

PN-AA-834
Department of Agricultural Economics and Rural Sociology
Agricultural Economics Series No. 38 October 1985
Alabama Agricultural Experiment Station Auburn University
David H. Teem, Acting Director Auburn University, Alabama

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Data Collection in Subsistence Farming Systems A Handbook

James L. Stallings



FOREWORD AND ACKNOWLEDGMENTS

This handbook summarizes a 1980 United States Agency for International Development (USAID) Personal Service Contract No. AID/afr-C-1607 (Revised); Project No. 598-0135, "Collaborative Survey and Analysis of Agriculture--Rwanda" (9). As part of this contract, the author was directed to "prepare a state-of-the-arts paper on the techniques for measuring area and production in intercropped or associated cultivation and the enumeration of livestock numbers and livestock products, as well as summarize the information available in the best written material on the subject" (9). Dr. John M. O'Sullivan, presently at North Carolina A & T, also contributed to this handbook through a paper written under the author's direction while he was a M.S. student at Auburn University (8).

Many sources, published and informal, were used in writing this report. A complete list of these is contained in the two papers mentioned above. Only portions of these will be cited here since this handbook is in outline form. However, a few were used more extensively than others and deserve special mention. Collinson's book (2) was drawn upon heavily, as was Hunt's (5). Dalrymple's book (3) was very useful, as were selected papers presented at the Workshop on Field Data Collection in Rural Areas of Africa and the Middle East (1, 4, 10). Other important sources were from Karl (6), and Norman (7). There has been no attempt to research further references after the two main source publications were written in

1980 in compiling this handbook. This handbook was written mainly to service requests for the more bulky source publications mentioned above (8, 9).

While many of the recommendations in this paper are the result of review of literature for the above-mentioned USAID contract, they are also from the author's own experience in using students for conducting surveys in Tanzania in the late 1960's while on the faculty of Morogoro Agriculture College, as well as his experience in the U.S. Census of Agriculture in the early 1960's.

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Information contained herein is available to all without regard to race, color, sex, or national origin.

DATA COLLECTION IN SUBSISTENCE FARMING SYSTEMS --

A HANDBOOK

James L. Stallings*

I. INTRODUCTION

Surveying farming systems in subsistence agriculture is more difficult, in many ways, than conducting a similar survey in a highly developed economy. Unlike the agriculture of developed economies, subsistence agriculture usually involves many special problems. These include complex and non-standard cropping systems, intercropping, and double cropping. There is usually a high degree of illiteracy which precludes use of mail questionnaires. Records are poor if any are available at all. There is usually poor recollection of harvested or collected amounts of crops and livestock products, as much of the production is harvested intermittently for home consumption. Enumerators encounter poor roads, poor accommodations, and poor communications. There is no cadre of educated personnel which could be hired to assist in enumeration. Boundaries are uncertain, as well as ownership patterns. Also, farm and off-farm work patterns tend to confuse the type of farm-to-farm enumeration common in western agriculture. Finally, migratory livestock systems pose special problems not usually encountered in settled agriculture.

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The purpose of this handbook is to aid the various researchers, both expatriates and locals, who must attempt to conduct surveys in such situations. While most of the suggestions here can be found in some form in the various literature reviewed for the two source publications, the information is scattered and not easily found under one cover, and much of it is unpublished material. This handbook attempts to condense some of the more important of these sources, plus reporting the author's own experiences.

II. THE COMPLETE PLANNING OF A SURVEY

Before discussing some of the specific problems encountered in surveying the complete farming system, it might be well to review what a "complete" survey could involve. Obviously a survey could vary from a small sample survey, with limited objectives, for one enterprise, in a limited area, to a massive national census involving an attempt at complete enumeration of all rural residence and producing units. The planning would necessarily be more elaborate for the latter. The following outline, therefore, is an attempt to cover most aspects of planning a survey from start to finish, keeping in mind that seldom, if ever, will all steps be used.

