



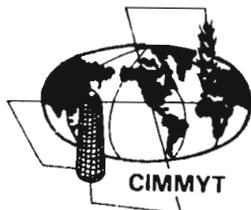
AN OCCASIONAL SERIES OF PAPERS AND NOTES ON METHODOLOGIES
AND PROCEDURES USEFUL IN FARMING SYSTEMS RESEARCH AND IN THE
ECONOMIC INTERPRETATION OF AGRICULTURAL EXPERIMENTS

NUMBER 14

DATE: NOVEMBER 1985

TEACHING NOTES ON THE DIAGNOSTIC PHASE OF OFR/FSP
CONCEPTS, PRINCIPLES AND PROCEDURE

CIMMYT EASTERN AFRICAN ECONOMICS PROGRAMME
INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTRE (CIMMYT)
P.O. BOX 25171, NAIROBI, KENYA
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PREFACE

This document was put together using the various publications of CIMMYT and lecture material delivered by CIMMYT staff and other resource people who participated in our training workshops in the region and elsewhere. This is one of the many documents which deals with the process of On-Farm Research with Farming Systems Perspective (OFR/FSP).

Often it was brought to our notice by the trainees that they did not find any single document which provides a comprehensive coverage of the materials taught in our workshops. This hand book has been produced as a basic reference document for use by trainees who have completed the training workshops. The current version is a preliminary working draft. It will be updated as we receive reactions and comments from users. We are also planning to develop a series of supplementary materials which would complement this manual. These will be handed over to the national trainers as training materials.

I would like to thank Drs. M. Collinson, A. Low, M. Rukuni, J. Ransom and Prof. M. Blackie for their contribution and useful comments. The materials in this manual are still being developed and we would therefore appreciate comments, criticism and suggestions from the users.

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November 1985

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DEFINITION AND CHARACTERISTICS

On-Farm Research with Farming Systems Perspective (OFR/FSP)

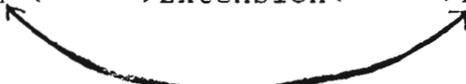
Definition

A set of Agricultural Research Procedures conducted in farmers fields with the participation of the farmers, to develop relevant near term technologies/recommendations (which solve priority problems) for an identified group of farmers.

The process recognizes the fact that an understanding of the production process and decision behaviour in traditional agriculture is crucial in determining the true relevance, practicability and potential success of any innovation. Emphasis is given to building-on indigenous farmer knowledge and other information.

Characteristics of OFR/FSP

1. It is conceptually based on a Farming Systems perspective i.e. deals with the whole production systems.
2. It aims to generate technology to increase resource productivity for an identified group of farmers especially in the short term.
3. It explicitly integrates socio-economic and biological circumstances of the farmers in developing the technology. Diverse objectives of the farmers are incorporated.
4. It is farmer based and a close researcher-extension-farmer interaction is considered to be indispensable.
5. It quickly begins to focus on a few major problems (leverage points in the system) even while a broader system perspective is maintained.
6. It is complementary to on-station research and depends heavily on station based research results.
7. It is multidisciplinary.
8. It is site specific.
9. It is cost effective and focuses on well-defined target group, thus heterogeneity among farmers is given explicit recognition.
11. It strengthens Research <----->Extension<----->Farmer linkage.



On-Farm Research Procedure (OFR/FSP) is thus:

- . Client driven
- . Problem oriented
- . Multidisciplinary

OFR does not necessarily mean that all research activities are solely carried out in the farmers field only. OFR includes surveys and experimentation. Depending on the available technical information and representativeness of the station situation to farmers environment, experiments could be either carried out on the station or in the farmers field. It is important to remember that technology could be generated from the station as well as the farmers field.

Terminology used by practitioners:

- . Farming Systems Research - FSR
- . Farming Systems Research and Extension - FSR/E
- . Farming systems Development - FSR/D or FSD
- . On-Farm Research with Farming system Perspective - OFR/FSP
- . On-Farm Client oriented Research - OFCOR

In the last two cases on-farm research is used as a vehicle for developing relevant recommendation(s). The terminology is not that important as long as the user defines what he/she means by that term when he/she is using it.

On-Farm research like any other scientific research procedure follows the same logical steps (problem identification, development of hypothesis, hypothesis testing, evaluation, accepting or rejecting hypothesis and if necessary modifying the original hypothesis) and still carried out on commodity basis. The key differences are:

- . Research thrusts are derived from the clients i.e. from the farmers through diagnostic activities.
- . The technology is tested under farmers own environment before recommendations are made.
- . The systems interaction is given explicit consideration in identifying problems, technical interventions and in evaluating technologies.
- . The evaluation criteria used are consistent with the ones used by farmers.

STAGES OF OFR/FSP

The integrated research process is illustrated in figure 1. By looking at the stages of OFR/FSP one could identify three major phases:

1. The Diagnostic Phase (Stage 1) - The major objective of the diagnostic phase is to describe and understand the current production system, identify the key farmer problem and some preliminary ideas on how to help solve these problems. There are 4 major steps involved in this phase:
 - a) Identification of Target group of farmers.
 - b) Collection, analysis, and interpretation of background information i.e. farmer circumstances.
 - c) Exploratory or informal survey.
 - d) Formal or verification survey/quantification survey.
2. On Farm Experimentation Phase (Stage 2,3,4) - Deals with planning, implementation, management, evaluation and interpretation of on-farm experiments.

It is important to note that experiments both on station and on-farm could be carried out with different objectives.

- . Experiments could be carried out to define the problems.
 - . Experiments could be carried out to establish the causes of the problems.
 - . Experiments could be carried out to generate quantified technical information for planners and policy makers.
 - . Experiments could be carried out to fine tune available technology to make recommendations.
3. Extension Phase (Stage 5) - deals with the wider dissemination of the identified technology/technological components; widely and rapidly as possible.

This set of lectures deals with the diagnostic phase of OFR/FSP. Once completed, the diagnostic phase fulfills several purposes:

1. Provides a description of current farmer circumstances and practices.

Stages of On-Farm Research

On-Farm Research

1. **Diagnosis**
Review of secondary data, informal and formal surveys.
2. **Planning**
Selection of priorities for research and design of on-farm experiments
3. **Experimentation**
conduct experiments to formulate improved technologies under farmers' condition
4. **Assessment**
Agronomic, statistical and economic analysis of experimental results in order to derive recommendations.
5. **Modification**
6. **Recommendation**
Demonstrate improved technologies to farmers
7. **Wider dissemination** of the recommendation

Choice of target farmers and research priorities
 ← Identification of policy issues

Policy National goals, input supply, credit, markets etc.

New components for on-farm research
 ← Identification of problems for station research

Experimental Station Develops and screens new technological components

2. It identifies key enterprises and production practices that provide opportunities for research. It is relatively easy to form a list of factors which limit production but a real challenge is to identify the few areas where research can lead to innovations that will increase productivity, reduce risk or increase system intensity.
3. Enable one to understand the nature of the constraints which cause the problems that have been identified so that technologies could be tested which are compatible with FS.

ROLE OF OFR/ESP IN RESEARCH AND DEVELOPMENT

1. Identifies which recommendation from past technical component research is most relevant to local farmers present needs, and if necessary, adapting it to fit their particular circumstances.
2. Feeds back unsolved technical problems to commodity and disciplinary researchers thereby providing a mechanism for setting priorities for on-station research based on observed farmer needs.
3. Identifies extension needs and problems enabling extension to scrutinize the relevance and priorities of their work.
4. Link farmers, researchers and extension workers in the final development of technology in local on-farm situations. It provides an empirical test for the technology under the farmers environment; the farmers contribute to the specification of design parameters (technical, managerial and economic) and both farmers and extension staff are involved in the evaluation.
5. Provides guidelines for policy formulation by identifying the non technical problems which might hinder the adoption rate of the selected technology.
6. Enables better planning (Development Planning) at the sectoral and regional level.

NEED FOR OFR/FSP IN TECHNOLOGY GENERATION

Why OFR/FSP is gaining popularity?

1. Shift in emphasis from cash crop orientation to food crop orientation. The overall growth and development of most developing countries (except oil-producing countries) is dictated by the growth of the agricultural sector. Some of the salient features worth noting are:
 - a) Agriculture is still playing a predominant role in the national economy. (Food, GDP, Foreign exchange, employment, raw materials supply, etc.)
 - b) Food production is not keeping pace with the population growth.
 - c) The major proportion of the food is being produced and consumed by the small farmers.
 - recognition that the surplus has to be generated from this sector.
 - least understood sector in the food production system.
 - d) Most Agricultural Research Systems are cash crop or commercial farmer oriented, because of historical reasons.

In order to handle the ever increasing population growth and demand for food, there is an urgent need to develop the small farmer sector. Thus a shift in the emphasis in most independent nations.

2. There has been a general failure of the past research and development efforts to attain the desired goals. One could identify various reasons for this:
 - a) Poor policies - prices, marketing, credit etc.
 - b) Poor support services - marketing extension services etc.
 - c) Inappropriate technologies for farmers needs:
 - technology is the heart of development and has had a top-down orientation (both attitudes and institution)

Though considerable amount of success has been accomplished through the traditional approach to agricultural research, the productivity of the

limited research resources could be substantially improved by overcoming the following weaknesses:

1. Top down approach. Absence of researcher - farmer link and lack of problem orientation.
2. Predominance of higher crop yield as a criterion or improvement rather than maximizing family income after meeting subsistence requirements. The farmers are interested in improving the level and reliability of their incomes; a stable food supply, eliminating labour peak, etc.
3. Single commodity and single resource orientation. Traditionally, commodity and resource oriented research ignored the fact that farmers produce several commodities and manage several resources in one integrated system. This often leads to compromises in management, due to multiple objectives and limited resources of the farmers.
4. Gap between experimental and farmer circumstances and management:
 - (i) the natural circumstances that the farmer faces are different from that of the researcher. Cropping history, soil fertility status equipment or power available for operation are often different from the situation in farmers' fields. It is important to remember that the research station sites are often unrepresentative.
 - (ii) Economic circumstances - available resources may be limiting, the critical factor in small scale farming is labour and timing of labour application. The labour constraint as it exists on small scale farm cannot be reproduced on experiments conducted in the station and very often ignored in technology generation.
 - (iii) Nonexperimental variable - very often the nonexperimental variables such as fertilizer rates, weed control, plant population, etc., are set at high levels, at the research station. Yield adjustments are often required for the results obtained from experimental station or these levels should be adjusted when technology is taken to the farmers' field.

- (iv) Biological circumstances - weed infestation, pest and diseases etc.
- (v) Management level - Generally researchers are better managers than the farmers.

It is important to make sure that the researcher should include the farmers' level as a treatment comparison and should consider holding nonexperimental variables at the farmers level.

5. The non-technical factors affecting adoption namely risk, credit, marketing, training of extension, and farmers institutional mechanisms are often not taken into consideration when giving recommendations. Most recommendations currently made require a much higher level of purchased inputs and heavily rely upon institutional changes, in areas such as credit and marketing.
6. The traditional recommendation expects the smallholders to modify their system to fit the technology and vice versa. It is important to realize the fact that a gap exists between experimental and farmer situations. The traditional approach usually fails to utilize information about the farmer's own system and needs. The traditional approach does not cause either the researcher or the implementer to learn about the complete environment in which the small farmers are operating.
7. Prescriptive tradition and blanket recommendation of the traditional approach. The researchers select out the 'best' results and prescribe these as 'improved management recommendations' to the extension services to 'teach the farmers'. It has meant a failure to appreciate how farmers' circumstances dictate what they can absorb by the way of change.

Improper recommendations not only fail to be effective but also result in the demoralisation of extension services, poor motivation, slack management; etc, which are very difficult to regain. This also leads to the wastage of the available scarce research resources.

- d) Adoption behaviour of the small farmer tends to be stepwise.

- e) Dominance of the National priorities in planning and policy formulation.
3. Small farmers operate a production system with:
- a) Multiple objectives:
 - subsistence objectives, i.e., provision of food
 - cash requirements to meet other basic needs
 - risk avoidance, i.e., maintaining stable food supply
 - Social and cultural obligations
 - maximizing the total production of the system
 - security
 - consumption and production decisions
 - requirement for market and non-market goods
 - b) Multiple enterprises:
 - Crops - food, cash, insurance crops: animal feed
 - Animals - for food, insurance, power source, manure, cash, accumulation of wealth, sociocultural ceremonies.
 - Trees - Soil fertility, fodder, fuel wood, cash
 - Off-farm employment

These enterprises compete for the same limited resources and have implications for the adoption of new technology.

It was felt by the development practitioners that there is an urgent need to:

1. Reconcile the national priorities with the local priorities. The local priorities are reflected in the objectives and current production systems of the farmers.
2. Tailor the technologies to the needs and capabilities of the local farmers.
3. Change the attitude on the part of people and institutions:
 - farmers are rational
 - the current system is evolved based on their experiences.

The OFR/FSP provides a logical approach to accomplish these objectives and hence the emphasis. In many countries, this has been facilitated by decentralized development efforts and policies.

OFR/FSP is systematically trying to handle these weaknesses:

- Target grouping: site specific recommendation
- Surveys: - identify and prioritize problems
 - provide the contents for OFE
- OFE - provide an opportunity to test the technology in their own environment
 - Farmer participation in evaluation.

TRADITIONAL RESEARCH VS. OFR/FSP

	Traditional Research	OFR/FSP
1. Approach	a) Reductionistic	Holistic where system interaction is explicitly recognized
	b) Single discipline or Crop oriented	Interdisciplinary. Objective is the same as that of the farmer
2. Objective	Maximum exploitation of biological potential	Varies and is complex depending on the degree of market orientation and multiple objectives of the farmer.
3. Selection criteria	Maximum output per unit of input: often land. (contradicts the economic principle)	Whether he can better satisfy his objectives from whichever resource is limiting his present activities. Appropriateness should be evaluated in relation to farmers priorities his resource use pattern.
		<ul style="list-style-type: none"> - Biological feasibility - Economic viability - Risk - Systems compatibility - Objective & resource use pattern - Social acceptability
4. Research priority	Often set by crop-wise and discipline-wise orientation. Mechanism used in setting priorities may be different from the farmers, and may reflect researchers' interest.	Often derived from identified farmer problems and priorities Provides a basis for evaluating the relative importance of these problems within the system and to better considerations of farmer priorities.
5. Experimental methods	a) Contents: Determined by the researcher	a) Dictated by the system/problems identified
	b) Non experimental variables are often set at 'optimum' levels	b) Non experimental variables set at the farmers levels
	c) Design: often more complex. Try to keep variability managed	c) Dictated by the level of confidence that the researcher has in the technology. Usually simpler. System variability both environmental and management is sampled.
	d) Management: completely researcher managed	d) Depend on the nature of the trial.
	e) Site: often research station	e) Farmer's field/environment
	f) Plot size: smaller	f) Plot size: often larger, depends on the nature of the trial.
	g) Replicates: multi-replicate per location	g) Minimum 2 per site, farms could be used as replicates.

CHARACTERISTICS OF SMALL FARMS/FARMERS

- . Complex objective function, i.e., multiple objectives.
- . Smallholdings and low resource endowments.
- . Lack of capital and credit facilities.
- . Inadequate technologies or use of "traditional" agricultural technologies.
- . Low use of purchased inputs
- . Low income level.
- . Multiple enterprises
- . Risk avoidance
- . Interest in the productivity of the whole system.
- . Polyculture or mixed cropping systems.
- . Use of heterogenous germ-plasm.
- . Possible use of minimum tillage (slash and burn system) with fallows.

High illiteracy rates]	
Short life expectancy]	Associated with farmer
Generally low living standards]	
Large family size]	

FARMING SYSTEMS PERSPECTIVE

The concept of Farming Systems has been defined differently by different people. Collinson (1980) defines farming systems as the way farmers satisfy their needs and priorities with the resources at their disposal, in the circumstances (natural and economic) in which they find themselves. CID (Consortium for International Development) guidelines define farming systems as complex arrangement of soils, water resources, crops, livestock, implements, labour, and other resources within an environmental setting that is managed by a farmer; with the help of his or her family in accordance with their capabilities, available technologies, and preferences.

Andreon (1977) analyses the term by defining each word separately. He defines a system as a set of components that work together for the overall objectives of the whole system. The systems approach then is the way of identifying the components of the whole system and the environment in which the system actually performs for the achievement of the overall objectives. Therefore the farming systems approach is simply a way of thinking about these total systems and their components. Kampen (1974) claims that the farming system involves the entire complex of development, management, and allocation of resources as well as all decisions and activities which within an operational farm unit or a combination of such units result in agricultural production. The processing and marketing of the products are also directly related to the system that produces them.

Norman (1980) concludes that a farming system¹ is the result of a complex interaction of a number of interdependent components. A specific farming system arises from the decisions taken by a small farmer or farming family with respect to allocating different quantities and qualities of land, labour, capital, and management to crop, livestock and off-farm enterprises in a manner which, given the knowledge that the household possesses, will maximize the attainments of the family goal(s). The farming systems approach therefore is holistic. It examines the full range of household activities, including livestock production, off-farm enterprises, domestic tasks, and the interactions among them rather than studying only cropping activities within the farm operation (Gilbert, Norman, and Winch 1980). The types of interactions are:

¹A system can be defined conceptually as any set of elements

Crop(s)	<--->	Crop(s)
Crop(s)	<--->	Livestock(s)
On-farm activities	<--->	Off-farm activities
Farm	<--->	Household

A farming system therefore refers to a collection of distinct functional activities or enterprises such as crops, livestock, processing, marketing, and investment. These enterprises interact in receiving resources and delivering outputs to the prevailing environment (Schwemer 1981). Environment in this context refer to rainfall, soil characteristics, vegetation, population size, and distribution, and social and economic infrastructure. In addition location-specific norms and planting capabilities, risk and uncertainty play a role in farmers' decisions about their FS (Zuckerman 1979). One should note that although there is considerable variation in the content given by various writers to the notion 'Farming Systems' it evokes an image of the complicated interrelated, dynamic decision making problems that farmers actually face. The components involved in existing farming systems and their linkages are represented in Figure 1.

It is important to realise that:

- Families have various objectives with different levels of priority.
- Families have limited resources to realise these objectives.
- Strategies are developed to manage resources to achieve priority objectives.
- Strategies often require compromises, so objectives of lower priority may suffer because resources are limited and everything cannot be done in the best way.

