintenance of the village's ability to grow food. Village kinship ties, institutions and customs bind the village together as a productive force. Thus this decision level as well as that of the farming unit must be taken into consideration in order to understand why farmers act as they do.

While rural Rwanda is not organized in villages, careful consideration of ethnograph factors must be accounted for. For example, certain fields are farmed communally and cattle and other livestock are held for certain reasons which are important to the local farmers, but which might be dismissed by the researcher. The researcher does so at great peril to his effort.

AGRICULTURE - LIVESTOCK

The other major subsector of the farming system is the livestock system. While there might well be the confusion found in ag sector analysis (in terms of definitions of activities, holdings and other aspects of livestock systems), there seems to be less literature available and less conceptualization. In agriculture, intercropping problems have generated a significant body of literature (but where is the comparable literature about the livestock component of mixed farming systems?).

The literature seems to address questions relevant to national issues such as meat exports, offtake rates, herd size change, etc. There is literature on ranching problems and the Fulani-type cattle herding systems but there seems to be little which is relevant to Rwanda.

Here again, it would be useful for me to visit Rwanda in order to understand the problem and it is noteworthy that Bill Morris' report does not mention animals at all except in reference to the most recent Five Year Plan which proposes increasing goat and sheep production (2.5% per year), beef production (4.4% per year) and very large increases in poultry and rabbit production (32.0% per year) (Morris: 103). Historically, cattlekeeping in Rwanda has been tied to the ruling Tutsi although because of the Revolution at Independence, that situation has been put into question. It seems to me that no meaningful understanding of animal holdings can be achieved without an ethnographic study of how animals are owned and managed in Rwanda today.

This point was emphasized at a recent conference held in Harpers Ferry; the workshop on Pastoralism and African Livestock Development where a major conclusion drawn was, "...development intervention in the livestock sector

should be a) small-scale, and b) based on existing cultural-ecological systems" (Horwitz, "Report of the Workshop," 1980: 6).

However, as Harwood notes: "...commercial sector of the animal industry is the focus of most research and development efforts" (Harwood: 93). Yet most often this aspect of the animal industry is not that of the rural farmer. Thus, just as in the ag sector of FSR, close coordination and consultation with the animal owners is needed to develop the data base and see directions for planned improvements.

I have gone through literature on livestock production in West Africa from Theodore Monod's Pastoralism in Tropical Africa to D. S. Ferguson's "A Conceptual Framework for the Evaluation of Livestock Production Development Projects and Programs in Sub-Saharan West Africa" (CRED, no date), John Staatz' "The Economics of Cattle and Meat Marketing in Ivory Coast" (CRED, 1979: 589 pages), Jeremy Swift's "West African Pastoral Production Systems" (CRED, 1979: 110 pages) and Christopher Wardle's "Promoting Cattle Fattening Amongst Peasants in Niger" (CRED, 1979: 42 pages). None of the above seemed to address questions relevant to Rwanda.

While there are ways to count cattle (in migration, at watering points, etc.), previous government programs to "destock" in Rwanda will be a major stumbling block. Furthermore, as is noted in the Workshop Report: "Existing data, about the present and past, are almost totally useless. Unless some (prior) attempt is made to consider the relative importance and incident of trend, cycle, seasonality and random variation, the knowledge that the cattle population was X thousand on 1-1-30 and 3X thousand on 6-6-60 should lead to absolutely no conclusion at all" (Horowitz: 5).

Goats and sheep, chickens and eggs present similar problems though it seems as though even less information is available. There has been some theoretical interest in small ruminants. I have a Winrock Report: "Proceedings of a Workshop on the Role of Sheep and Goats in Agricultural Development" (Winrock, 1976: 43 pages), and AID is funding Title XII research with small ruminants. It is evident that data collection about these animals will have to be done within the FSR context outlined above.

Involved in the livestock subsector of agriculture is not only the animals themselves, but also information about food for these animals and their disease problems. Frank Abercrombie has written a useful introduction to these problems in his "Range Development and Management in Africa" (1974: 59 pages). This booklet provides suggestions about data collection methodologies in these areas of interest.

These problems in livestock production abound. Animal data is not standardized and efforts elsewhere in this problem do not seem relevant to the Rwanda situation. Overall, a FSR approach is the most logical one and should be useful in Rwanda.

VI. LITERATURE SEARCH METHODS

I have tried to cover a lot of territory in this paper; parts of it are weaker than others. I tried to follow up on the latest methods of data collection in developing countries by contacting people in AID and various people at universities around the country. I also contacted people at the Bureau of Census involved in this project. People were very helpful and provided me with fresh leads and documents.

I also used bibliographies and references to books and articles in the holdings of the Ralph Brown Draughon Library at Auburn University. While this is a fine library with over one million volumes, it is not (nor does it claim to be) particularly strong in international and especially African material.

I did one computer search on the AGRICOLA data base, but time did not permit me to use this resource adequately. I had hoped to look at ERIC and CAB as well, but was not able to get to them. A thorough search of the computer data bases is a logical next step. Dr. Willis Shaner at Colorado State has done this for FSR and should have a publication on this subject in late summer.

VII. CONCLUSIONS - SURVEY DESIGN

There are two major types of surveys possible to collect the data needed for the agricultural census bureau of Rwanda: one-shot surveys and multiple visit (longitudinal) surveys. For reasons we have seen throughout this study, one-shot surveys are ordinarily not useful for serious data collection. If the data collection is to be done within the guidelines of FSR then multiple visits will be necessary.

As already argued, all data collection must be done with the full cooperation of the producers, both men and women. The key link in the system will be the enumerators; a point confirmed by the ADC report Field Data Collection (Kearl: 115-130), as well as from my own experience. Delgado worked by hiring five enumerators after a ten day training program with nine candidates at the Centre Voltaique de Recherche Scientifique (Delgado: 61).

The project paper reveals a concern for this aspect of the problem in the project preparation strategy, but I stress my concern with the lack of female enumerators and the potential political problems the 141 assigned enumerators may provide (especially if the surveys are done within administrative units).

Since the approach taken is the FSR one, David Norman's "Methodology and Problems of Farm Management Investigations: Experiences from Northern Nigeria" (Michigan State University: 1975) is a very useful document.

Thus, I see the following needs:

- 1) Carefully screened enumerators;
- 2) Carefully chosen non-administrative unit sample areas;
- 3) Education, contact and cooperative design of survey instruments with the farmers--both men and women;
- 4) Multidisciplinary farming systems research;
- 5) Farmer decisions included as part of the situation; and,
- 6) On-farm gardening systems research.

APPENDIX B

PERSONS CONTACTED*

Bureau of the Census; Ms. Barbara Carlsen
Purdue University, Department of Ag Econ; Office of Bill Morris
SUNY, Binghamton; Office of Dr. Michael Horowitz
Computer Data Center, Auburn Library; Ms. Jassman
Colorado State University; Dr. Willis Shaner
AID/Washington; Mr. Quincy Benbow
AID/Washington; Dr. Douglas Boutchard
AID/Washington; Dr. Rex Rehnberg
Alabama Crop and Livestock Reporting Service
U.S. Bureau of Census, Outlying Units; Ken Norell
Delta Research Service (formerly Bureau of Census), Coral Gables, Florida;
Richard Storm

* For both the main paper and the O'Sullivan paper.

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