A. PLANNING THE SURVEY

1. Determine the objectives of the survey
 - a. Get advice from potential users
 - b. Consult with experts
 - c. Review literature and previous surveys

2. Decide on whether the survey should be a sample or a complete enumeration
 3. Determine kinds and forms of data needed
 - a. Consider the objectives
 - b. Consider all user needs
 - c. Set up dummy tables with tabs, intervals, etc.
 4. Determine statistical procedures
 - a. Determine the sample frame--this may require a preliminary survey(s)
 - b. Determine the sample size
 - c. Determine error control
 - d. Determine measurement equipment needed, if applicable
 5. Draw the sample, if applicable
 6. Design questionnaires and other enumeration instruments
 7. Write training manuals for such participants as supervisors, crew leaders, and enumerators, as applicable
 8. Recruit supervisors, crew leaders, and enumerators, as appropriate
 9. Train supervisors, crew leaders, and enumerators, as appropriate
- B. CONDUCT PUBLIC RELATIONS CONCERNING THE SURVEY
- C. CONDUCT A PRETEST OF INSTRUMENTS AND PROCEDURES

1. Conduct actual field enumeration pretest with limited staff and enumerators
 2. Return and hold critique of all procedures, instruments, and manuals
 3. Revise procedures based on the critique
 4. Conduct further, more elaborate, "pilot survey," if appropriate, before beginning a large, extensive survey
 5. Revise again as appropriate after pilot survey
- D. CARRY OUT SURVEY--CONTENT WILL VARY BUT MAY INCLUDE:
1. Determination of soil types and general land use-- agriculture and non-agriculture--by types of farming areas
 2. Nature of agricultural holdings, including ownership patterns
 3. Sociological data concerning the family, household, and associated institutions
 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, off-farm work, and other miscellaneous
 7. Farm inputs, implements, facilities, and practices,

including labor use, improved varieties, and erosion control

8. Prices received, market channels and methods, by enterprises

E. ANALYSIS OF DATA

1. Receiving, editing, precoding, and coding
2. Data processing, tabulating, and generating tables
3. Computation of enterprise cost and returns, as applicable
4. Computation of measures of farm income, as applicable
5. Calories per capita, per hectare, and other appropriate computations, as applicable

F. PUBLISH RESULTS

G. USE THE RESULTS FOR PLANNING AND POLICY FORMULATION

H. CRITIQUE RESULTS FOR FUTURE SURVEYS

III. RECOMMENDATIONS FOR SELECTED PROBLEMS

A. DETERMINING CROPS GROWN AND CROP AREA

1. Determining General Land Use

In farming systems research in subsistence agriculture, it is usually desirable to know both general land use for the area or country as well as area of agricultural holdings,¹

¹ Throughout this article the term "holding" will be used to designate the home or farmstead and any associated agricultural land, contiguous or not, operated as one unit by a farmer and the extended family. The term "subsistence agriculture" implies the holding mainly is engaged in production for home consumption, but does not exclude off-farm sales.

including areas of specific plots and crops. However, general land use is quite a different problem from enumeration of specific plots or holdings and will not be treated here.

For areas of specific plots, holdings, or crops, however, there are several approaches. The most desirable, if possible, would be to simply ask the farmer, using a mailed questionnaire or personal enumeration. This is usually not possible in subsistence agriculture for two reasons: a large portion of the farmers may be illiterate and could not read and fill out a mailed questionnaire; and, they do not have in mind, in many cases, a concept of area in the holding and of specific crops. Even if a farmer did know the area of the holding or crops, 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, to be discussed in more detail later, include: distortions 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, and community production.

Other than directly asking the farmer, however, there are several objective measurement approaches to determining area 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 into a polygon and broken into triangles. The area of each triangle can then be determined as $1/2$ the base x height to apex.
- c. The area of a polygon can also be determined by traversing the circumference, measuring the different segments, and taking bearings to determine appropriate polygons or triangles.
- d. The area of a polygon can also be determined by plotting it 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.

Because of the difficulties of any other approach in subsistence agriculture, it appears that these direct measurement technique would be more appropriate than simply asking the farmer. 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 may involve the chance of destroying crops, in some cases, and might be difficult because of obstacles in other cases.

2. Measuring Area on a Slope

This is a problem concerning the actual area of sloping land projected on the face of the earth as if the area were flat. This is a problem sometimes mentioned in literature, but rarely are any recommendation made. 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 percent slope, the difference between projected area and actual area is only about 5 percent, and this is probably among the least of the uncertainties attaching to a good deal of this work in developing countries," (5, p. 46). If the problem were in accounting for all land in general land use in a country, slope might be an important consideration. Most studies, however, deal only with samples of holdings. These holdings usually account for only a certain percentage of all land use. General land use is usually determined by more macro methods (aerial photos, etc.). In subsistence agriculture, however, actual area in holdings and in specific crops is usually more important than area on the face of the earth in enumerating.