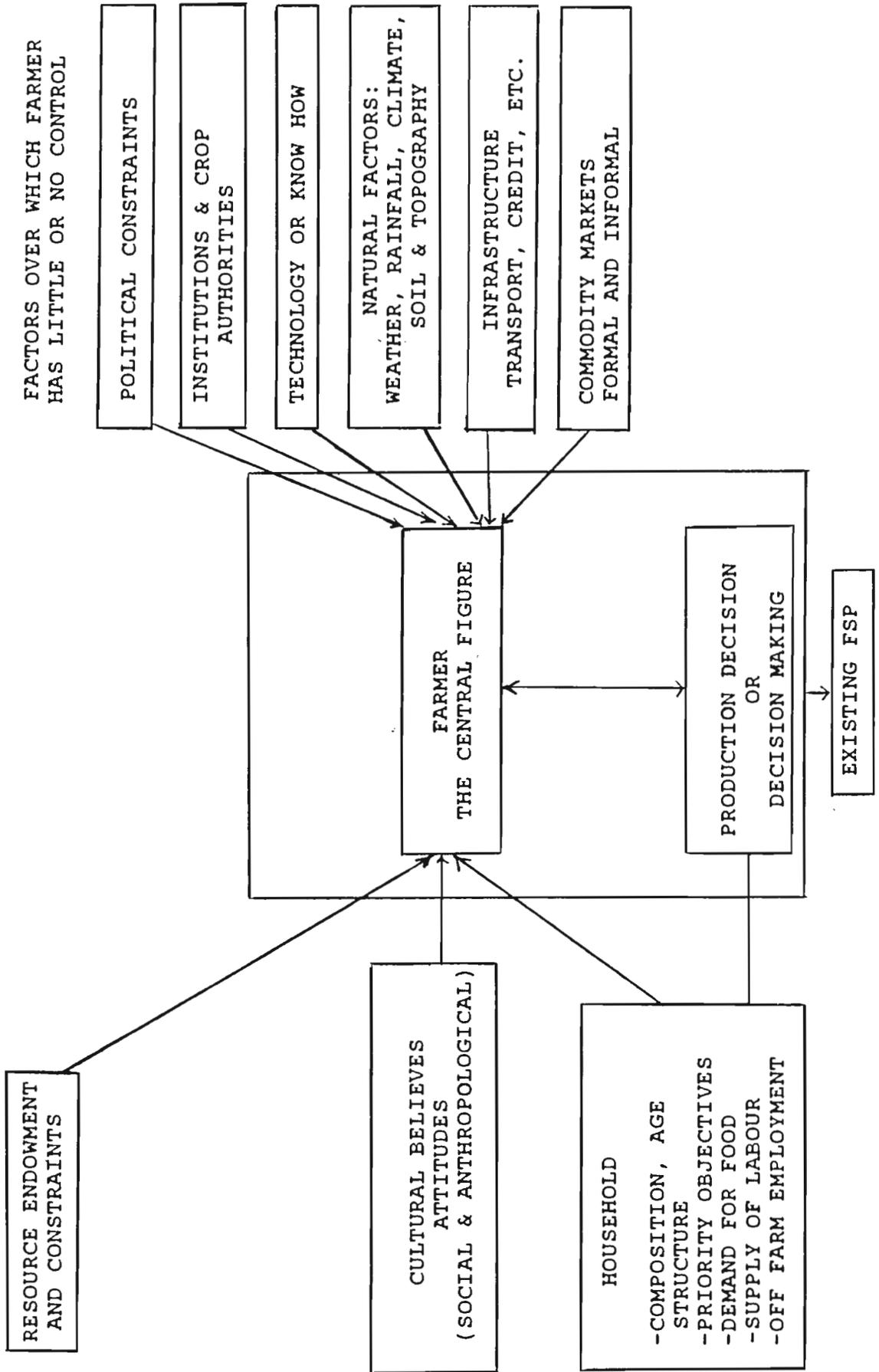
The concept, "Farming System Perspective" therefore implies 'seeing things from the farmers' view point.

It means that researchers should:

- . Be sensitive to farming systems interactions.
- . Understand how the farming systems operates.

Figure 1

COMPONENTS AND LINKAGES OF THE EXISTING SYSTEMS



- . Use this understanding in designing and evaluating research activities.

Importance of Systems Perspective in Technology Generation

- It is the perspective farmers use in managing their farms.
- It is the perspective farmers use in evaluating new technology offered to them.
- It is a perspective that OFR researchers use to understand why farmers do what they do on their farms.
- It allows OF researchers to plan their experiments and new technologies with the same perspective that the farmers will use in evaluation.
- It is not a perspective used in traditional agricultural research where emphasis is on a biological or technical perspective rarely coincidental with that used by farmers.
- OFR using a systems perspective allows OF research to draw upon those component technologies derived by specialist technical researchers that are identified as consistent with the systems perspective of local farmers.
- It acts as a bridge between technical research and farmers.

Kinds of interactions in a FS

- . Interaction over space, e.g. from intercropping.
- . Interaction over time, e.g. carry over from one cycle to another i.e. residual effect.
- . Interaction over time and space e.g. of relay cropping.
- . Competition for farmers' resources e.g. labour or cash.
- . Interactions arising from risk, or farmers' food preferences.

Use of System Interaction in OFR/FSP

DIAGNOSES:

- . to identify trade offs and compromises in the system

- . to understand the process of resource allocation

PLANNING:

- . to identify indirect solutions to the conceived problems

EVALUATION:

- . to identify the indirect costs and benefits.

How do we identify system interactions:

The best guide to identify system interactions in any given system is the enterprise calender.

TARGET GROUPING OR RECOMMENDATION DOMAIN

Because of its farmer orientation and site-specific nature; OFR must explicitly identify the farmers for whom the research is intended.

Definition: Recommendation domain

Conceptually, a domain is a group of farmers who will adopt the same recommendation given equal access to information; or a group of farmers whose circumstances are similar enough so that the same recommendations are applicable. In practice domains include farmers with similar enterprise pattern, production practices, similar opportunities for development, similar resources, and for whom the same research and development efforts are most likely to be relevant.

Need for target grouping

Target grouping helps to avoid two equally unpalatable alternatives.

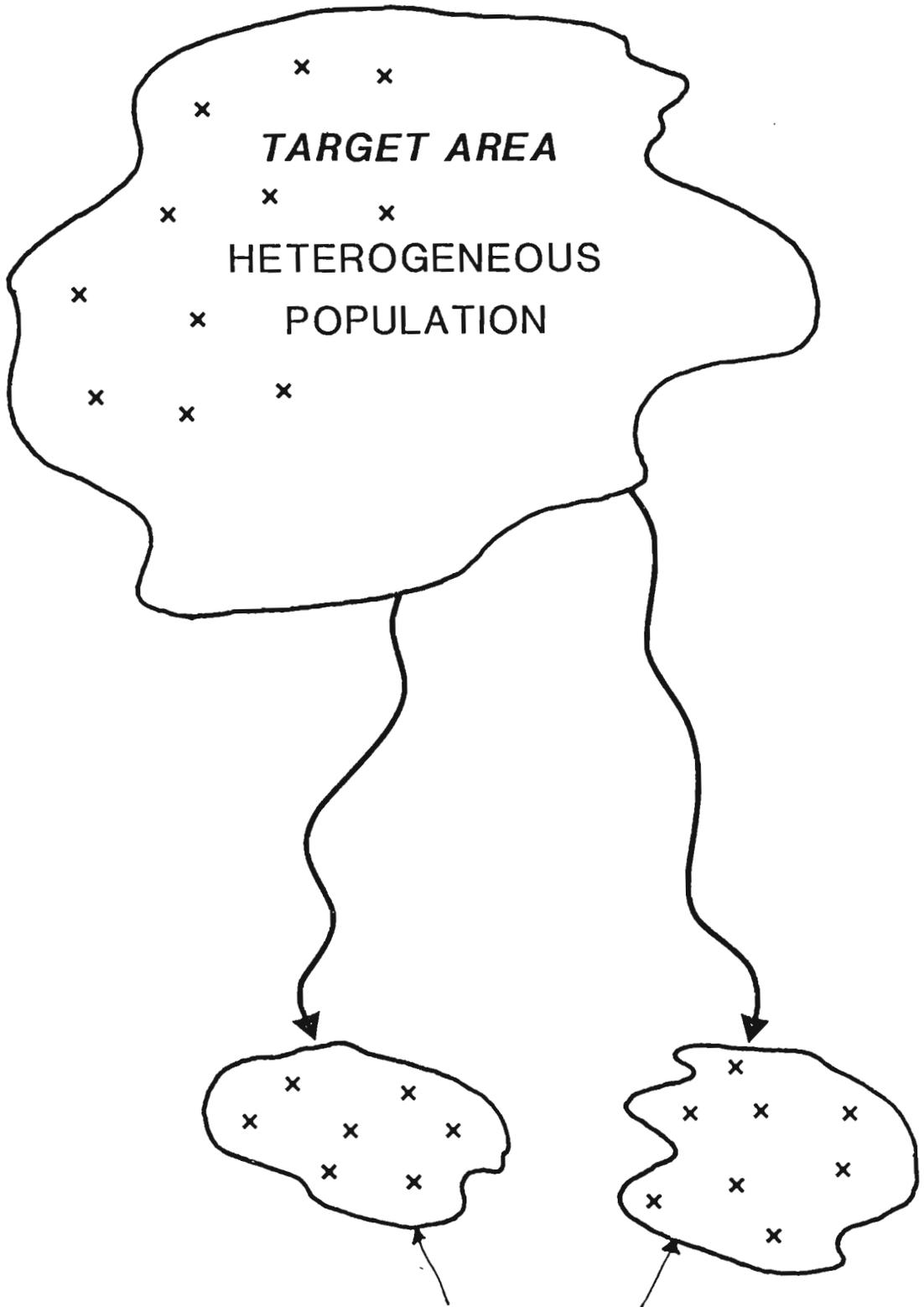
- a) Defining a different experiment/recommendation for each farmer, a methodology which is too expensive and not practicable; or
- b) Designing one experiment/one recommendation for the whole farm population despite differences in circumstances and farming practices (a methodology which is irrelevant for many farmers).

Target grouping, in essence, is a way of stratifying the whole farm population. It is possible to divide a heterogeneous population into subpopulations each of which is more or less internally homogeneous, with respect to those factors that influence choice of alternative technologies.

It is important to keep in mind that the concept is not static but dynamic. The characteristics of the same target group can be refined or redefined as understanding of the system improves or as different technology options are considered.

Note:

1. The recommendation domain is a group of farmers and not a geographical area or land type. Domains are composed of farmers because farmers and not land types take decisions on new technology; but land type is taken into account in farmers' decision making process.



**Homogeneous with respect
to those factors under consideration**

2. Socio-economic criteria are taken into account when defining domains in terms of groups of farmers.

In target group formation keep in mind:

Our basic objective is to group the farmers who use similar production practices and who share similar opportunities for improvement. Therefore in defining target groups we should note the following:

1. There is no unique formula for identifying the recommendation domain. there are no predetermined criteria for forming a domain. The researcher should identify the best stratification criteria.
2. Heavy reliance on researchers' judgement.
3. Both agroclimatic and socioeconomic variables are equally important in target grouping. One should consider the following variables:

a) Agroclimatic variables:

i) Climate

Temperature
 Frost incidence
 Rainfall - intensity, distribution, duration
 Risk of drought
 Risk of flooding
 Irrigation

ii) Soils

Texture and structure (soil type)
 Drainage
 Slope
 Depth
 Nutrient supply capacity
 PH
 Salinity
 Toxicity
 Organic matter content

iii) Biology

Disease incidence
 Pest incidence
 Weed complex/incidence
 Crops grown and combinations

b) Socioeconomic variables:

Farm size
 Land tenure
 Access to markets-purchase of inputs, sale of crops

Access to family labour/hired labour/shared labour
 Access to credit
 Access to cash
 Power source and availability
 Access to irrigation
 Off-farm employment opportunities
 Food preferences and diet
 Community customs and obligations
 Local institutional memberships.

However, there are some guidelines for forming tentative domains/target groups.

Guidelines for Target Group Formation:

1. Available secondary data can assist in forming the initial target group. Agroclimatic zoning and administrative boundaries may be used as starting points.
2. One might also use a questionnaire to agricultural administrators and extensionists at the lowest administrative level to which these workers are assigned.
3. Farmers are usually grouped into relatively homogeneous groups based on their existing farming systems.

There are three reasons for this grouping:

- a) The farmers' existing system is a result of interaction between their exogenous, natural, economic, and cultural circumstances and their own priorities and resource capabilities. Current FS best reflects the balance of factors important in identifying homogeneous group of farmers.
 - b) Farmers operating a similar system often have the same researchable problems and exploitable development opportunities. The same new technologies will be relevant to the group.
 - c) The existing system is the starting point of development. One should build on to the good part of the existing system instead of destroying it.
4. List those variables or factors that may possibly serve as criteria for stratification. State how these variables affect the farmers' practice and opportunities for its improvement. Select as stratification criteria the one or two variables that most strongly affect the current farmer practice and opportunities for improvement.

5. As research opportunities and farmers' practices change and as farmers' circumstances become better understood, the need may arise to redefine the domain. Assessment of farmers' circumstances and formal and informal surveys may assist in refining the domain formed. Further subdivision of one domain into several others can lead to an improved research focus.
- . Target Groups may be defined/determined by solution problems under consideration/investigation.
- . Target Groups may be determined by specific selection to a problem.
- . Sometimes target groups may be determined by the analysis of the experimental data.
- . The same farmers may fall under two different target groups depending on the problem under consideration.

Factors determining the number and size of domains

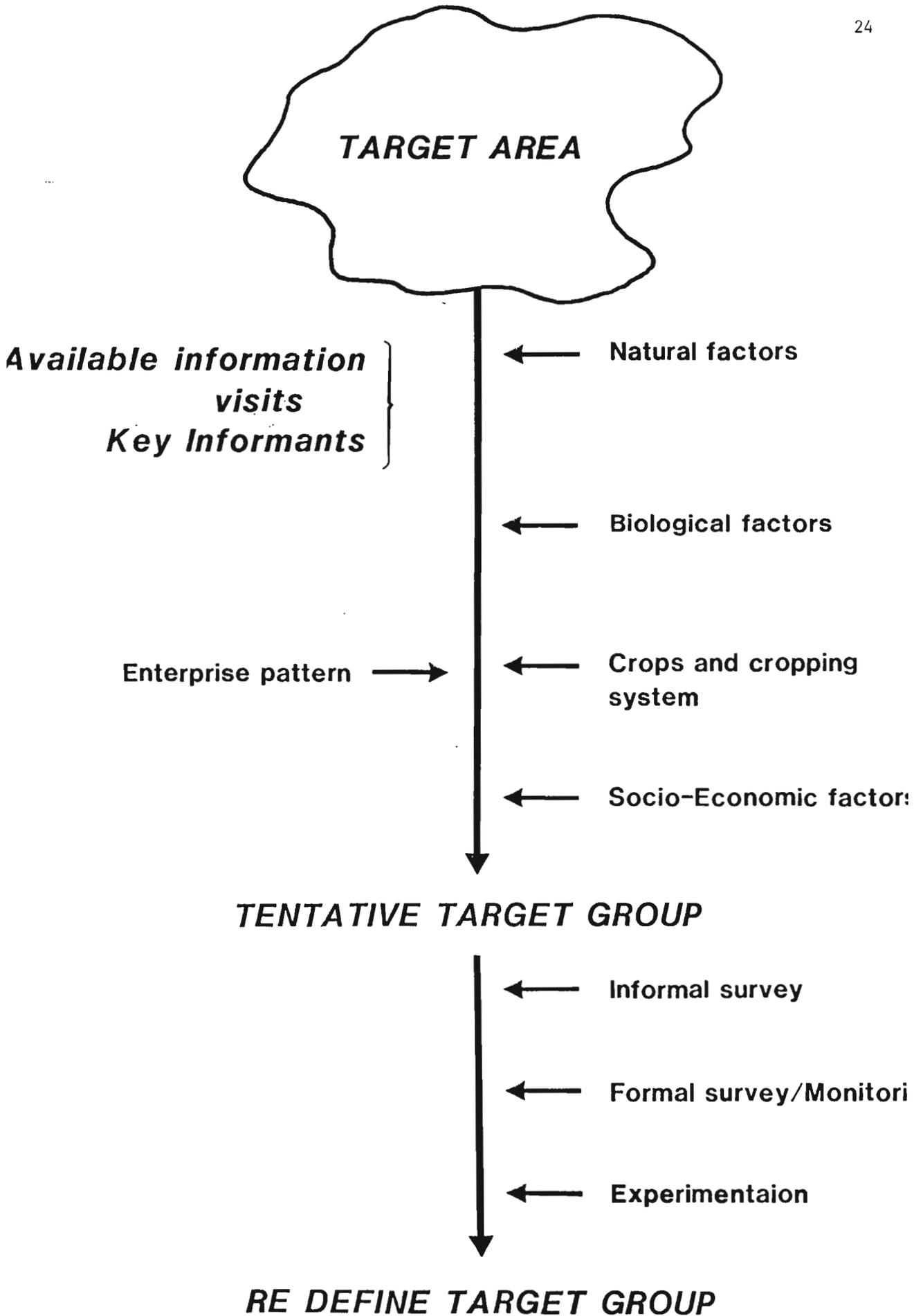
1. Availability of research resources - more resources means more and smaller domains.
2. Target area heterogeneity/variability. Greater the heterogeneity means more and smaller domains.
3. Desired recommendation precision: for a more precise recommendation one needs a well-defined domain.

The selection of target group or area should:

1. Attempt to be compatible with government needs and priorities. Selecting areas and groups can be a political decision.
2. Give a fair chance of obtaining tangible results in reasonable time.
3. Be broad enough to spread the cost.

Target Area vs Target Group

In most of the national programs the teams are required to work within a target area. Once the area is defined, then researchers should look at the available secondary information about the area to decide whether it is possible to identify the target groups within this area. If the information is not sufficient try to talk to the local government and extension staff in the area. Supplement this information by visits to the area to make some visual observation, and if possible talk to some local key



informants. This will enable the teams to identify a 'tentative domain' to begin the diagnostic process. As the diagnosis proceeds it is possible to get a clearer understanding of the target groups. Very often one may identify more than one target group within the same target area.

FARMER CIRCUMSTANCES

Definition: Farmer circumstances - This term refers to all factors that influence farmers' decisions. It is the situation in which farmers find themselves and have to manage.

It is important to collect, analyze, and interpret the available secondary information before collecting any primary data to describe a system.

Why do we need to know the farmer circumstances?

1. To identify the management challenges that farmers are facing. This is a key element in determining farmers' management strategies.
 - A) Challenge: unreliable rainfall
 Strategies: staggered planting
 intercropping, e.g. maize/sorghum
 multiple cropping, e.g.
 maize/rice/cassava
 growing insurance crops such as
 cassava and sweet potato
 early vs late varieties,
 low-yielding but draught-resistant
 varieties
 mixed varieties, e.g. beans
 low level or no purchased input
 used
 low plant population
 - B) Challenge: pest and disease incidence
 Strategies: crop rotation
 adjusting time of planting
 changing the crop itself
 mixing varieties grown in the same
 place at the same time
2. To provide an initial understanding of the system
3. Farmer circumstances not only determine the current production technology but are also important in a farmer's decisions concerning technology change. If a change in technology conflicts with any of the circumstances of farmers, that technology may be rejected (system incompatibility).
4. Information on farmer circumstances might reveal important discrepancies between stated policy goals and actual implementation:
 - a) Late arrival of credit leading to untimely use of inputs

- b) Late payments for crops acting as a disincentive for production.

5. Defining or redefining "target group".

Farmer circumstances may be grouped into five categories:

1. Physical and Biological
2. Institutional
3. Infrastructure
4. Economics
5. Social and cultural settings

The various items considered under these individual categories are given in Table 1. These factors can also be classified either as internal or external circumstances (Table 2). External circumstances are those factors over which the farmer has little or no control, e.g. policies, institutions, infrastructures, etc. Internal circumstances are those factors over which the farmer has control e.g. labour, food preferences, etc.

1. Natural Circumstances (Physical and biological)

Impose biological constraints on crops and livestock thereby influencing farmers' decisions.

- a) To define the farming environment in terms of:
 - production feasibility of a group of particular crops
 - management patterns in relation to farming operations
- b) Help delineate areas by defining environmental variations:
 - useful in target grouping
 - useful in site selection and experimental design

A) Rainfall: Both total rainfall and distribution are equally important. The distribution patterns often provide management challenges to the farmers. Effects of rainfall on the system:

- a) Agronomic -
 - i) length of growing season
 - ii) crops/livestock grown and combinations
 - iii) amount of time spent on farm operations
 - land, preparation, planting, weeding, harvesting, etc.

TABLE 1 FARMER CIRCUMSTANCES1. Physical:a) Natural

Climate - rainfall - (intensity duration and distribution) reliability
 soil - type, location, fertility status, texture, PH topogra
 - shape, altitude

b) Biological - current farming systems - animals - types and number
 crops - types and acreag
 pests and diseases

2. Institutional

Marketing and distribution mechanism
 Tenure arrangements (could be social)
 Credit programs) Types of programme
 Extension programmes) Number participating
 Farmer organization - village councils
 - cooperatives
 - clubs

3. Infrastructure

Road net-work
 Accessibility
 Health and educational facilities

4. Economic circumstance

Population density
 Settlement pattern
 Crop statistics - average] relative importance of
 - production] enterprise

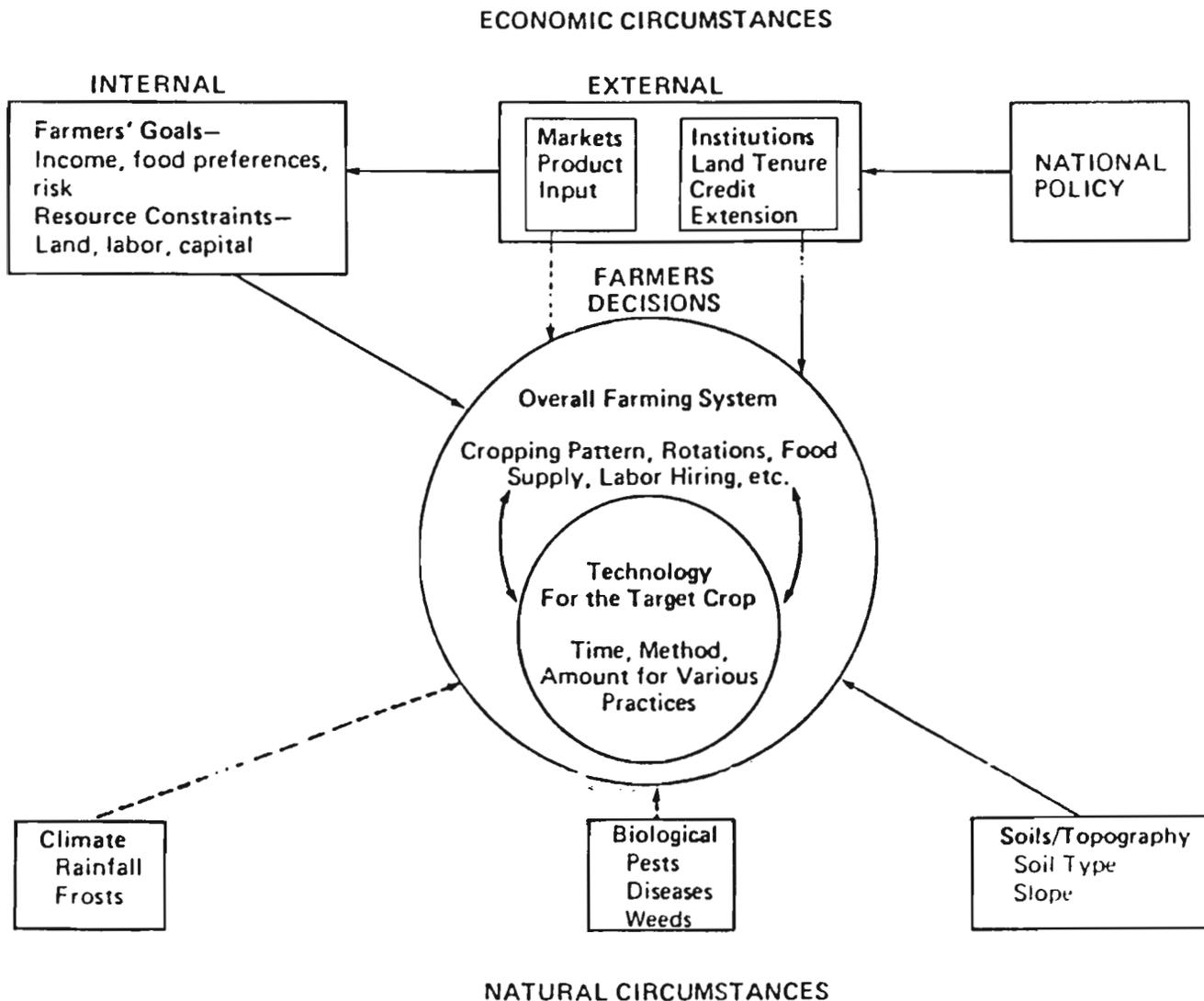
Marketed product
 Purchased inputs
 Timely availability - products/inputs
 Price fluctuations - products/inputs
 Relative prices of the crops in the system
 Land and labour - availability, source, Mode of Payment
 Retail markets

5. Social and cultural setting

Beliefs and attitude
 Food preferences
 Social obligations

Table 2.

Various Circumstances Affecting Farmers' Choice of a Crop Technology



---> Circumstances which are often major sources of uncertainty for decision-making.

- iv) pest and disease incidence
- v) incidence of weeds - species
- vi) crop spacing
- vii) method used in crop husbandry, e.g., tillage methods
- viii) livestock feed quality and availability

b) Socioeconomic - circumstances

- i) variation introduces risk
- ii) affects input availability and marketing of products

Analyze the rainfall data to:

1. Determine the variation - year to year, monthly etc.
2. Determine the risk associated with variation
3. Determine the strategies followed to overcome risk - both presently used and other possibilities.

B) Soils and topography: the soil type and topography could influence the following:

- i) drainage/water retention/erosion
- ii) fertility
- iii) crops and cropping combinations
- iv) cultivation practices - tillage method - timing, etc.

Soils and rainfall together can influence the following:

- i) wetting depth - moisture retention
- ii) erosion
- iii) loss of nitrogen

All these factors, either directly or indirectly, can influence the production system and the practices followed by farmers.

C) Pests and Diseases: the incidence is often associated with climatic factors. They are important but the farmer may at times be unable to name or identify them.

2. Institutional Circumstances

A) Community organization and structure: can influence the resource use pattern and access to services and inputs.

B) Land tenure and settlement patterns

- a) Different settlement patterns have different implications for access to water and grazing. Special crops, e.g., crops requiring intensive care or crops playing an important role in the local diet, are often located in specific fields.
- b) Land ownership may influence farmers' decision making process. For example, sharecropping is often a disincentive to intensive management.
- c) Distribution of land among family members.
- d) Allocation of parcels for particular crops.

C) Credit facilities

Source (formal, informal, cost, and timely availability are equally important and can influence farmers' ability to:

- a) use purchased inputs
- b) use hired labour
- c) Decide up selling/storage strategies

D) Extension services

- past efforts and impact on the system, attitude of farmers towards extension
- recommendations accepted and rejected, reasons
- farmers' knowledge of the recommendations and extension messages.

E) Policy

Government policies can influence decisions and management practices used by the farmers:

- pricing policies - both inputs and product
- input distribution-supply of fertilizer, pesticides, certified seed, etc.

3) Infrastructural circumstances and institutions

The extent of a road network and conditions of these roads during the wet season may influence the crops grown/livestock reared. A poor road network and unreliable distribution system will often force the farmers to grow their own food and less perishable

commodities, causing the low productivity of resources employed.

4) Economic circumstances

- a) Product markets - Information is needed on:
- marketing channels
 - volume sold/purchased (both inputs and products)
 - selling and buying strategies
 - seasonal, annual variation in prices
 - spread between consumer and producer prices
 - government price support
 - local milling or processing facilities
 - availability and reliability of staple food
- Market information improves the understanding of what circumstances farmers face in producing more for sale, buying for consumption, or using produce on the farm
- Trends highlight the changes in the current production system (what is coming in and what is going out). Trends are easier to reinforce than to reverse.
- b) Labour and machinery:
- Availability of labour. Source of alternative employment opportunities: mode of payments; availability of machinery and equipment; maintenance or hiring services; etc. These factors can influence the strategies adopted by the farmers.
- c) Input market:
- Availability, volume purchased, price, reliability of supply price fluctuations, etc. These factors can influence the decisions taken by farmers.
- d) Resource availability and use pattern: One should establish the magnitude and timing of cash and/or labour constraints in the system as these two factors will greatly influence strategies adopted by the farmers in such things as: buying, selling, choice, and timing of cultural practices, etc.

5) Social and cultural setting

Food consumption patterns and preferences can influence the choice of variety, planting dates, resource allocation at farm level, storage and marketing strategies, etc. The culture also to a certain extent influences the attitude of farmers towards risk. Natural, economic, and institutional circumstances can introduce risk in farming. Farmers do follow definite strategies to minimize risk.

NOTE

Once again it is important to realize that farmers' circumstances are not static. We may observe:

- changes in socioeconomic circumstances - such as price variation
- changes in infrastructure - new road
- changes in institutional circumstances - credit, seed certification, etc, which can influence the farming operation

For example, price variation and relative price changes might lead to:

- a) changes in enterprise combination
- b) changes in resource use pattern
- c) changes in management practices

SOURCES OF SECONDARY DATA

Before conducting surveys, use recorded secondary information (published or unpublished data collected for some other purpose) to identify farmers' circumstances.

Often data on rainfall, soil types, vegetation, population, and prices are already available in published reports. In using these data one has to look for:

- a) Accuracy and reliability - should be checked by comparing data from different secondary sources.
- b) Adequacy of the data, e.g., rainfall data (daily, weekly, monthly, annual).
- c) Recent data: for socioeconomic information timely data is important. Recent information is more suitable. Secondary data on socioeconomic topics that are more than five years old should be verified.

One could look to the following sources for secondary information.

- 1) Weather reports - individual station
- national stations
- 2) Topographic maps
- 3) Soil maps (soil types) and aerial photographs (natural vegetation)
- 4) Census reports - population data
- 5) Agricultural census and annual reports - production data
- 6) Market information reports
- 7) Research reports; farm management survey reports
- 8) Personal communication with researchers and local administrative personnel in the area

DATA GATHERING METHODS FOR OFR/FSP

The following methods could be gainfully employed in generating the data needed for OFR:

1. Review of secondary information
2. Key informant surveys
3. Group Interview Techniques
4. Informal survey
5. Single visit verification (formal) survey
6. Multiple visit informal survey
7. Multiple visit formal survey
8. Technical monitoring
9. Case studies
10. Experiments
11. Participant observation

The method of data collection used in any OFR process is determined by:

1. Purpose/objective
2. Use
3. Availability resources: money, hire, personnel, equipment available, etc.

Invariably a combination of these methods is used in generating the required information. In any diagnostic work there is usually a set of objectives which requires combination of techniques. Steps involved in planning data collection are:

- determine purpose and the type of data required
- identify the best source of information for the various types of data
- determine the methods of data collection which would produce these data cheapest in terms of:
 - . time
 - . personnel and
 - . logistics required

Census, Sample surveys and Casestudies

The objectives of the various approaches to data collection are to describe characteristics features of target populations and to determine the variability of major parameters quantifying the farming system.

In principle, all three approaches support the objectives, whereby

a census investigates	all...
a survey investigates	some...
a casestudy investigates	few....

units of the total population i.e. all units of a particular target group.

Census:

A census in its attempt to completely cover an area involves considerable administrative, logistical and financial efforts. It has its limitations in that only few variables can be investigated; even then it can become very costly and time consuming. It is therefore done mainly for demographic purposes on a national scale, and then only at large time intervals (ten years).

For farming systems work, it may be applied to particular, small sub-sets of a population, say all vegetable traders in a target area, and investigate few, very specific aspects. Such, it forms the base for further, more detailed survey work.

Sample Survey:

The feature of a Sample Survey is that it investigates a selection of units drawn from the basic population. Often, this is done with the intention to achieve representativeness and to draw conclusions on the characteristics of the basic population. To accomplish this, the selection has to follow certain sampling procedures which support statistical inference.

Sample surveys are suitable for both descriptive and analytical purposes and range from quick studies on one topic in one area to multi-purpose studies with multiple visits over long periods. They are therefore adaptable to many survey situations, allow more detailed and differentiated investigations than a census and are generally faster, cheaper and easier to organise.

Limitations of sample surveys (mainly as compared to a census) relate mainly to the sampling procedures, basically the definition of the sampling frame, the adequate sampling method and an appropriate sampling size.

Case Study:

Case studies investigate few units of the population and may serve several purposes:

- during the pilot phase of an investigation, selection of few representatives of a target area
- often not sufficient information is available to talk about specific target groups - may give a first impression on the various aspects of farming. The case study results form then a base

to determine the scope and content of a more detailed sample survey.

- After secondary information and informal surveys have provided adequate information to stratify the population and identify various target groups, few representative cases, one to three, are selected from each strata for detailed further investigations. Such case studies are particularly useful to determine intentions and attitudes of target groups and how these result in behavioural patterns and actions.
- as follow-ups of sample surveys, case studies can investigate particular farming activities, where sample surveys do not provide adequate results. An example is determination of labour requirements for farming activities.

The strength of case studies lies in the potential to obtain a deep understanding, even in quantitative terms of the mechanisms which drive a farming system, in particular of the behavioural aspects.

The main problem with the case study approach is that of generalizing the findings of the study. The question which arises is how to generalize from a statement of a respondent not randomly selected to valid characteristics of the whole group. If a population is completely homogeneous, one representative will give information valid for the rest of the population. Though this is hypothetical, it is the researchers' task to assess to what extent the stratification of the investigation area leads to sub-groups which come close to that homogeneity. This assessment can help in determining the degree to which a case is "typical" and "representative" for a target group.

The table below is an attempt to classify these three procedures according to various criteria:

Table 1. Characteristics of Census Surveys and Case Studies

Aspect	Procedure		
	Census	Survey	CaseStudy
Coverage of population	all	some	few
Representativeness	total	---->	doubtful
Depth of investigation	shallow	---->	detailed
Approach to investigation	rigid	---->	open
Researcher Involvement as investigator	low	---->	complete
Organisational requirement	high	---->	modest

While a census may not be considered a widely applicable method in farming systems investigations, sample surveys and case studies are commonly used. The table below categorises data collection requirements according to Scale of enquiry, Interview type, Observations and Frequency. Across, some sort of various intensity levels have been defined. A combination of these criteria/classification groups gives different scenarios which dictates the appropriate method of data collection to be employed. Accordingly case studies are closely related to Category A investigations, which sample surveys are typically represented by type C studies.

Table 2. Categorization of Investigation Techniques

Criteria	Case Study -->.....--> Formal Survey		
	A	B	C
1. Scale of enquiry	Phenomenon of interest rare and clustered	Village or community level specific site or institution	Phenomenon of interest widely distributed throughout area
2. Interview type	free-ranging unstructured	Open ended questions, attitudinal studies	Closed and/or structured questionnaire
3. Observations and measurements	Technical, requiring professional skills	Accurate and detailed	Simple counts and measures
4. Frequency	Continuous or very frequent	Multi-visit over years	Single visit

Source: A Handbook on Monitoring and Evaluation of Agricultural and Rural Development Projects, World Bank November 1981, p. 54.