An appropriate recommendation, therefore, would be to do

as good a job as possible in measuring actual area planted, harvested, and prepared as if the area were flat, and not be concerned with projected area. Even if the differences were great, the concept sought is actual area of crops.

3. Boundary Problems

In many cases in subsistence agriculture, 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.

There appears to be no good solution to this problem except judgment. If, in the enumerator's judgment, 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. Other approaches will be treated later.

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

The question may arise as to whether the area of a plot should include such things as paths, ditches, erosion barriers, and weed patches 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? The usual recommendation seems to be as follows: If the non-productive area is man-made and definitely associated with production of crops (i.e, irrigation ditches, access strips, paths or roads, and

erosion barriers) it should be counted as land in the plot. For other natural, non-productive areas (i.e., weed patches, and boulders) judgment 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 percent 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 and in wooded areas so that it is impossible to define a plot or field. The problem then becomes one of whether to try to estimate an area for such production at all and, if so, how? In estimating areas, the enumerator needs to address the concept of what concentration of plantings of a particular crop is necessary before it can be considered as a solid stand.

If, in the enumerator's judgment, the area in question is not a solid stand or an intact plot for measurement purposes, 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 solid stands of different crops developed for that purpose. If this production has been planted outside the boundaries of the contiguous area easily recognizable as "the holding," the equivalent area may 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 year of enumeration.

If these areas are suitable for cropping (as opposed to rough, non-usable land), they may 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, cultivated, or otherwise used for agricultural purposes in the enumeration year, a rule may be made that if it has been used or cultivated within some reasonable recent time, say the last 5 years, it should be counted. All other land can be classed as "idle land," "homestead," "roads, paths, etc.," or other category, as appropriate.

7. Prepared vs. Planted Areas

Should the whole portion 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 is 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 is that after determining an appropriate boundary for planted area, the rest of the area may be recorded as "fallow" cropland. Also, fallow land for part of a year may become planted land later in the year. If so, it may eventually be included in planted and/or harvested cropland.

Any land formally prepared for planting may be measured and allocated either to fallow cropland or to planted and/or harvest area. "Formally prepared" may 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. Both planted and harvested acres are also useful in estimating the extent of drought or other natural disaster in the enumeration year.

9. Different Varieties of the Same Crop

The question becomes one of 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 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?

These are judgments for which general recommendations cannot be made without specific information as to the objectives of the survey. 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 significant differences in either cultural practices, yields, use, or marketing methods. Rules will have to be made for specific cases and included in appropriate instructions or manuals.

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 off the contiguous holding, to different categories on the holding itself. If the areas harvested are on the contiguous holding, there is little problem other than devising appropriate categories for enumeration. If off the holding, however, enumeration becomes more difficult.

A suggestion is to not include in the holding any pasture land on which migratory herds graze and which is not owned or controlled by any one holding. Similarly, do not include in

the holding definitely defined areas of communal grazing. Within the holding, however, 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) versus 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 for a specific holding. This should be estimated by standards developed and included in enumerator's instructions if the areas are not formally defined and not capable of being measured.

11. Forest and Land from Which Forest Products are Harvested

This category of products has caused trouble in many surveys and censuses 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" or "holdings." 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 farming systems research, they should be accounted for as part of the effort expended and income obtained by the farm family in the total farming system in the same manner as off-farm work. Labor used for tending and harvesting forest products also should be accounted for in recording general labor use. 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 judgment. If the forest products are of a cultivated nature (i.e., capok trees from which capok is harvested or other forest enterprises grown in rows and cultivated), they should be treated as any other crop in the holding. Production from wild or non-cultivated areas, either on or off the holding, need only be recorded.

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

In subsistence agriculture 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 usually lumped into an area called the "farmstead" or "homestead" in most of the world

after accounting for all other economic and idle or fallow farmlands.