Table 1. Characteristics of Data Collection Technique Usually Employed by CIMMYT

Characteristic Type of Data Collection Technique(1)

	Exploratory Survey	Verification Survey	On-Farm Experiments
1. Number of Variables included	Initially very large, but narrowing as the survey proceeds and as accumulated data is analyzed daily	Small, focusing only on variables determined in the exploratory survey to be important for technology design	Very small--includes two to four priority factors identified in the farmer surveys
2. Degree of structure	Relatively unstructured, with questions formulated specifically for each interview, depending on accumulated information and the particular farmers	Structured questionnaire used with specific questions asked in a given sequence	Common experimental designs
3. Researcher field participation	Researchers conduct interviews and record and analyze data	Enumerators often employed to conduct interviews under researcher field supervision	Researcher conduct and observe experiments
4. Extent of multidisciplinary cooperation	Very high, with technical and social scientist working as a team	Questionnaire designed by multidisciplinary team but implemented by economist	Experiments designed by multidisciplinary team, but implemented by agronomist
5. Degree of observation	Includes observation of farmers' fields and practices, especially biological dimensions of crop production	Usually based on interviews, sometimes with field observation a special problem	Crop responses are directly observed and measured
6. Frequency of data collection	Usually only one visit to each farmer		Multiple visits to observe experiments and farmer practices and conduct informal farmer interviews
7. Degree of quantification of variables	Emphasis qualitative data, but with sufficient quantitative measurements to prescreen alternatives	With sufficient formal statistical tests	Quantification of yield response to technological alternatives
8. Estimation of confidence intervals on variables or hypotheses	Only subjective confidence intervals possible. Random sampling not used, but efforts made to sample variation	Random sample allows formal statistical tests	Selection of representative farmers based on verification survey. Replication in and across sites allows statistical tests

(1) source: Byerlee, D., L. Harrington, D. Winkelmann. "Farming Systems Research: Issues in Research Strategy and Technology Design".

INFORMAL SURVEY OR EXPLORATORY SURVEY

Definition: Informal or exploratory survey*

A survey undertaken without a formal sampling procedure, pre-tested questionnaire, and other means that permits statistical analysis. Developed in response to felt needs.

- a) Needed to help the scientists to get acquainted with farmers
- b) Needed for rapidly obtaining agro-socio-economic information to guide production teams in technology generation
- c) Needed for cost-effective survey procedure

If properly executed with minimum cost, this type of survey can produce:

- a) A rich description of life in a farming community
- b) An understanding of how farmers, local traders, extension workers, and other perceive their condition and make decisions
- c) Can also give accurate comprehension of local farming systems and ecology.

Basic aspects of informal survey

- 1) Observation of the farm and the farmers
- 2) Conversation with the farmers

During diagnostic survey generally two levels of information are collected:

- 1) Information on general practices of farmers
- 2) Information on variation in the general practices in order to understand why variation occurs
 - could be used for redefining target group
 - could also be used to identify technology

Objectives of the Informal Survey

- 1) To understand the local farming system: What? Why? How?
 - Priorities and decision criteria
 - Management strategies
 - Resource use pattern
 - Relative importance of enterprises
 - Attributes common to most of the farm population
 - Social and customary constraints to reallocation of resources
 - Local terminology, unit of measurement, etc.

*Also known as reconnaissance survey

- 2) To identify production problems and constraints or missed opportunities
- 3) Based on management flexibilities and constraints to identify new feasible technologies
- 4) Provides the basic information required for the design and execution of formal survey
- 5) Information gathered will form the content for subsequent on-farm experimentation.
 - Definition of a problem --> experimental variable
 - surveys --> help to set the levels of non experimental variable

Procedure

The informal survey is the most crucial part in the diagnostic phase. The process involves visits to the target area by a team of scientists, at the minimum an agronomist and an agricultural economist or social scientist. Depending on the production system, a livestock production specialist also could be included. The basic idea is to understand the local farming system and decision making criteria of the farmer. An unstructured conversation technique is used. However, usually guidelines are used to assist the discussion.

The biological scientists try to identify the compromises in farmers' management practices which underexploit the full biological potential of the enterprise(s)/system (Figure 1). The social scientist try to identify the reasons for compromises. Together the scientists try to gain an understanding of the system and begin to identify priority problems and possible solutions. They discuss with farmers, make notes, compare notes, identify information gaps, and fill in the gaps identified by subsequent interviews. Farmer-researcher interaction continues until researchers are confident that they thoroughly understand those aspects of local farming from the guidelines. The researchers jointly look for "New Improved Management Practices" that better exploit the system's biological potential and at the same time are consistent with the farmers' priorities and objectives (Figure 2).

Fig 1 : **Identification of Management Constraints**

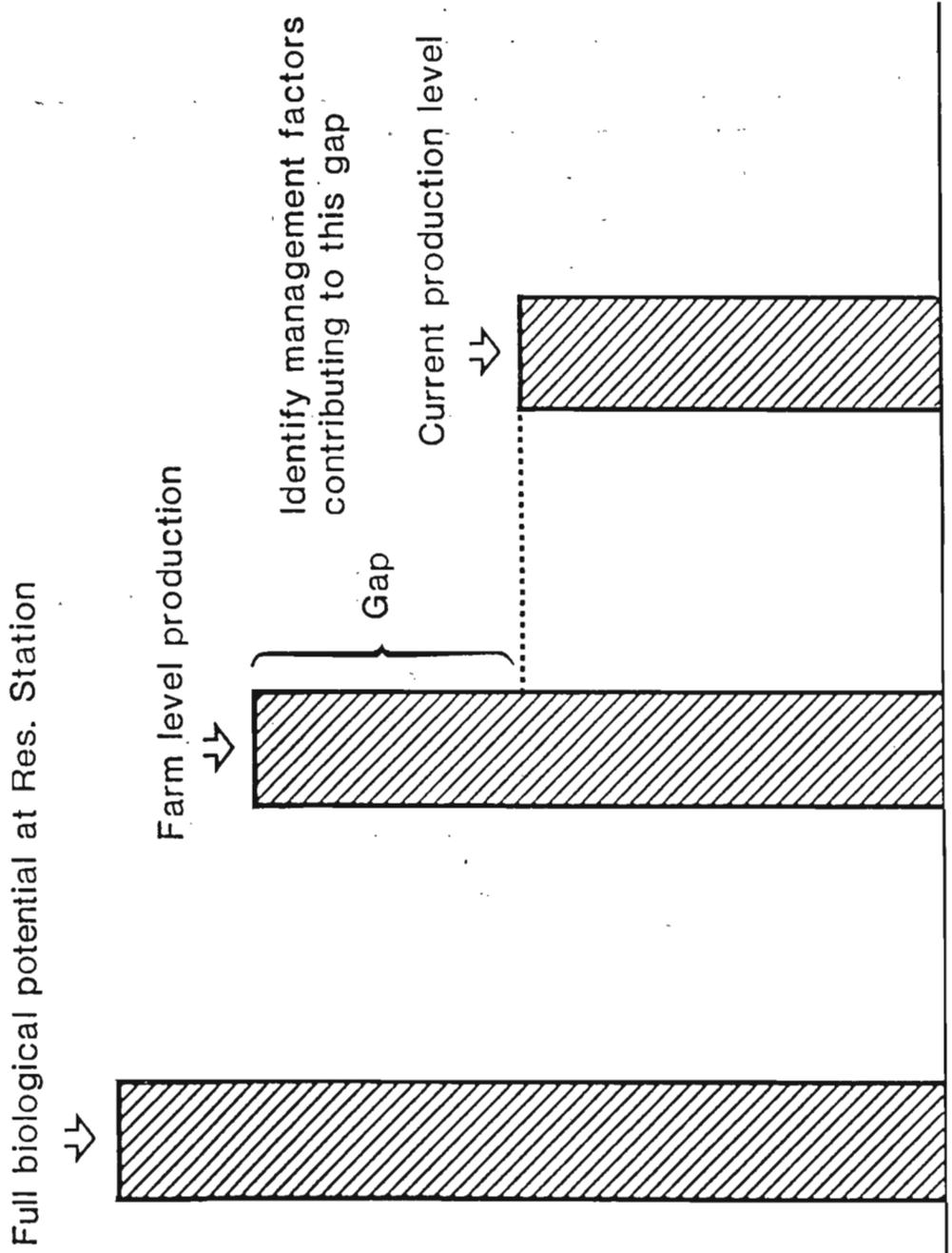
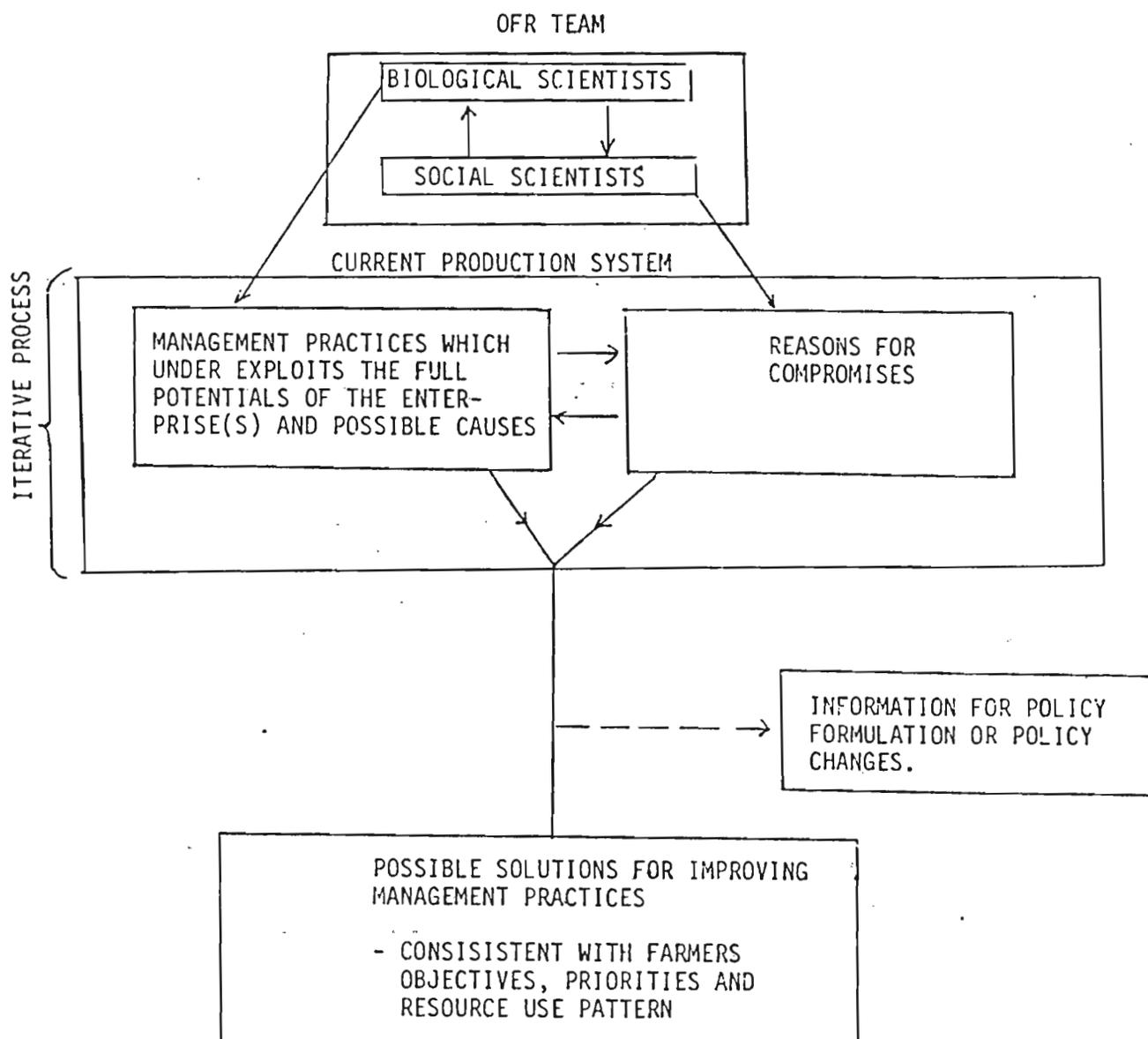


Figure 2 Informal Survey Procedure.



This is the stage at which one can get the best and most useful interaction between the social and biological scientists; between the scientists and the farmer. This interaction should be an essential element of the informal survey. In carrying out an informal survey consideration should be given to the following:

1) Field Work Preparation

We do not use statistically selected samples. It may be difficult to arrange meetings but is important to make sure that the farmers in fact belong to our target group of interest. Make sure that the local authorities are fully aware of your visit and farmers are informed about your activities.

2. The choice of farmers is critical to the process. Ask screening questions to make sure that they are in the target group. If you use local extension staff to identify the farmers, depending on the situation you may have to exercise a greater care in interpreting the information. Get off the main roads to get representative farmers.

3. Approach

- 1) Low profile - as much as possible
- 2) Avoid oversized vehicles bearing official numbers
- 3) Do not go in large numbers; two or three people should be maximum
- 4) Do not behave in a manner which might create suspicion
- 5) Be friendly and open, create a relaxed atmosphere
- 6) Introduce yourself according to local customs. Give your name and organisation
- 7) Open your conversation with some general remarks. Talk about weather, how the crops are doing, etc.
- 8) Explain the purpose as clearly as possible:
 - a) to know how the farmer farms
 - b) to talk to the farmer about the problems. Give the impression that he/she is the expert and you are learning about the farm activities.

- 9) Mention how the farmer was selected
- 10) Verify that the farmer is actually the manager of the farm. As much as possible include the main workers or other decision makers in the discussion.

4. Location, duration, and timing

Location: Whenever possible interviews are carried out in the farmer's field. If not possible, tour the farm first and then start the dialogue.

Duration of interview: Duration of a single interview vs duration of the survey
As long as the farmer is willing. Do not extend more than 30-45 minutes unless the farmer is in a talkative mood. No need to discuss everything listed in the guideline with one farmer; can discuss sections of the guideline. If possible interview at times of the day convenient to farmers. do not interfere with farm work. An informal survey takes about two to three weeks to complete depending on the size of the target area and also its heterogeneity.

Time: When the crop is in the field (peak of the vegetative stage)

5. Dialogue

- 1) Language: Always interview in farmer's native language. If you are using a translator make sure he/she is good. Use plain understandable language with the farmer.
- 2) Emphasize interview and observation. Best to begin by touring the entire farm, making observations, backing up what the farmer says with what you see.
- 3) Keep you conversation open, informal, and nonstructured yet oriented to the question guidelines. If you get useful information let farmer's conversation stray.
- 4) Maintain a flow of conversation - mix questions with comments.
- 5) Do not suggest answers or ask biased questions.

- 6) Avoid sensitive questions to start with. When farmers are cooperative and relaxed explore sensitive issues.
- 7) Do not promise anything that your team cannot deliver.
- 8) Camera is useful as:
 - a) a research tool
 - b) winning his confidence for future work - send him a free copy but know the local customs or restrictions.
- 9) Field recording of information: Depends on the situation (reaction in the area, use of translators).

Best rule is to abstain from using pencils until you feel that the situation is relaxed. Make sure that you obtain permission before you start writing. Jot down major points only if you cannot make notes when the conversation is in process. Spend some time noting down the points before approaching the next farmer.

6. Departure

Politely terminate your conversation and make sure that you thank the farmer for his/her assistance.

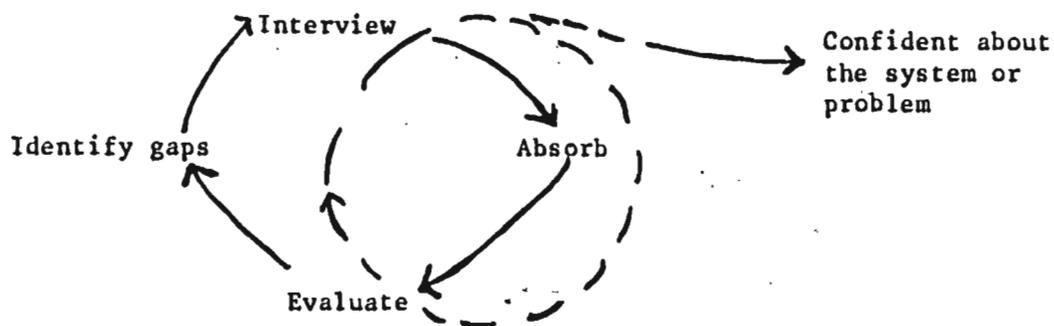
7. Recording and Evaluation

After each interview review your notes and allow sufficient time for evaluation. At the end of each day:

- a) exchange interview experiences
- b) write up the pertinent information to sections of the guidelines
- c) evaluate technical possibilities; re-evaluate target grouping
- d) note gaps in the data

This iterative process (Figure 3) of researcher-farmer interaction continues until the team is confident that they have understood the production system fairly satisfactorily.