After all 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 the contiguous 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, it should be included in the holding but 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 judgment 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, 1 hectare may be the minimum necessary to be enumerated, or even a larger area. However, if the crop was intensive and of high value, such as a vegetable crop, even 1/10 hectare may be large enough to be significant in a survey. While some sources might advocate different minimums for different crops, that, too, causes a problem and may not be worth the extra effort. Before a minimum is set, some preliminary study may have to be made as to how much, what crops, and 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 a crop grown as an herb in the yard or farmstead area, although production may be recorded. However, if a crop with small area per holding is widespread throughout the area, a significant contribution to the agriculture of the area may be missed by setting the minimum too high per holding.

Considering that most holdings in subsistence agriculture are small, and areas of individual crops are even smaller, with high value per unit of area, the recommendation most often suggested 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 some symbol, with a footnote "less than 5 square meters or 0.0005 hectare if the area is less than 5 square meters.

14. Multiple Cropping, Double Cropping 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 enumera-

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 of each crop and 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 estimates of the total area in the holding would be distorted.

15. 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 plants are of similar size. 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, or plants are not of similar size, areas of row-planted crops may become more of a problem, especially between crops of widely different growth patterns and heights (For example, wheat in narrow rows or planted solid abutting maize planted in rows of 2 or 3 feet, or fruit trees 15 to 20 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 the area of wheat or cotton extends somewhat under the branches of a tree crop, the judgment decision will have to be made as to whether it will be called intercropping. If not considered intercropping, the boundary may be estimated at some average of the overlapping area where the two crops meet. In summary, if areas are capable of being definitely separated and are not judged to fall under the classification of intercropping, 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 judgment in many cases.

16. Mixed Intercropping

In farming systems in tropical areas, multiple cropping frequently consists of interplanting the various crops by a scattering of the plants of one crop, which is 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 traditional pattern of cropping in the neighborhood. In other cases, there appears to be no definite pattern 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 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 as if 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 "judgment" 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 single 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. 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 concept of specific acres of specific crops at any one time adding up to total cropland in the holding.
- d. The "Mixed Crop Approach": This approach is particularly applicable when there are certain traditional 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-Sweet potato 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 any time, 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 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 individ-

ual 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. 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.

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 multiple cropping or mixed intercropping: Get area of the overall plot first or 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 area of the plot(s) to individual crops using the "Area from Harvested Production" approach (e) using standards 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 in the office.

17. Relay or Sequence Intercropping

Subsistence agriculture is often found in tropical areas without great variations in rainfall and with growing seasons where crops may need to be planted and harvested in overlapping sequences rather than planted and harvested all at one time. 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 collected and published for both land area in general and area of multiple cropping. While the concept is not difficult, the carrying out of the enumeration is.

Whenever this type of production occurs, and it appears commonly in subsistence agriculture, 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 to 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 sample holding once a week to note new plantings and to record harvesting. If this is not possible within the budget, 2-week or 1-month intervals may be sufficient, but the time interval should probably be no more than 1 month between visits at the most.

18. Changing Area and Location of Plots in the 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 and others started in another area with the original plot being abandoned. This may occur some distance away from the holding and the farmer may not

think to mention the fact to the enumerator. This is particularly bothersome when the enumerator must go out early in the enumeration year and initially get area of all plots in the holding. Considerable area and production on a particular holding may be missed unless the enumerator is constantly alert to increased cultivation being started during the year and other plots being finished and abandoned.

As with the relay or sequence problem, the only solution 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, and proceeding to measure and add this area 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. Judgment 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 to them. This may represent a significant

amount of food consumption at certain times of the year in some cases, and products sold for cash in others. This is similar to certain areas in the Western United States, 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 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 this type is certainly agricultural production and should be accounted for if important to an individual holding or if significant to an area. The question then becomes one of whether or not to account for it in formal holdings or in general in some way.

One recommendation is to 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 to estimate equivalent land area necessary to grow that production and this area may be added to

area in the formal "holding" as if it were a part of it. This is similar to the hay cut from 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. Much judgment will be involved in these cases.

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

The type of tenure and ownership arrangements listed in the title are not uncommon in subsistence agriculture 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 in another area 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 has 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.

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; the area can be estimated using the "Area from Harvested Production" approach and added to the area of the formal holding. If the farm 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, such areas would not be included in areas in a holding. They would, however, be accounted for in general land use 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.