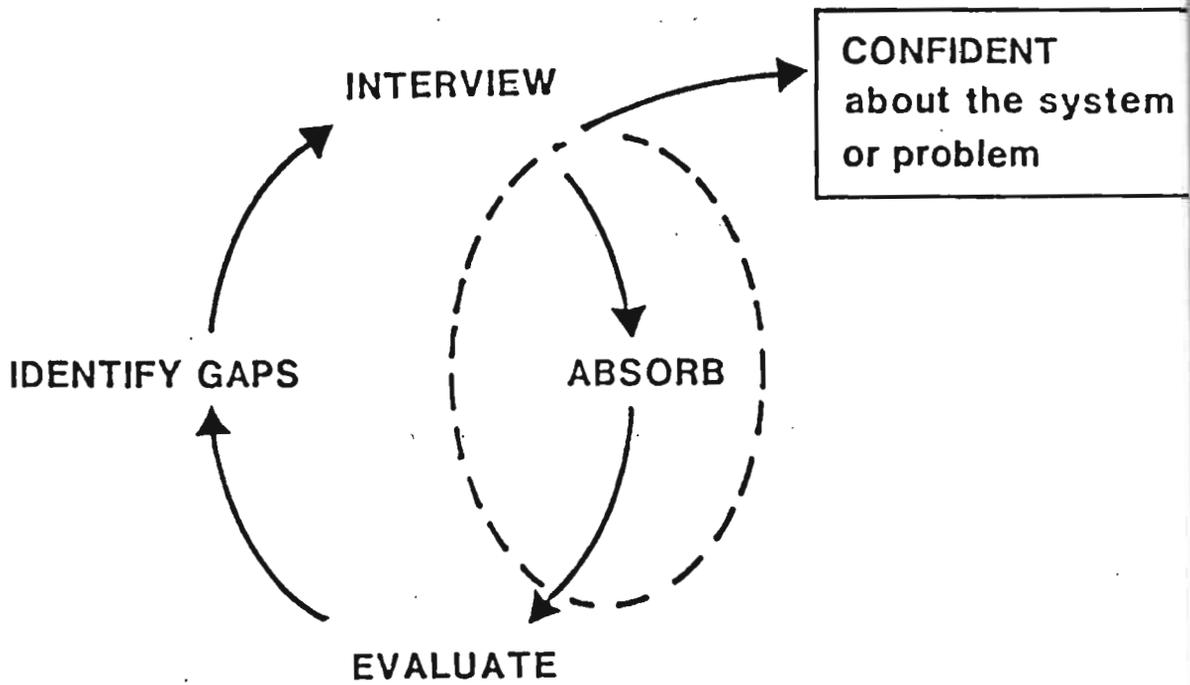
Figure 3. Iterative Process

**Note:**

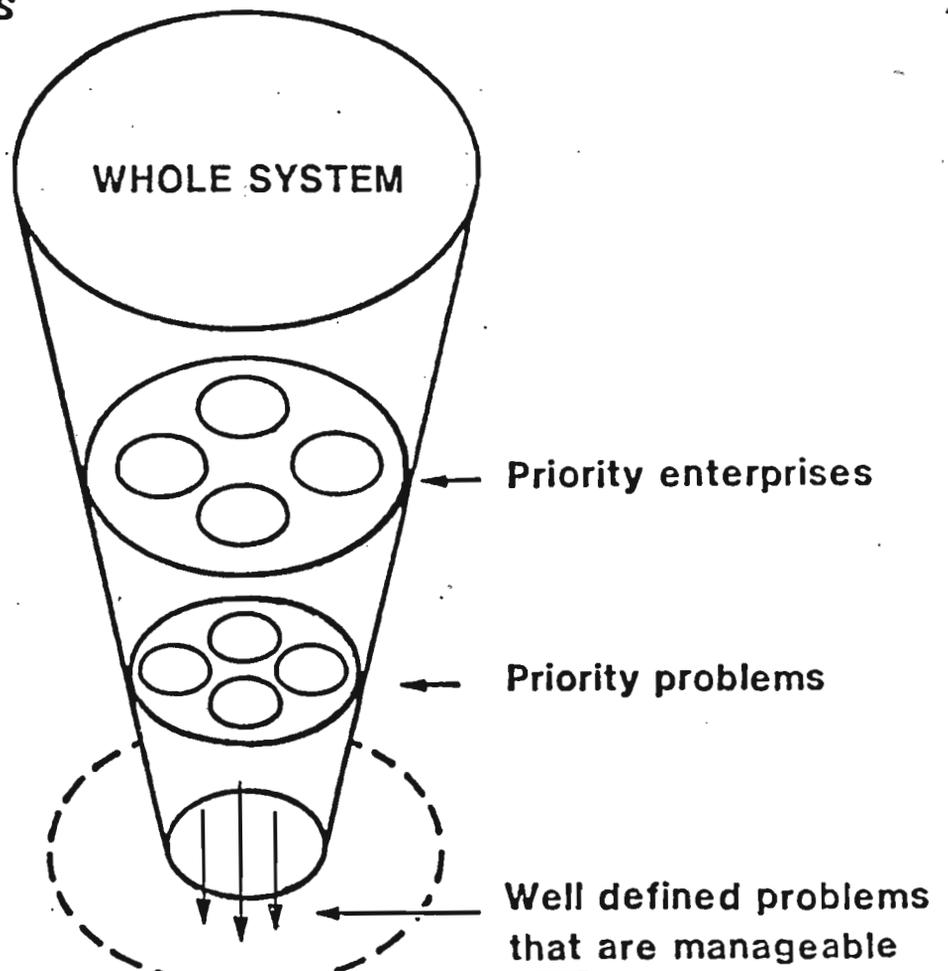
1. As the survey proceeds, the focus becomes narrower and sharper.
2. Though the interview process is considered to be methodologically simple, it is physically tough. The researcher must be entirely village oriented, able to extract information in fields, marketplaces, bars, or wherever the farmers' daily routine carries them. Researchers should be willing to face village hardship.
3. Requires both mental and methodological flexibility.
4. Information collected is mostly qualitative, hence additional sources are required for quantitative information.
5. Use of rough guidelines can be helpful as a checklist, not as a questionnaire.
6. Information generated depends on:
 - a) a team effort
 - b) multidisciplinary participation
 - c) maximum interaction
7. There is no substitute for experience - the interview is an art.

Informal Survey

AN ITERATIVE PROCESS



Focus becomes narrower and sharper



The information collected from an informal survey could be supplemented by:

- a) interviewing other 'actors' in the production system (market people, input suppliers, etc.)
- b) group interviews with farmer group
- c) key informant survey.

Criteria for selecting major enterprises

- 1) Preference and objectives of the farmer
- 2) Relative importance of alternative enterprises in the system
 - . Based on current resource allocation, i.e., land and labour utilization
 - . Number of farmers growing the crop(s)
- 3) Research opportunities associated with the crop
- 4) Specific mandate of the research institute conducting on-farm research

Need to Prioritize Problems

In any given production system one may identify a large number of problems. Given the current circumstances many research institutions in many developing countries, it is not possible to handle all of these problems simultaneously. There are three basic reasons for setting priorities:

- 1) Limited research resources
 - . Funds
 - . Mobility (fuel and transport)
 - . Trained manpower
 - . Time
- 2) All problems identified are not of the same level of importance, based on
 - . Farmers' objectives and preferences
 - . Impact on the system (yield, cost, benefit, etc.)
- 3) Stepwise adoption behaviour of the farmers - Need to establish the importance and impact of individual components to identify the critical element(s) for recommendation.

Rank Problems to Set Research Priorities

The following criteria could be used to rank identified problem areas:

1. Problems important from the farmers' point of view.
 - . Problems affecting the farmers most (impact)
 - . Problems affecting most farmers (number)
2. Potential for improvement once the constraint has been removed.
3. The researchers' ability to solve the problems based on available technology, i.e., the existence of apparently feasible solution to the problem. If the problem is important from the farmers' point of view and no technical information is available, then this will receive high priority in on-station research activities (in some cases even in on-farm experimentation).
4. The frequency with which the problem occurs.
5. The cost associated with the research, i.e., likely cost of conducting the research program to solve the problem.
6. The flexibility of the farming system with regard to this problem, i.e., the relative ease or difficulty of removing the constraint/problem.
7. The political acceptability.

The first five criteria are critical on many occasions and the last two may play a minor role depending on the circumstances. A matrix could be formulated/constructed using these criteria and a ranking of problems could be completed.

The actual research opportunity arising from the existence of a production problem is dictated by the causal factor of the problem or system interaction. In defining the problem it is important to distinguish the symptoms from causes. The same problem may stem from a number of causes which will determine the potential solutions. Similarly, a system interaction may enable one to identify an indirect research opportunity.

Output from the informal survey

Two written items are output from the informal survey. They are notes written up according to the guidelines and a summary or overview of the systems encountered.

1) Guidelines Notes

A set of notes should be produced against the guidelines sections and numbers. Each note should be a consensus from the group for the item with respect to the target population. In addition to the consensus, a note should be added on variations found among farmers interviewed and one or two examples given with roughly estimated numbers that the group feels were fairly typical.

2) System Overview

The system overview is designed to focus the OFR team on the system, to make decisions about constraints in the system, and to give initial indications of possible research thrusts in relation to major constraints. A table of contents for the overview is set out below. No more than two pages need necessarily be written on any one section (A-E).

- A) Farmer circumstances: Not a full description but a specification of those natural and economic circumstances within which the target group operates which seem to strongly affect farmers' management practices. (These are followed up in 'D' below.) If possible, the specifications should be supported with background data.
- B) The farming system: A very brief outline of the system under nine headings supported, where it is thought useful, but descriptive secondary data (e.g., area and production statistics from surveys, and where practice is variable, by the percent of growers 'having' or 'doing').

Outline headings:

1. Socioeconomic characteristics of the Target group
2. General cropping season in the study area
- 3) Enterprise pattern; crops and areas, pure vs mixed, varietal information
- 4) Calendar through the season
 - a) for each crop by land preparation, weeding, harvesting, and any cultural particular to the crop in question.

- b) for each food used on the farm, showing periods of plenty and use of substitutes in periods of scarcity.
 - 5) Methods of production; power source and purchased inputs used, including hired labour, oxen, or tractor.
 - 6) Resource availability and use; land and labor available to farmers, level of cash used on farmers for input purchase, for food purchase, labour peaks.
 - 7) The alternative uses and approximate levels of the main outputs.
 - 8) System trends, i.e., what is changing and why.
- C) Resource constraints: Farmers have limited resources (land, labour, cash) to meet their priority needs in the face of basic constraints and must employ these each season. The team must reach a decision on:
- 1. Which resource(s) are presently limiting system performance and the farmers' ability to meet their needs? (It will either be land and cash or labour and cash. Cash can augment either land or labour).
 - 2. What management strategies have farmers taken up to use these limiting resources as fully as possible, or to satisfy needs despite the limitations? (May include off-farm work, craft work, charcoal production, beer brewing)
- D) Technical compromises: How have management practices in the face of basic constraints (B) and resource limitations (C) resulted in husbandry which falls short of 'good technical practice'?
- E) List and rank the production constraints, especially technical shortcomings that limit production of the major enterprises identified.
- F) As much as possible clearly define problems, establish causes, and identify system interactions if any.
- G) Technical opportunities: What research results can we bring to bear on these 'husbandry gaps' which look as though they will improve

performance, but which also will help farmers manage basic constraints more effectively and will not exceed farmers' resource capabilities? A list only but related to each of the husbandry gaps described in (D).

The system overview need not be a written piece but should be made up of lists and short specifications in note form.

GUIDELINES FOR EXPLORATORY SURVEY

During the diagnosis we are interested in describing and understanding the current production system. By combining this information with the current production technology available for the farmers, one may be able to identify the potential research opportunities. During the diagnostic phase we are interested in the following aspects. This list could be used as a checklist during our discussions with farmers:

A. INTERPRISE PATTERN AND SYSTEM TRENDS

- Crops and livestock kept by most farmers
- Varieties grown (for each enterprise)
- Changing patterns; year to year variation
- Rough estimate of each

B. DETAILED MANAGEMENT PRACTICES OF CROPS

We should know the current detailed management practices followed by the farmers in order to come up with potential improvements in management. We would like to know the following for the major crop enterprises:

- Decision about growing a crop (including location)
- Land preparation: method, sequence, starting time, special arrangements with farmers
- Planting: time, method, sequence if intercropped or mixed cropped, spatial arrangement
- Variety used (reasons, check)
- Stand establishment: visual assessment and probing, pure vs mixed or intercropped
- Weeding: Timing, frequency, method, implement used, types of weeds
- Thinning: Time, use of thinned plants
- Soil fertility management:

Organic fertilizer: price, availability, method of application.

Inorganic fertilizer: amount applied, time, method of placement, frequency.

- Pests and Diseases: type, stage of occurrence, control measure (visual assessment)
- Harvesting: time, method
- Seed selection and preservation
- End use of the products: consumption, sale, location of sale, price, storage methods used.

If any of these is suspected to be a potential problem area then get more detailed information.

C. LIVESTOCK: Cattle

- Herd composition, breeds
- Breeding: age, method, calving interval, calving time
- Calf management: feeding, health, weaning, etc.
- Feed and feeding: Feeding regime, feed shortage, access to water
- Disease and disease control: common diseases, control measures, etc.
- Housing
- Milk production; number of milkings, length, amount of milk
- Use of livestock products: draft power, manure disposal, milk sale, sale of animals, etc.

We can follow similar investigations for other species, too.

D. TREES ON FARM

Growing of trees in the farms is another aspect about which we may need some information.

- Types of trees grown, uses
- Fuel wood: source, availability, etc
- Use of tree products
- Benefits of tree crops as assessed by farmers

E. ENTERPRISE CALENDAR, FOOD PREFERENCE, FOOD CALENDAR

Enterprise Calendar

- Timing of operation for each plot, each enterprise, and each planting (reasons)
- Establish busiest period(s)

Food Purchase and Food Calendar

- Main dishes used and availability
- Substitute dishes used, timing, availability
- New foods if any
- Food purchases, major items, prices, months of purchase

F. RESOURCE ASSESSMENT

Land

- Availability, special land for special crop rotation practices (plot specific)

Labour

- Availability, busiest periods, sources of additional labour modes of payment

Cash

- Sources of cash income, need for cash in farming, availability for farm operation, source of credit, availability, mode of payment or cost.

Purchased inputs

- Item, price availability

Since there is no substitute for experience at the early stages one could use the detailed guidelines given in the next section to facilitate the exploratory survey.

DETAILED GUIDELINES FOR EXPLORATORY SURVEY DISCUSSIONS WITH FARMER AND AGRONOMIC ASSESSMENT

Note: DO NOT USE THESE GUIDELINES AS A QUESTIONNAIRE

These guidelines are useful during discussions with farmers. Each set contains questions that may require from one to two or more hours on the farm.

In the course of the exploratory survey three or four farmers may be asked each set of questions. The researcher may feel clear and confident about responses to some question sets after talking to only two farmers; other sets may require discussions with five or six farmers. After a set of questions has been discussed with two farmers, detailed notes in the same number format as the guidelines should be written up. Information gaps for that set can be filled by questioning other farmers.

It is useful to decide on several specific introductory questions to establish that the new farmer is indeed in the target group being investigated. The questions should refer to some key characteristics of the target group.

Further to discussion with the farmer the productivity of the farm should be evaluated against an acceptable yield potential for the area.

An agronomic assessment of the farmer's field is to identify problems that might not have been mentioned by the farmer during the discussion and to help verify problem areas identified by the farmer. A useful understanding of researchable problems can only occur when discussions with farmers and an agronomic or biological assessment are considered together.

In any evaluation, a standard by which the performance of a crop can be judged must be determined. A reference crop should be a crop that will produce an acceptable yield given the environmental constraints of the area. This standard will be likely to vary from area to area and year to year. Background data, especially climatic data, can be useful. The best managed or highest yielding field in the area may be considered an appropriate standard. In some instances, a crop in the experiment station might also provide a useful basis for field evaluations. Examples: if farmers in the area generally produce 1 t/ha of maize, and the experiment station yields in the area are 9 t/ha, and the best farmers are obtaining 5 t/ha, we might use the best farmer crop or a 5 t crop in determining why average yields are low (what is the difference between the good and the average fields?). This comparison will enable the biological scientists to identify the current management practices that underexploit the full biological potential of the enterprise under consideration.

SET A

These questions help describe the farming system through the enterprise pattern and use of products within it, and help identify recent changes in the relative importance of the enterprises. Questions (1) and (2) are preliminaries for all respondents.

Enterprise pattern and system trends

- 1) List the crops grown and livestock kept by local farmers. Note whether each enterprise is carried out by most or just a few farmers and, if only a few, what is special about them.
- 2) For each major crop, list the varieties grown, making it clear whether each farmer grows more than one variety or some grow one and others another.
- 3) Changing patterns:
 - a) Note crop varieties or livestock that used to be widespread among farmers in the area but are now

disappearing. Assess why these enterprises are declining.

- b) Note crop varieties or livestock that have recently become increasingly widespread. Assess why these enterprises are expanding.

Based on visual observations and discussion, the team should be able to identify the major enterprises in the production system. Detailed information is collected for the enterprises identified.

SET B

These questions seek to detail the compromises on production practices and timing of activities on crop enterprises that have been identified as points of leverage on the farming system.

1. How does the farmer decide where to plant a crop?
What factors are considered in making the decision?
2. Land preparation:
 - a) What is the method of land preparation?
 - b) When does land preparation start in relation to the start of rains and to planting time?
 - c) What sequence of work is involved if there is more than one operation?
 - d) How does the farmer work? Is a whole field prepared before planting, or a portion of the field prepared and planted the same day?
 - e) What is the final form of the seedbed?
 - f) Are there alternative methods of land preparation? If yes, what are they, and why are they used?
3. Planting:
 - a) How are the plants of the main crop arranged in the field? (i.e., number of plants per station, spacings). Random counting field measurements should be made.
 - b) If other crops are mixed with the main crop, it is important to describe the sequence in which the crops are planted in the fields.
 - c) How do the farmers plant in relation to rainfall (i.e., dry planting before the rains, the same day

of rainfall, within a certain period after the rains begin)?

- d) Do farmers make one or several plantings of the crop each season?
- e) Do farmers commonly replant their main crop?
- f) What is the method of putting seed in the ground, and how many seeds are planted per hole?

4. Variety:

- a) Is the variety used recommended?
- b) Does it have adequate yield potential for the area?
 - a) Does it lodge?
 - b) Is it susceptible to common diseases?
 - c) Will it respond to input or changes in management?
 - d) What is the storage quality of the variety?
 - e) Are there any other desirable features that make growing this variety worthwhile?

5. Stand establishment:

- a) Is the stand efficiently utilizing incoming radiation? At flowering the soil should be completely shaded. In small grains a complete ground cover is expected by the end of tillering.
- b) Are the recommended plant density and spacing being followed?

If plant numbers are adequate but complete ground cover is not achieved then poor plant growth is probably related to other factors, such as moisture or nutrients.

- c) If stand establishment is inadequate then consider the following:
 - i. Is the correct amount of seed being sown - are the farmers using the recommended rates?
 - ii. If yes, was the seed viable?
 - iii. Was the depth of seeding and method of incorporation appropriate?

iv. Was crusting or waterlogging a problem at the time of emergence?

1. Does the soil have a high silt content?
2. Was the crop seeded dry?
3. Are the soils heavy and do they drain slowly?

v. Were there diseases or insects affecting the seed or seeding?

d) Is the stand density too high?

i. A low number of tillers in small grains due to interplant competition.

ii. Maize plants are spindly and prone to severe lodging.

6. Weeding and thinning:

Weed competition can reduce tillering, plant height, and yield, but only in severe cases plant stand. Whenever a visit is made the following should be noted:

- a) Weed density (% ground cover of the weed).
- b) Types of problem weeds (annual, perennial, broad- or narrow-leaved).
- c) Height of the weed relative to the crops.
- d) Remember competition by weeds before flowering is much more damaging than competition after flowering.
- e) Any time weeds are the same size as the crop for two or more weeks, or if weeds are taller than knee high at flowering (given a relatively high density), then weed competition should be considered a serious problem.
- f) When prioritizing problems, remember that a serious weed problem will cause nutrient deficiencies in crops, and the efficiency of applied fertilizers will be seriously reduced.
- g) What implement or implements are used for weeding and what pattern of work is followed among the plants in the ground?