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 the 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 Livestock Grown or Raised by
Only a Few Farmers

These are categories for which sampling or a formal survey is not appropriate. While there may be only one or a few holdings in a country growing or raising some special crop or livestock, the production may be quite important for a country or political unit. In other cases, while area or value may be small, the consequence of missing the production of some special crop or livestock in a sample survey 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 three farmers in a political unit grow orange trees, but a spurious amount or none is recorded when the data are published, the usefulness of the data may be undermined, even though expanded data from samples for more widely distributed crops and livestock are quite accurate.

For such cases, where sampling is inappropriate, a system of "Special Farms Cards" is recommended, compiled from 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 cases or of others who grow or raise the same special crop or livestock. The list of special farms should be completely enumerated and continuously updated until no more are found.

B. 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 reach 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 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.

A usual recommendation is to determine the unit used locally for each crop being enumerated and the form in which it is usually harvested. Then develop conversion tables for the enumerator to use for each crop and farm situation likely to be encountered. Enumerate in the common unit and form and have the enumerator convert to the standard unit and form in

the field before sending the data to the processing point.

2. Techniques for Physically Measuring or Obtaining Production Data

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. Weigh or count units of crops harvested at some point
- c. Eye judgment by experienced reporters
- d. Crop sampling and cutting or harvesting by the enumerator
- e. Utilization tables

In the above, asking the farmer, eye judgment 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 technique; even this approach has its drawbacks because of the practice in subsistence agriculture of starting harvest before maturity for many crops. In spite of this drawback, it seems that actual weighting or counting of output is most desirable, if possible. 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 also 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.

3. Non-Homogeneous Production

This problem results from the practice of harvesting at various stages of production, as mentioned above, as well as from different sizes and weights of units, such as tubers of cassava and sweet potatoes, 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.

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, 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 may 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 or at the time accepted as "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, and animals
- d. Field losses due to shattering at harvest, transport to storage, and
- e. Losses in storage from pests, rot, or other deterioration

For example, maize eaten as green corn before harvest is quite a different product from mature maize, so much so that underdeveloped countries have been known to discourage the practice of pulling and eating green maize before maturity because total food value was greater 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, the potential amount at some chosen point of harvest or maturity, or some amount actually reaching consumption after various losses and deterioration. 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. But, because harvest and consumption may often occur before maturity in subsistence agriculture, the recommendation is usually to record production as at the first point of storage just after harvest, plus estimated 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), judgment 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, time, and maturity of production already mentioned. Record as recommended above, but keep production amounts by specific plot of intercropped area, especially mixed intercropping and sequence intercropping, in order to be able to estimate area

of each crop later.

6. Unharvested and Incompletely Harvested Production

For various reasons, certain crops may reach maturity and remain unharvested or incompletely harvested. 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?

While estimation of potential production is done in some countries for some purposes, most sources would estimate only production actually harvested in the enumeration year. Area prepared, planted, and harvested in the enumeration year also will have been recorded, however, as will areas simply carried over from previous years as with perennials.

7. Production in Progress but not Mature in Survey Year

This problem is common for such crops as tree crops, pineapples, bananas, and certain other crops. It is also common because of the nature of year-round production in certain tropical areas. The recommendation is usually to record production when it occurs and not "potential" production. Area should be accounted for in land use data, how-

ever.

8. Wild Production

This is very important in some areas and in some seasons of the year in subsistence agriculture. The recommendation is for the enumerator to 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 by holdings and would be an important omission if missed in many cases. If equivalent area can be estimated, the recommendation is usually to count this production as from the holding. If the farmer and his family do not have definite exclusive rights to the output, but received output in some manner not related to labor or other inputs, consider anything received as "other income." Account for it in family consumption, however, 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 an arbitrary minimum area to record. Also, important production may come from small "kitchen gardens," from

random trees in the farmstead and along boundaries, and from vines on roofs and in trees. All of this type of 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.

In many counties, especially highly developed countries, if this production is all for home consumption, it is usually not recorded. However, in subsistence agriculture, where production for home consumption is usually 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, or (2) it is a special crop grown by only a few holdings, or having a high value, and to miss it would result in lack of usefulness in the survey by users. If it would convert to less than some minimum area, record production anyway with appropriate notation.