- h) How soon after planting is the first weeding done? Does the timing vary with conditions? If so, how much and under which conditions?
- i) How many weedings will be done? Will this vary with the date of planting, weather, or the soil in the field?
- j) Do they thin the plants either in the row or from each planting hole? If so, what age or stage? Do they use the thinnings for cattle feed?

7. Diseases and insects:

- a) What diseases and insects are present?
- b) What percentage of the plants is affected?
- c) For foliar pests, - what percentage of the leaf area is affected, what percentage of the top 20% of the leaf area is affected? Damage to younger leaves will usually reduce yield more than damage to the lower leaves.
- d) Is the root system well formed, and disease and insect free?
- e) What is the timing and control method for major pests/diseases?
- f) Assessment of proportion of local farmers using pest/disease control.

8. Soil fertility:

Moisture stress often masks any symptoms of nutrient deficiency. If moisture was not deficient (are there vigorous crops in the area or on the experiment stations) look for the following:

- a) Is nitrogen limiting? N deficiency is characterized by poor plant growth, light green leaves, and firing or premature death of lower leaves.
- b) Is phosphorous a problem? P deficiencies cause poor plant growth and lack of vigor, low tiller numbers, and short plant height (compare to an acceptable standard). Leaves may be darker green than normal. Purpling can occur in maize but be careful of variety effects. Rarely does a purple color occur in small grains.

- c) Use of fertilisers/manures:
 - i. Type of fertiliser/manure and source?
 - ii. Usual rate, method, and time of application?
 - iii. Assessment of proportion of local farmers using fertiliser/ manure?
 - iv. Price and availability?
- 9. Moisture stress:
 - a) Are the plants suffering from lack of moisture? Maize leaves curl, become onion-leaf like, plants are shortened, and tillering reduced (depending on the stage of development).
 - b) Was the crop planted at an appropriate time for optimum water use?
 - c) Are the plants frequently subject to excess water? Plants grown in waterlogged areas tend to be yellow and have very shallow root systems.
- 10. Use of leaves, plant tops, and stalks for feeding cattle.
 - a) Proportion of local farmers following this practices?
 - b) Method of feeding animals?
 - c) For leaves indicate the number of pickings made and the number of leaves taken.
 - d) For plant tops indicate the stage of plant growth when the top is taken. Is this a critical time for cattle feed?
- 11. Method and timing of harvesting and storing:
 - a) At what stage does harvesting begin?
 - b) What method is followed in picking and shelling the crop and disposing of stover and other crop residues?
 - c) How is the crop stored? (i.e., is it dried? are preservatives used?)
- 12. Seed selection and preservation:

- a) Do farmers usually select seed in the field or from their stored harvest? If from storage, when is it selected?
 - b) What criteria do local farmers use when they choose the next year's seed from their own crop?
 - c) Do they process and preserve the chosen seed in a special way?
13. Is the crop treated in any way, either while in the field or in the household?
- Are there resources used in growing the crop in a way not covered here?
14. What items are usually purchased for each enterprise (seed, fertilizer, herbicide, insecticide, fungicide, hired labour, or machinery, etc.)?
- i. Source of purchase
 - ii. Quantity purchased, price paid
 - iii. Year purchase started for each crop
15. For the major crop varieties and animals, list the end uses to which they are put. In the case of crop varieties this includes the fruit and any other part of the plant used as a by-product. Animal products and by-products are equally important.
16. For each identified end use, detail the sequence from field preparation through harvesting, storage, processing, and use. Include when, the product is taken during the life-cycle of the plant or animal.
17. If marketed, then:
- a) Source, location of sale
 - b) Form in which produce is sold
 - c) Quantity sold
 - d) price received by the farmers
 - e) Problems in marketing

If livestock (cattle) is a major enterprise then follow the line of question indicated in SET C. If not, obtain some general information about livestock in the system and proceed to set D.

SET C LIVESTOCK (cattle)

These questions seek to detail the compromises in production methods and the timing of production activities in livestock enterprises that have been identified as points of leverage on the farming system.

1. Livestock ownership:
 - a) Herd size
 - b) Ownership (self/on loan/held in trust/others)
 - c) Herd composition according to species, breed, and class (sex and age)
 - d) How are their animals acquired (breeding, gift, loan, purchase)?

2. Breeding:
 - a) Age/weight at first mating
 - b) Systems of mating (seasonal vs continuous)
 - c) Methods of mating (uncontrolled/controlled mating)
 - d) Use of artificial insemination - if not, why; if yes, potential advantage
 - e) Average calf crop over the past five years; and last year
 - f) Weaning percentage (of the total cows calved, what is the proportion that raised calves to weaning)?
 - g) Average calving interval (in months)
 - h) Culling due to old age (hence total number of calves per lifetime)

3.
 - a) Which month of the year do the animals usually calve?
 - b) Is it the same month every year?
If not, on what does the month of calving depend?
 - c) Does calving at this time cause any problems:
(i) with the calves? (ii) with the mothers?
 - d) What period of the year is preferred to have calves?
 - e) What benefits would this bring:
(i) to the calves? (ii) to the mothers?
 - f) Is any control exercised over the time when cows are selected?

4. Discuss with the farmer the calving history of the animals. To try to elicit for one or two animals:

- a) Age at first calving
 - b) Number of calves born:
 - (i) Died as calves
 - (ii) Survived
 - (iii) Disposition of survivors
 - c) Calving interval
5. Calf management:
- a) Management of calf immediately after birth to some few weeks of age (identification, weighing, health and hygiene, colostrum feeding, whole milk feeding).
 - b) Bulk feeding of the calves prior to weaning (starting age, methods of feeding and whether concentrates, hay and fodder are provided)
 - c) Age of weaning (any early weaning practices)
 - d) Post-weaning management practices, including ways to counter post-weaning checks on growth.
6. How are the calves reared?
- a) What access do they have to their mother?
 - b) Up to what age do they continue to suckle?
 - c) Is any special food or treatment given to encourage weaning?
 - d) Do the calves run with the herd?
 - e) Do farmers rear male calves?
 - f) If not, how are they disposed off? And at what age?
 - g) If reared, at what age are they normally disposed of?
7. Milk production:
- a) Who milks the animals?
 - b) Number of milkings per day?
 - c) Average number of milking cows during the wet and dry season?

- d) Average milk yield per day during the wet and dry season?
 - e) Milk consumption pattern during the year (home consumption, sold; fed to calves, etc.)?
 - f) What period of the year are animals dry and are they all dry together? How do they maintain a continuous supply of milk to the household?
8. Feeds and feeding:
- a) Livestock feeding during the wet season:
 - i. Availability of pastures
 - ii. Control on grazing areas communal vs individual
 - iii. Distance to grazing areas
 - iv. Time spent on grazing per day (hours)
 - b) Grazing management (continuous vs rotational grazing or deferred rotational grazing system)
 - c) Feeding of livestock during the dry season:
 - i. Feeds used during this period (standing hay, conserved forage, straws, stovers, legume residues, concentrates, by-products after processing, etc.).
 - ii. Distance to grazing areas
 - iii. Time spent on grazing per day (hours)
 - iv. Control on grazing areas (e.g., grazing of harvested fields)
 - d) Feeding regimes:

Is feeding practiced according to age/sex categories, production status, or reproduction status (pregnant/dry cows, breeding bulls, etc.)?
 - e) Most difficult months for feeding the animals
 - f) Feeding priority within the herd
 - g) Fodder grasses in the system:
 - i. Do farmers grow fodder crops?

- ii. If yes, which one (Bana grass, Napier, etc.)?
- iii. If not, why?
- iv. Do farmers feed animals on any tree or shrub leaves? or seeds?
- v. If yes, which ones?

9. Watering:

- a) Sources of water for livestock (drinking, dipping, or spraying)
- b) Whether the sources are seasonal or permanent
- c) Distance to watering points
- d) Frequency of watering (how often animals are taken to water in the wet/dry season)
- e) Control of water use

10. Diseases and disease control:

- a) Common livestock diseases in the area
- b) Main causes of livestock deaths in the herd over the last five years and last year
- c) Routine disease control measures taken in the area in the herd (dipping, deworming, vaccinations)
- d) Who is responsible for control of livestock diseases in the area (whether extension personnel, private or parastatal organizations)
- e) Do farmers have their animals vaccinated?
- f) If yes, against what disease?
- g) If not, why?
- h) Do farmers dip or spray their livestock?
- i) If yes, which species and age class? How often? At what cost per herd?
- j) If not, why?
- k) 10 (d) should include what treatment? For which disease? Do farmers have access to veterinary services? If yes, at what terms?

11. Housing, farm structures, and equipment:
 - a) Housing/kraaling of calves (whether housed throughout or not at particular times)
 - b) Housing of adult animals (kraaling or night paddocking); and if animals are housed/kraaled/paddocked according to age and/or sex groups
 - c) Farm structures specifically meant for livestock (crushes, milking parlors or shelters, feed storage structures, etc.)
 - d) Equipment for livestock management (eartags, tattooing machines, weighing scales, branding iron, dehorner, handsprays, wheelbarrows or carts, etc.)
12. Livestock husbandry practices (specify seasonal variation):
 - a) Who herds the animals during the day?
 - i. Are the animals herded together or is the herd split up?
 - ii. Is there any communal herding?
 - b) Who decides where animals will go to graze at various times of the year?
 - c) How are the animals housed at night? Are they all together?
13.
 - a) Has the farmer had any animals die over the last year?
 - b) What are the main causes of death among farmers' animals?
 - c) Is there anything done to prevent unwanted death?
 - d) If animals are ill, can the farmer take steps to treat them?
14. Draught power:
 - a) Use of animals for draft purposes
 - b) Species used (donkeys, mules, cattle, etc.)
 - c) Operations performed by draft animals (e.g. tillage, haulage, etc.)

15. Manure:

- a) Uses of livestock manure (manuring, biogas production, building, etc.)
- b) How the manure is handled prior to application (including mixing with other materials or already mixed in stall, e.g. with bedding, feed leftovers)
- c) Whether manure is stored prior to application (site and methods)
- d) Is the night shelter a reasonable site for storing manure without too much loss of quality?
- e) At what time of the year is the manure moved out of the night shelter?

16. Disposal:

- a) Main ways of disposing of animals
- b) Who is responsible in deciding when and which animals are to be disposed?
- c) Disposals over the past two years, type and channel of disposal
- d) Number of animals disposed last year
- e) Are some categories of animals difficult to sell?

17. Marketing:

- a) Sales of live animals
- b) Categories of animals sold and reasons for selling certain categories and not others
- c) Where animals are sold and average price per head
- d) Sale of milk products (cream, butter, ghee, etc.)
- e) Sale of meat and by-products, such as skins and hides, blood and bones (processing into livestock feeds and other uses, specify)

18. What other farm animals are kept in the farm? Assess their importance in the production system.

SET D TREES ON FARM

1. Trees grown/found on farm:

a) State number of different trees species on the farm. How many of these have been deliberately planted?

b) Fill out table (using by each type of spatial arrangement) (x) Spatial arrangement: fuel: sawwood: poles: fruit: fodder

Scattered trees
Boundary plantings
Woodlot

c) Specify which, if any, trees or tree products are sold. Elicit price and estimate annual income.

2. Effects on crops:

How do the trees on the farm affect the agricultural crops? Probe for farmer's explanation (e.g., shade, below-ground competition, increased soil fertility, etc.)

EFFECT ON CROP	TREES*	EXPLANATION
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Negative

Neutral

Positive

3. Fuel wood (direct questions to women):

a) Does the farm always produce enough fuel wood to meet need?

b) Does the household ever purchase fuel wood? If so, what is the source (e.g., other farms, market)? Estimate expenditure per week or month (annual total).

c) Are any other fuels used (e.g., crop residues, dung, paraffin)?

d) If fuel is collected off at the farm, estimate distance of source and time spent in collection.

e) What are the major tree species used for fuel wood? (Use local names if common or scientific names unknown.)

4. Shelter and soil conservation:
 - a) Does the farmer consider wind damage to crops to be a problem?
 - b) Is there evidence of soil erosion on the farm? (Discuss with farmer and explain.)

5. Farmer's assessment of tree needs:

Does the farmer or other household member perceive a need for more trees on farm? If so, why have they not been planted, (probe for attitudes and constraints), and what type do they desire?

SET E ENTERPRISE CALENDAR, FOOD PREFERENCES AND FOOD CALENDAR

Questions to further describe the farming system through specification of the enterprise and food calendars and food preferences.

1. For each planting of main crop(s) establish the usual time of seedbed preparation and usual time of planting.
 - a) Assess the major reasons why local farmers use different varieties, and, if relevant, plant them at different times.
 - b) Determine reasons for varied planting of the crops (if appropriate).
 - c) Identify the latest possible time for a variable planting, i.e., when does expected yield justify the enterprise?
2. For each crop variety, establish the usual time for direct harvest for the use from the field (if appropriate) and the usual time of final harvest.
3. For each livestock type, establish:
 - a) The usual timing of births
 - b) The usual milk producing and dry periods
 - c) Any special time when meat is consumed
4. Detail the main dishes eaten by the farm families in the area. Include preferred constituent and the preferred state of each constituent.
5. What substitute dishes are eaten when preferred foods are not available?

6. Identify whether any new foods are becoming popular and replacing traditional ones. Assess why old foods are losing popularity and why new ones are gaining popularity.
7. For which crops is the loss of output in a season most serious for the farm family? Identify the critical ones.
8. For each crop variety a certain level of output is expected for each crop:
 - a) What is the lowest output the farmer remembers?
 - b) What year was this?
 - c) What factors caused that low output at the time?
 - d) Can other factors also strongly influence output?
 - e) How soon in the season can the farmer tell output will be poor?
 - f) When this is noticed, what action is taken to look for other sources of food/cash?
 - g) If output is poor - for example in the year mentioned - how does the farmer manage for food/cash?
9. For each major crop, the size of the area planted was estimated:
 - a) Does this area change much from year to year?
 - b) Which year was the smallest area the farmer planted?
 - c) Why was the area small that year?
 - d) Which year did the farmer plant a lot more area than usual?
 - e) Why was the area planted larger that year?
10. Are there main foods that are purchased by families all the year round or at certain periods?
11. Are there main foods that have to be purchased at certain periods in poor years? If so, indicate for each food:
 - a) How frequent does this occur?

- b) What is the reason?
 - c) When did this occur last for most families in the area?
12. What are the prices on the major foods just before and just after the main harvest?
13. Food preferences and shortages:
- a) What are the main preferred starchy staples in the area?
 - b) Do you face any shortages of these major starch staples? If yes, during what months of the year?
 - c) What are the substitute starches used by the farmers? Are these readily available? If facing shortages, during what months of the year?
 - d) What are the main relishes consumed by the farmers? Are these readily available? If facing shortages, during what months of the year?
 - e) Does the farmers use any substitute relishes? What are they? During what months of the year do they use them?

SET F RESOURCE ASSESSMENT

These questions prompt for information on the types of constraints on land, labour, and cash and also on how they may hinder expansion of the system.

- A) Land, labour, and cash:
1. Can the farmer get more land for crops if it is felt to be necessary?
 - a) How would more land be obtained?
 - b) Would it be near or far away from the village?
 2. Will all the crops grown do well on all of the farmer's land?
 3. Are the same crops grown in the same place year after year? If not, what rules are used to move to different fields?

4. Some questions about the farmer's household:
 - a) How many people are there in the family?
 - b) How many work on the farm?
 - i. Full time?
 - ii. Part time?
 - c) Which work on which crops is done only by:
 - i. Men?
 - ii. Women?
 - iii. Children?
 - d) Are there special responsibilities for:
 - i. Water?
 - ii. Fuel?
 - iii. Cattle herding and feeding?
5.
 - a) Which are the busiest months of the year for farming in the area?
 - b) What work is going on at this time and on which enterprise?
 - c) Is there another busy period?
 - d) What main work goes on at that time?
 - e) Are these the two busiest periods every year? If not, how do the circumstances change?
6.
 - a) Is labour hired during the year?
 - i. Permanent
 - ii. Casual
 - iii. Customary
 - b) When and for what work is casual or customary labour used?
 - c) Do other farmers in the area hire labour during the year? Are their reasons the same as this farmer's?
 - d) Mode of payment for hired labour
7.
 - a) Is any machinery used during the year?

- b) If so, what crop/operation is it mainly used for and at what time of the year is it used (hired)?
 - c) Do neighbours use machinery?
Are their reasons the same?
8. What do the farmers in the area do for cash income?
9. Do many families have members working off the farm?
- a) Permanently - what are the locations and types of work?
 - b) Temporarily - What kind of work is temporarily taken up?
 - c) Is it taken up at this time because opportunities arise or farmers need cash?
10. What is the most difficult period of the year for cash for local families?
- Is it because income is scarce or expenses are very high? If expenses are high, what are the major items requiring cash?
11. Obtain rough estimates for each enterprise:
- a) The number of fields devoted to it
 - b) The total area involved
 - c) The output the farmer would usually expect from this commitment

B) Soil physical properties:

An understanding of soil physical properties can help us understand why low yield potential is to be expected from an area. It can also help identify management problems and characterize sources of variation within a given recommendation domain.

Items to evaluate:

- 1. Soil depth, particularly if it is less than 1 m.
- 2. Soil texture - silty soils tend to crust, sandy soils retain little moisture, and clay soils may have drainage problems and are often difficult to cultivate.

A simple hand method to quickly determine soil texture is adequate.

3. Soil compaction - Are there layers that are impervious to plant roots? A soil pit to determine rooting depth helps to identify compaction problems. A typical crop plant should be able to extract nutrients and moisture well below 1 m.
4. Color - Color can be a basis for characterizing soil variability within an area. Waterlogged areas can be identified by grayish color.

KEY INFORMANT SURVEY

In key informant surveys, individuals knowledgeable about certain subjects or topics are asked to supply information.

The key informant survey differs from a regular survey in that the person interviewed does not answer questions about himself but about the subject in which he is an expert or has a very good knowledge. A knowledgeable farmer, for example, describes the farming practices followed by the farmers in his area but does not describe his own farm. If they are carefully carried out, key informant surveys can provide a large amount of high quality, quantified information quickly and at low cost. Only a few individuals at any given site need to be interviewed.

The quality of the data can be verified by interviewing two key informants about the same subject. The answers of the two informants can be compared. In most cases all the answers should be fairly close. In those cases where differences in answers occurs, people can be questioned again to get the right information.

If during a key informant interview it becomes obvious that the selected person is not knowledgeable enough to answer the questions, the interview can be terminated tactfully and another more knowledgeable individual may be selected as a key informant.

Depending on the nature of the information needed, one could interview any of the following persons: experienced farmers, shopkeepers and merchants, the local extension agent, local village administrators, school teacher, mid-wives, farmers who hold position of traditional leadership, input suppliers, or the leader of a farmer group or association.

If one needs information on about farming practices a farmer may be selected as a key informant. One should consider the following factors in selecting a farmer as a key informant:

1. The farmer must have lived and farmed in the village/area for a number of years.
2. The farmer must be the one making decisions in his/her household.
3. The farmer must be actually engaged in farming.
4. The farmer must be knowledgeable about other farms in the area.
5. The farmer should be above average in education and intelligence.

6. The farmer should be cooperative.

If the farmer is chosen by the local extension agent he or she may not be a representative farmer. On many occasions, because of their past relationship, the extension staff often think that researchers are trying to evaluate their activities. Thus often progressive farmers are selected.

Some general information about the village may be obtained from local village administrators. Questions related to aggregate or overall characteristics of the village are particularly appropriate in this kind of survey. Any record that is kept at this office should be obtained. One could obtain the following information:

- total land available
- land types
- land area committed for cropping
- communal grazing
- forests
- number of household
- marketing days
- marketing location
- communal activities
- extension services, etc.

This initial contact with local administrators will enable the researchers to better explain the purpose of the research and facilitate future cooperation.

An extension agent can provide information such as common growing seasons, crops grown under different types of land, input source, supply price, transport facilities, etc. They can also provide an overall impression of the characteristics of the village and the problems facing the farmers.

In some cases it is also possible to get some biased answers. Being the government representative at the grassroots level they might give official views about the issue; sometimes they may even interpret the questioning as evaluating the efficiency of their administration. Thus, though a considerable amount of information could be obtained by key informant interview one has to be very careful in assessing the information obtained.

GROUP INTERVIEW TECHNIQUE

Group interviews are useful for tapping the collective wisdom or memory of a community. controversial issues or issues which are not very clear from the informal survey could be used as topics or themes for group interview. There is no need to have a formulated question or statement but the researchers should have a clear idea of the issue that they would like to get resolved. They should be able to guide or direct the discussion but not restrict it. This needs some special skill. The farmers should be encouraged to talk openly about the issue under discussion. The group interview is ideal for:

- a) questions that relate to phenomena which uniformly affect all farmers
- b) good for controversial issues or questions, where farmers gave different answers

This is an efficient process to collect information. However, it is very difficult to conduct a very successful group interview due to:

1. Group composition - may not be representative of one target group i.e., top farmers and bottom farmers.
2. Dominating individuals within the group. Difficult to draw out opinion from other people.
3. Difficult to organize them
4. Cultural constraints

Young farmers may hesitate to contradict their elders. Wives may not like to contradict their husbands.

Thus very often the group may come out with consensus and variations may be ignored. If the researcher is aware of the problem this situation could be handled. Do not let one farmer to dominate. Best to orient conversation about what most people in the village/area do instead of what individuals do.

FORMAL SURVEY OBJECTIVES AND STEPS INVOLVED

Definition: A formal survey is one that uses:

- a) A standardized or structured questionnaire and
- b) A random sample of farmers;
- c) Enumerators are often used to administer the survey.

The formal survey is different from traditional farm management surveys in that it does not focus on the whole complexity of the system but concentrates on the specific problem areas and issues identified during the informal survey.

Purpose

Formal verification surveys are carried out with the help of a structured questionnaire to see whether the understanding gained and the hypotheses developed during the informal survey with selected farmers are indeed true for the whole target group. Here, a uniform set of data is obtained from a large number of farmers who are representative of the target group.

Specific Objectives

1. To verify the information obtained from the informal survey, i.e., the description and understanding of the farming system.
2. To test the hypotheses developed. Target grouping and the priority given to a particular problem(s) may be adjusted.
3. To obtain additional information about the priority problem(s) identified.
4. To quantify certain parameters, know the limitations (for example, the labour profile)
5. To enhance credibility.
6. To assist in the better design and interpretation of OFE:
 - timing of operations
 - identify experimental and nonexperimental variables
 - develop evaluation criteria, etc.
7. To test farmers' opinions and attitudes about proposed technologies or technological components.

8. To identify cooperating farmers for OFE.

Steps Involved

1. Questionnaire development - content, format, organization
2. Questionnaire translation
3. Sampling
4. Recruitment and training of enumerators
5. Field testing of questionnaire (pre-testing)
6. Questionnaire revision
7. Actual implementation of the field survey
8. Analysis, interpretation, and completion of survey report.
 - identifying and prioritizing critical constraints/problems
 - identifying possible interventions

QUESTIONNAIRE DEVELOPMENT

In a formal survey, a questionnaire is the principal instrument used to obtain information from respondents. An interview is a conversation with a purpose. In a face-to-face formal interview, there are three interacting components: the interviewer, the questionnaire, and the respondent. A well-designed and administered questionnaire will greatly assist in the realizing of the goals/objectives of the survey.

The questionnaire consists of sheets of paper containing a list of questions. The answers from the data, which subsequently analyzed. The aim is to collect a standard set of data from a number of farmers. Questions therefore need to be clear, consistent, and unambiguous.

Content

Content refers to all that is contained in a questionnaire. The content of the formal survey questionnaire is dictated by the informal survey. The formal verification survey does not deal with the whole system, but deals with the major problem areas identified during the informal survey. Therefore, the content needs to be very selective. The exploratory survey provides background information on the area including the geographical, physical, technical, as well as the socioeconomic information about the area and the target group. Such information eliminates the chances of asking irrelevant questions.

The content of the questionnaire is:

1. Specific for each survey
2. Unique for the target group under consideration
3. Dictated by the informal survey

Development of questionnaire content

1. Identify the priority crops and problem areas.
2. Identify the main issues related to these crops and problem areas.
3. List the information needed to resolve the issues. Use the objectives of the verification survey as a guide to list this information, keeping in mind how the data are going to be used.

4. The researcher should know beforehand the type of tabulation and analysis to be made to make sure all necessary items are included.

Note: If the researcher is not certain how he/she will analyze a piece of data and how that analysis relates to the specific objectives, then the information should not be collected.

Format

The questionnaire's format is the way the questions are formulated and laid out in the questionnaire. Some general guidelines for formatting include:

A. General Layout

1. Title page:
 - Title
 - Respondent's name*
 - Name of the evaluator
 - Name of the village
 - Location
 - Date
 - Starting time: Ending time:
 - Name of the organization carrying out the survey
 - Serial number of the questionnaire
 - *Sometimes each respondent is given a code number. It is advisable to copy this code number onto the top right-hand corner of each page.
2. Each page of the questionnaire should be numbered. Each page should also bear the serial number of the questionnaire.
3. Sequence of questions (rules for organization)
 - screening questions
 - general to specific
 - simple to complex
 - maintain a logical flow
 - early questions help elaborate later ones
 - opinion questions - re: specific management problems
 - sensitive questions - yield, income, disposition of crops, amount of land owned, etc.
4. Number of questions.
5. Group the questions and introduce each section.

6. Language of the questionnaire: use the language common in that area. The interviewer must be well versed in the language of the respondents. Great care needs to be taken to ensure that the substance of the questions is not distorted in the process of translation.
7. Instructions for interviewers should be set out very clearly and in bold print.

B. Format of Individual Questions

Before discussing the format of the individual questions it is necessary to distinguish the different types of questions.

a) Questions of fact vs questions of opinion

Factual questions seek to elicit facts, such as dates, quantities, etc.

Opinion questions are less specific and seek the respondent's opinion.

Opinion questions are sometimes called 'subjective' questions; for example, "What do you think is the best variety of maize/sorghum for yields, storage, and drought resistance?"

b) Closed vs open questions

In closed question, the responses are predetermined and included in the questionnaire. (see examples below.)

Advantages of closed questions:

1. Easy to analyze
2. Channels answers

Disadvantages:

1. May lose information
2. Lack of flexibility, i.e., the question limits the options
3. Requires thorough advance knowledge of the system.

In an open question the respondent gives a response which is not predetermined but recorded by the interviewer. Given these types of

questions, one can identify four formats used in asking individual questions.

- i. parallel question - The same format is repeated over and over again. For example:
"During last year, did you purchase any:

"Fertilizer	Y/N
"Seed	Y/N
"Herbicide	Y/N"

- ii. Open-ended questions

"Why do you keep cattle?"

- iii. Closed questions

Why do you keep cattle?
(Tick answers)

1. Milk
2. Meat
3. Prestige
4. Marriage
5. Draft
6. Manure
7. Other (describe).....

- iv. Tabular format

Here, the information required is constructed in a tabular form. This saves space, greatly reducing the length of the questionnaire, but requires some additional special care.

One may need additional information or footnotes to guide the administration of the questions. Provide codes, instructions, and definitions (e.g., multiple planting-time). Provide these items on the same page as the table.

- c) Wording of questions

Wording should be simple, clear, explicit, and easily understood by the enumerator as well as the respondent. The question should be carefully worded to communicate the exact meaning of the enquiry. For example, in an area where rainfall is bimodal and there are two cropping seasons, one asks a question: "How much sorghum did you harvest last year?" In this case the farmer may give two possible answers. Depending on the season, both

are reasonable. This confusion could be avoided by asking two specific questions instead of one:

"How much sorghum did you harvest during last (year's) short rain season?"

"How much sorghum did you harvest during the last (year's) long rain (ratoon!!)"

In wording questions, avoid:

1. Overlapping answers

Example: Did you use an ox plough and hoe to weed your maize plot?

During the 1986/87 wet season did you operate a farm and were you engaged in non farm work?

Better wording:

Did you use an ox plough to weed your maize plot?

Did you use a hoe to weed your maize plot?

2. Use of vague terms

"Often", "frequently" and similar adjectives do not have the same meaning to everyone and should be avoided.

Example: How often did you weed your maize plot last season?

Better wording:

During the last cropping season, how many times did you weed your maize plot?

3. Multiple questions

Each question should focus on a single point

Example: Did you grow maize and groundnuts in your farm?

Better wording:

Did you grow maize in your farm?

Did you grow groundnuts in your farm?

4 Technical terms

Agricultural jargon and other technical terms may be unfamiliar to farmers. Use descriptive phrase or explain the technical terms or use farmers' terminology.

Example: During the last cropping season did you apply basal fertilizer to your local maize?

Better wording: Did you apply fertilizer before planting the local maize seeds in your maize plot?

5. Specific about times and locations

Farmers do not follow the same practices every season. Accurate information can only be obtained with time-specific questions?

Did you plant R201 during the 1986/87 short season?

6. Be specific about the unit of observation but be able to translate it into standard terms.

Farmers also operate more than one plot of land. Their information should be collected on a parcel basis.

7. Try to split aggregate data in order to obtain more accurate information.

8. Avoid asking leading questions?

Do you use recommended spacing in planting your hybrid maize?

Organization:

The subject matter areas and questions in these subject areas should be ordered as to:

- Make administration of the questionnaire easy, ensuring that the interview flows smoothly.
- Capture and maintain the interest and participation of the respondents. Questions should appear logical to the respondents and facilitate conformity with the data processing and analysis scheme.

1. Subjects to be covered during the interview must be grouped into sections that focus on a single topic, such as questions about land tenure, marketing, or input use.
2. Sequence of sections.

Each section must be placed to facilitate the introduction of the next section. The general plan can be:

- a) Set according to functional organization, i.e., activities (weeding, fertilizer application).
- b) Set according to the structural organization of the farms, i.e., by enterprise.

Usually some middle position is adopted.

3. Ordering of questions in each section.
 - a) Each new section should have an introduction
 - b) As far as possible, proceed from general to particular and from simple to complex.
 - c) Ask about recent events first
 - d) In ordering the questions a time and subject matter sequence should be observed. If there is a conflict and both cannot be accommodated then retain the subject matter sequence.
 - e) It is useful to request more familiar information first, followed by less familiar data such as prices of produce at a different location or sale point. Ask what is the price at the local sale point before asking the urban market price.
 - f) Make sure that all questions are pertinent to the study and that there are no unnecessary repetitions.
 - g) All touchy questions should be put near the end of the schedule.
 - h) Cross-check questions should be used to detect the accuracy of the information on the spot.
 - i) Enough space should be provided for all answers and margins should be left for making remarks or notes.

QUESTIONNAIRE TRANSLATION

Questionnaires are usually formulated in English. When implementing the questionnaire, enumerators ask the questions in the native language spoken by the farmers. Therefore, to make sure we are getting accurate information, it is often desirable to translate these questions into the farmers' native language. All questions should be worded to give the same meaning as the original ones and should also be worded in the way the questions would be asked. In order to do a good job of translation one should be very familiar with local idioms and terminology.

Some tend to believe that the questions can be left in English and that the enumerator can translate them instantaneously. Experience suggests that it is highly unlikely that we will get identical and accurate information from different enumerators/schedule even though we are seeking the same information.

Examples where poor translation gave incorrect information:
(English -> Native -> English)

1. Malawi:

Original question: How old are your children?

Translation: How big are your children

The farmer started showing their height.

2. Kenya (done by the trainees):

Original question: Q.1 What did you do with the crop residue after harvest?

Translation: What did you do with the stover that you harvested after harvesting?

Q.2 Did you apply fertilizer to your wheat this year?

Translation: You are using fertilizer this year for planting wheat?

These are good examples to illustrate the need for translating questionnaires, especially if the survey is done by the enumerators. If the survey is done by the researchers themselves (as in Malawi) then we may be able to skip this step. The enumerators can be involved in translating all questions, and if necessary they should be pre-tested.

SAMPLING

If the characteristics of all members of a population were exactly the same, there would be no need to worry about sampling procedure. We would only need to select one individual to identify the population's characteristics.

However, the diversity of our biological, social and economic environment requires that we sample several members of the population for evaluation before any conclusions can be drawn.

Purpose of sampling: Is to select a subset of the population that has the same characteristics as the whole group or is representative of the population.

Population: The term "population" refers to all of the elements (such as farms, households) from which the sample is actually selected.

Samples: A representative portion of the population under study. Due to resource limitations (time and cost) it is not feasible to study or sample the entire population. Sampling minimizes the survey cost and at the same time enables us to make some valid generalization about the target group (gives credibility).

Sampling methods: There are several different ways of drawing samples. It is not our intention to discuss all of them here. We shall discuss the most common methods used by the researchers in this continent. The sampling methods can be classified under two broad categories:

1. Probability samples
2. Nonprobability samples

Probability sample: Is the term used to describe the various ways of drawing a sample that the probability of a particular individual being included in the survey is known or can be established with reasonable precision. The advantages of probability sampling are:

1. Risk of sampling bias is minimized
2. It is possible to draw inferences for the populations with levels of confidence that could be estimated statistically

Nonprobability sample: Used when the probability sampling is not practical.

A. Probability sampling methods

1. Simple random sampling

A random sample procedure insures that each respondent has an equal chance of being selected. It is applicable if the population is homogeneous (which it rarely is). The word 'random' refers to the process of selection, not to the properties of the sample.

Steps include:

- a) Define the population
- b) Prepare a list of the population
- c) Each member of the population is assigned a serial number
- d) Determine the sample size
- e) Selection is made using a random number table - a predetermined number is selected.

Advantages:

1. It is easy to implement.
2. It is appropriate if the population is concentrated in a single area.
3. Each member of the population has the same probability of being chosen.

Disadvantages:

1. It is often difficult to obtain a population list.
 2. The selected units may be geographically dispersed and therefore expensive to reach.
 3. When the population characteristics are quite variable, estimates are imprecise.
 4. If the population is not truly homogenous it may affect the representativeness.
2. Systematic sampling

Here every k^{th} unit from the sampling frame is chosen. The sampling interval $K = N/n$ rounded to the nearest whole number, where N is the total number in the population being sampled and n is the required sample size.

Advantage:

It is easier and quicker than random sampling.

Disadvantage:

If the sampling frame is not in random order, especially if there are periodic irregularities in the list, systematic sampling can lead to biases.

3. Stratified random sampling

Here an heterogeneous population is first divided into mutually exclusive homogeneous subgroups, then a simple random sample is selected from each group.

Once the population list is obtained, names are classified into various groups according to the predetermined criteria or known characteristics, such as type of land, size of farm, source of water, access to draft power, etc. Once the groups are formed, random or systematic sampling can be used to collect the required subsamples from each stratum or group.

This method is more efficient than simple random or systematic sampling in the sense that the selected sample is more likely to be representative of the population from which it was drawn. The differences within a group are small, but differences between groups are relatively large.

Advantages:

- a) It is easy to carry out.
- b) It guarantees that there are enough cases in each major group or state, and is very effective because the nonrepresentative farms (extreme values) can be put into a separate group.
- c) It increases the precision of the statistical estimates by minimizing the variability within strata.
- d) Useful in getting more information from the entire population.