11. Accounting for Home Consumptions vs. Sales
vs. Manufacturing vs. Kept for Seed

This is a matter of design of the questionnaire or other recording instrument. The recommendation is to design columns opposite each crop in each section of a questionnaire to reflect the above breakdowns of use of output as appropriate. 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 for greens several times during the life of the plant and then harvest the tubers. There may be other crops of this nature. If preliminary surveys indicate that two products from the same plant are important, the questionnaire will have to be designed to reflect this. 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 much of subsistence agriculture. However, if it occurs, area and production should be handled as for any other crop. The recommendation is to 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, charcoal, and poles, will not be formally grown or produced on a holding but will usually be gathered off the farm in "wild" areas. The recommendation is to record only production of forest products that are sold from wild production. Area may be accounted for as part of the holding, however, for certain

cultivated forest products, such as capok, which can be treated as any other tree fruit or product from the holding 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. The recommendation is to 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 difficult problem in subsistence agriculture. While it may constitute an important source of nutrients during certain times of the year, there is usually no way to accurately estimate amounts. For instance, in many tropical areas mangoes are grazed off the tree in large amounts during the season and constitute an important part of the diet. Such production must be estimated in some way other than from a survey. Perhaps this information would be obtained in more "in-depth" anthropologic studies which record activities, food eaten, etc. of families.

C. ENUMERATING LIVESTOCK NUMBERS AND PRODUCTION

There are many livestock systems in subsistence agriculture, 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 its 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, as well as problems of absentee owners who do not want their interests known. In many cases, there is a shared arrangement between an owner and a herder, with the herder getting the first born calf, milk, etc.

This section is not as long as the sections 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, no attempt will be made to break out the problems of specific breeds of livestock where the problem is the same for all.

1. Determining Kinds of Livestock, Ownership, Numbers, and Disposition

Regardless of the breed of animal and nature of production, the following information is needed on the questionnaire, or other instrument, in order to cross-check accuracy

and to obtain information usually desired by data 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 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 in many parts of the world. Traditional enumeration of holdings will usually 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 and experience indicates that it takes a special type of person, interested in livestock, to be a good livestock enumerator. Also, most references indicate that inquiries about migratory herds should be an entirely separate activity from enumeration of other types of subsistence agricultural holdings.

Migratory herds are not now as important as they once were in developing countries. However, to the extent that they exist, they should be considered much as the "special farms" mentioned earlier and not sampled and enumerated in the usual way. Rather, a livestock "expert" should be assigned to the enumeration 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 regular holdings.

3. Owners of Livestock Herded by Someone Else

It is common for people in cities in some developing countries to have interest in or own livestock which are kept on holdings by someone else or are kept in migratory herds. The recommendation is to 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 all livestock should be considered a part of a holding or managed herd regardless of ownership.

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. It will also vary by holdings and by whether or not herds are migratory. Livestock and products raised on, or associated with, a holding which also produces crops should be enumerated in much the same manner and at the same time the crops are enumerated--about every week or two or, at the most, no less than once a month. For migratory herds, they should be enumerated by an "expert" separately. Any products from these operations should be estimated at time of interview, which may be approximately quarterly (January 1, April 1, July 1, October 1, and December 31).

5. Enumeration of Numbers of Poultry and Small Animals

Poultry and small animal production have different characteristics from large animal production. 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 animal numbers raised, because more than one batch may be born, raised, and consumed or sold between the beginning and end of a year. The recommendation is to enumerate poultry and small animal numbers at 1-or 2-week intervals at the same time that

crops are enumerated, obtaining:

- Inventory January 1 by categories desired
- Numbers every 2 or 3 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 products may 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. The important thing is to enumerate frequently (every 1 or 2 weeks) to facilitate recall. Production should be in the units known, 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 may 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.

7. General Conclusion on Livestock and Livestock Products Enumeration

Authors which treat the subject are frequently frustrated at the inadequacy of livestock and livestock product enumeration in subsistence agriculture. 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" (5, p. 81). On another page Hunt (5) states, "Collection of livestock statistics in developing countries is usually either a reasonably straightforward process or an intensely difficult one." 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" (5, p. 78). While Hunt may seem unduly pessimistic, he represents most authors.

This author's own ideas on the subject of livestock and livestock products enumeration in subsistence agriculture were confirmed by review of literature and by personal experience. It seems that livestock and products take 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. It appears that enumerators chosen for livestock enumeration must be a "special breed" with a "special knack"; and, if the enumerator does not have this "feel" for livestock, he is doomed to failure from the start.

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