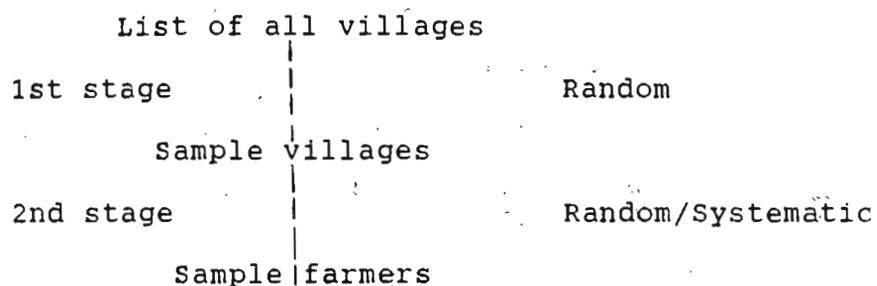
Disadvantage:

1. Prior knowledge about the population is necessary for meaningful stratification.

4. Multistage sampling

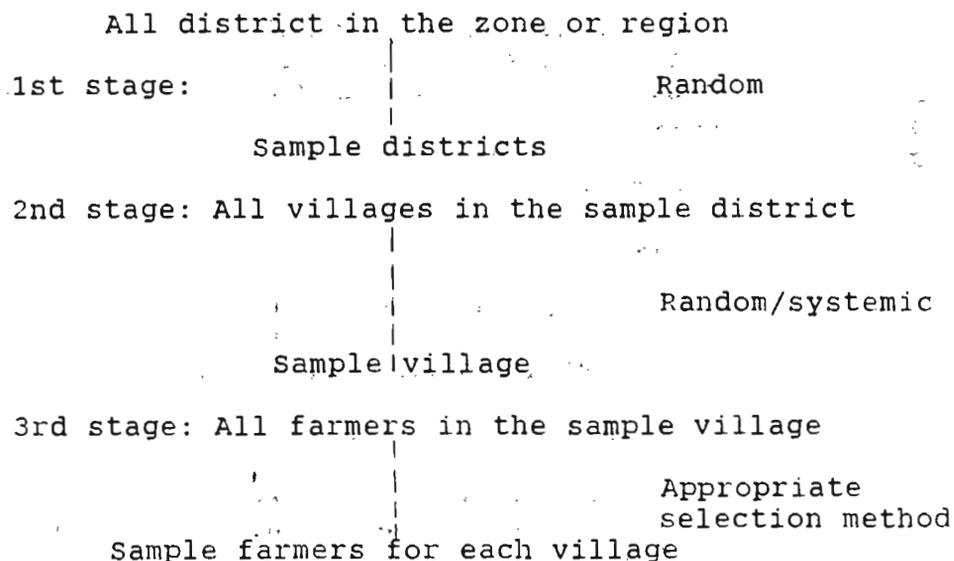
This sampling method combines several of the procedures discussed earlier. Normally two or three steps are involved:

- a) Two-stage sampling: To select a sample from a group of villages



A list of farmers within each of the sampled villages is used to draw the sample of farmers for that village

- b) Three-stage sampling: To select a sample group of farmers from a zone or region



Advantages:

1. When based on geographical units, multistage sampling can lead to a substantial savings in travelling time and cost.
2. It is not necessary to have a complete sampling frame.

It is possible to build the sampling frame as the process of sampling proceeds.

Disadvantages:

1. The procedure is rather complex.
2. It is difficult to generalize the estimates to the population.

5. Cluster sampling

Cluster sampling is a special case of multistage sampling. The population is first divided into groups or clusters of elementary units. Then a sample of cluster is drawn by random or systematic sampling.

Second, all the individuals in the sample cluster are included in the survey. In order for cluster sampling to be of low variance, we need heterogenous elements within each group. In cluster sampling we are talking about geographical concentration.

Advantages:

1. Reduces travelling time and costs.
2. A full sampling frame is not required.

Disadvantage:

1. The sample drawn is likely to be less representative of the population than, for example, a simple random sampling.

6. Section sampling

All farms in the area are grouped into sections. Each section consists of two, three, or four neighbouring farmers who can be interviewed by an enumerator in one day. These sections are used as "units of sampling". This is a modification of cluster sampling.

Advantages:

1. This technique meets all the necessary requirement of random sampling.
2. It improves the speed of the survey.
3. It saves travelling, and reduces cost, difficulty, and hazards of field work.

Practical problems leading to nonrandom sampling:

1. Lack of frames from which to sample
2. Lack of funds
3. Problems of substituting farms due to nonresponse
4. Problem of accessibility

Nonprobabilistic sampling methods:

1. Accidental sampling:

Sample those individuals who happen to come along. The risk of bias is very obvious (lazy, part-time, non-representative, etc.)

2. Purposive sampling (judgement sampling):

This is the deliberate selection of a sample by the researcher to obtain a representative cross-section of the population. Samples are drawn to represent/illustrate some particular characteristics in the population. For example, in studying a new technology which is not widely adopted (a new variety), only those individuals known to have adopted the new method might be sampled.

3. Quota sampling:

Quota sampling is used when stratified sampling is desired but a list of population units in each strata is not available. The enumerator visits farmers and asks screening questions to determine which stratum each farmer belongs to.

Quotas are established for different groups in the population. Sampling proceeds using either 1) accidental or purposive sampling until the required number of individuals to fill each quota has been obtained, or 2) random or systematic

sampling to fill the required quotas, in which case quota sampling becomes a special form of stratified sampling.

In actual practice, one is free to use a combination of these approaches.

Major practical considerations in sampling

1. Defining the sampling unit
2. Obtaining the sampling frame
3. Determining the sampling method
4. Determining the sample size

Defining the sampling unit

The choice of sampling unit depends on the purpose of the study. OFR/FSP usually focuses on farm families. However, clear identification of characteristics of the sampling unit or farm family under investigation is very important.

Obtaining the sampling frame

The major restriction to the use of probabilistic sampling is the sampling frame. Developing a proper frame and drawing a reliable sample is probably one of the greatest difficulties in data collection in rural areas. It is often unlikely that you will find a "perfectly complete" sampling frame at the level of the primary sampling unit.

All available sampling frames must be evaluated to determine which is most appropriate. At the village level several possibilities may exist and the researcher must evaluate each and determine its adequacies or inadequacies. Examples are: extension agent list, club membership list, irrigation parcel, voters list, cooperative membership list, credit union list, and ten cell lists.

It is important that the researcher should be aware of the biases that characterize his or her sampling frame before using it. In the final analysis selecting a sampling frame is a compromise. The researcher must weigh the magnitude of the biases that will be introduced by using a better population list. If you are using an available list make sure they are up to date and all sampling units as you define them are included.

If the sampling frame is not available then one has to make a list. Under such circumstances use a multi stage sampling.

Determining the sampling methods

Choice of sampling methods depends on:

- a) Objective of the survey
- b) Nature of the research problems
- c) Available population list
- d) Logistical problems of field work
- e) Time and money available
- f) Common sense

Examples

1. Interested in average values and distribution of values for a variable in one small village - simple random sampling.
2. Interested in estimating the value for the whole province - cluster sampling.
3. If we are interested in comparing the values between two different technologies - or distinguishing groups - stratified sampling.
4. Population lists do not exist, but are interested in making inter-group comparison - quota sampling.
5. Financial resources are limited but the research goal is simply to generate hypotheses a non random sampling.
6. Interested in a scientific sampling over a large area - cluster sampling.

Determining sample size

The sample size is determined by:

1. Variability of local farm conditions
2. Degree of precision required
3. Available time and money
4. Type of data handling facility
5. Available trained personnel
6. Details and complexity of the questionnaire

Statistical formulas are available to estimate the sample size, but such guides are often academic. As a rough guide, the conventional wisdom suggest that we need a minimum of 20-25 cases in each of the major sample categories in order to make comparisons between the groups. For our purposes a final sample size of 40 is usually sufficient for meaningful statistical analysis in a homogeneous group of farmers. Normally we select about 50 farmers so that we may eventually end up with 40 (non representative, substitution). If the sample size is smaller then it may cause some problems in testing hypotheses.

Substitution may be necessary in a survey because:

1. The source list may be wrong or out-of-date and consequently it may be impossible to find all farms in the same list.
2. Rural roads and bridges are impassable during the rainy season so that it may be difficult to reach a particular farm that is listed.
3. The selected farmer may not belong to our target group.

It is important to make sure that the substitute farmer is in the same category group and possesses the same characteristics as the farmer originally chosen for interview.

Note:

1. Designing the sample and organizing the logistics of field work are often complementary.
2. Be pragmatic in your approach.
3. Knowledge of the area and subjective judgement of the researchers are also crucial in selecting villages and samples.
4. Use the simplest procedure that will permit the achievement of the research goal. A simple method takes less time and less money for implementation.

Remember it is a false economy to use a procedure which is simple to implement but does not permit the researchers to make statistically valid generalizations about the target population.

5. Make sure that you are aware of the limitations of each approach. Use your own random technique but be aware of possible biases.

6. It is probably best to avoid local extension workers in selecting farmers. Biased selection of farmers would lead to biased answers and conclusions.
7. Accessibility also should be given due consideration in sampling.
8. As much as possible cover all the areas of the target group.
9. Statistical feasibility and practical feasibility often conflicts.
10. Under no circumstances should the researcher choose a sample larger than the financial and personnel resources can justify.
11. Sample design and field work preparation are complementary.

SELECTING ENUMERATORS

Enumerators are needed to administer surveys in which standard questionnaires are used to gather a uniform set of data from a preselected sample of farmers. The success of any survey largely depends on the enumerators. A good schedule and good subsequent analysis and presentation cannot compensate for mistakes made by enumerators. Enumerator selection and training has a definite influence on the quality of the survey.

Based on our experience, we have observed four possible sources of enumerators:

1. Evaluation unit or farm management unit enumerators - presumably trained in data collection.
2. Researchers themselves as enumerators - fewer problems of nonsampling error.
3. Use of local extension staff - important to get them involved at the very early stages.
4. New recruits - require much supervision and attention.

Considerations in enumerator selection

1. Personality:
 - a) Enumerators need to have a friendly, outgoing personality.
 - b) They must have a habit of working hard and travelling under unfavourable weather and transport conditions.
 - c) They must be patient, tactful, open-minded and sympathetic towards the farmer's problems.
 - d) Since no two farmers are the same, the enumerators need some flexibility.
2. Local knowledge:
 - a) The enumerators must have some knowledge of farming and must know the locality fairly well. They must have general knowledge of local farm conditions and practices.
 - b) They should be familiar with local idioms, units of measurement, etc.
 - c) They should be familiar with the local customary laws and the culture of the target group.

- d) Enumerators should be fluent in the local language. This makes the respondent more confident in expressing himself, especially when he/she has had limited formal education.
3. Enumerators should have sufficient education to:
- a) Do simple arithmetic calculations.
 - b) Make some measurements on the farm.
 - c) Be able to complete the questionnaire without difficulty.
 - d) Be able to extract the elements relevant for a particular question, especially when the respondent is not specific or to the point. If the respondent does not provide the answer required one has to use other ways of asking the same questions without changing the meaning.
4. Enumerators must be absolutely honest and motivated to do the job. Poorly motivated enumerators either quit the survey halfway or even attempt to falsify the data.
5. Racial and ethnic background is relevant in some societies based on historical development. Enumerators from the same ethnic group may find it easier to adopt the "right" language and to use the local customs in approaching the farmer.
6. Age and sex of the enumerators depends on the survey objectives and the culture of the target group.

ENUMERATOR TRAINING

Training the enumerator is another key step in formal surveys. The enumerator must know thoroughly how to use the questionnaire so that he/she makes no mistakes. The idea is to produce a team of enumerators who administer the questionnaire uniformly without biasing the results. One could provide two types of training:

1. Office training
2. On the job-training - go out into the field and interview a few farmers under the personal supervision of the researcher or an experienced person. This may be done at the pretesting stage. Ideally the training should include classroom sessions as well as field sessions. During the training, one should assist the enumerators to create their own field books.

Training objectives/purposes: There are three major objectives in training enumerators:

1. To provide an orientation
2. To instruct in the business of interviewing
3. To familiarize them with the questionnaire.

A. Orientation: Should provide the following:

1. Provide orientation about the purpose of the research and the objectives of the survey. Explain what a survey is.
2. Provide an orientation to the area and farming system being studied:
 - possibly a tour of the area
 - social and institutional structure including the local authorities.
3. Orientation to the concepts and terminologies used, i.e., define survey terms (farming system, target group, sample, etc.).
4. Orientation to the organization's field work:
 - sampling procedure, i.e., how villages and farmers have been chosen
 - number of farmers/villages or area
 - logistical support

- timetable for interviews
- person to be interviewed: decision maker, divided responsibility in farming
- mode of payment, timing, support, etc.

B. Business of interviewing: Tell enumerator to remember that the farmer is the important person in the process.

1. Introduction:
 - Greet the farmer in the local way.
 - Introduce himself/herself, name, area of origin, present job, etc.
 - Explain the purpose of the visit - objectives of the survey.
2. Confidentiality - Assure the respondent of the confidentiality of the information obtained.
3. Say how and why the respondent has been chosen.
4. Place and timing of the interview - when it is most convenient to the farmer (normally at the end of harvest.
5. How to ask questions:
 - give farmer plenty of time, do not rush
 - try to avoid asking stupid questions, and especially avoid asking questions already answered
 - try to keep farmer on track - tactfully
 - record the relevant, specific answers; do not write down everything
 - take care not to suggest answers
 - be tolerant if the farmer does not understand: rephrase the question and give time to respond
 - be alert for inconsistent answers and try to check on them.

6. Duration of the interview - maximum one-and-a half hours. The actual amount of time spent for each interview depends on the capability of the enumerator and the intelligence, concentration span, and cooperation of the farmer.
- 7 Termination of the interview - at the end make sure you thank the respondent for the time spent and his/her willingness to provide the information. Before leaving the respondent, the enumerator should check the questionnaire to see whether all the questions have been asked and answered objectively and correctly.
8. Missing respondents or uncooperative respondent - must be replaced

C. Familiarization of Questionnaire:

It is important to make sure that the enumerator understands all the questions that are being asked. Enumerators should have clear and consistent views on what information is needed, interpretation of questions, how they should be asked, and how and where to record the answers.

The best way to do this is to use the enumerator and the trainer. Use the professionals to interpret the intention of the questions and the type of answer expected. The enumerator then phrases the question in local language. You could ask the participants to comment on the translation. The trainer can then provide hypothetical answer and request the enumerator to record it. As you go through the questionnaire ask the enumerators to create their own field books to assist them during the survey.

While elaborating the questionnaire concentrate on six things:

1. Translation - local idioms and phrases. Make sure that all enumerators are using the same term.
2. Handling tables - explain the instructions at the bottom of the table.
3. Types of measurement - local units and methods. Also translate into commonly used units, so that there is an understanding of equivalence.

4. Difficult areas:
 - a) labour use details
 - b) yield data
 - c) farm size and crop acreage
 - d) subjective questions
5. Internal consistency - check. This also should be tested while pretesting. Make sure that you explain each question, including its purpose, explain any measurements to be made, etc.
6. This should be another check of the questionnaire. If it is difficult to train an enumerator on a specific item, you may have to change, rephrase, or drop the item.

PRETESTING THE QUESTIONNAIRE

No matter how well a questionnaire is drafted, there is always some doubt about its adaptability to the actual target group under consideration. It is possible that some items listed in the schedule are irrelevant to local conditions; that some items of particular importance in the area are overlooked; or that questions are not worded in the familiar fashion and are not perfectly understood by farmers. Pretesting the questionnaire will help to identify these problems; to include those items which are missing and to delete those found irrelevant and redundant, thereby revising the question, the format, or instructions on the use of the schedule.

Pretesting the questionnaire is simply a minisurvey to:

- evaluate the validity of the question
- evaluate the structure of the questionnaire
- develop the precoded response categories in the questionnaire, i.e., testing the data instrument

Specific objectives of pretesting:

1. To see whether the sequence followed is the best to obtain the maximum farmer cooperation.
 - one section should automatically lead into another section
 - adequacy of introduction to new sections
 - early questions:
 - simple to answer
 - help establish rapport with the farmer
 - should build the farmer's confidence
 - grouping of subject matter
2. To determine which questions are not easily understood by the enumerators and/or farmers. The questions should be explicit and clearly understood with no ambiguity. Very often farmers do have difficulties in understanding questions because of:
 - a) poor translation
 - b) unfamiliar terms
 - c) illogical ordering

d) complicated constructions

The questions for which:

- the enumerator got the same answers
- the farmers could not answer
- the answer indicated that the farmer did not understand the question
- that took considerable time to answer

Needs scrutiny - often rephrasing the question will remedy the problem.

3. To check whether the format of the question is OK. If the format is adequate the enumerators should be able to fill in the answers directly without any difficulty. Notes and calculations on the margin are a clear indication of a poorly developed questionnaire.
4. To check whether there are adverse reactions from the farmers to any foreseen or unforeseen sensitive questions.
5. To check for logical consistency (internal).
6. To test the training and understanding of the enumerators. This will provide an opportunity for the researcher to identify whether the enumerators are likely to encounter any problems in administering the questionnaire. The researcher could identify gaps in the enumerator's experience and provide additional training to fill the gaps that might have been caused by inadequate training.
7. To identify the irrelevant questions.
8. To identify the missing information.
9. To estimate the time requirements for the interview.
10. To pretest the tabulation set up of tables.
11. To test the adequacy of precoding. This will enable the researcher to find out whether he/she has all possible answers.

Who does the pre-testing:

Only experienced enumerators are capable of observing problems that the respondents might have in answering the question. Usually, pretesting is done by the researcher

using already trained enumerators. Occasionally, training of enumerators is combined with pretesting the questionnaire.

The researcher should note down questions where problems arise and note which questions are misunderstood by the enumerator and/or the farmer.

Where should pretesting be done:

For pretesting to be very effective, farmers typical of the target population must be interviewed.

Note:

1. A pretest must be made in all target agroclimatic areas where the survey will be conducted.
2. The farmers interviewed must have the same socioeconomic characteristics as the target population.
3. The pretest should also permit us to identify translation problems that arise from differences in the dialect spoken by the translators and the target population.

Summary

Based on the problems encountered and the experience gained, the questionnaire should be revised. Once the research team is satisfied with the questionnaire, the final version can be prepared and duplicated for the actual survey.

The researcher has to balance time and funds to avoid spending too much of them before the actual survey. It is important to note, however, that pretesting a questionnaire saves time and money in the long run.

When all corrections are made based on pretesting, the questionnaire is mass produced to be used in the survey.

FIELD IMPLEMENTATION OF SURVEY OR
QUESTIONNAIRE ADMINISTRATION

This deals with the data collection process.

Preparation of the survey:

1. Questionnaire completed, translated, and pretested
2. Enumerators recruited and trained
3. The administrators and local leaders should be informed
4. The target group should be generally informed about the exercise
5. Develop a cordial relationship with the enumerators so that they can freely discuss the problems
6. Prepare a schedule for interview and make sure that logistical arrangements are OK

In administering a questionnaire, the researcher will be the main administrator and the enumerator will be the implementor. The accuracy of the information obtained depends on many factors:

1. a well-prepared questionnaire
2. the training of the enumerators
3. tactfulness of the enumerator
4. respondent's ability to understand the question
5. respondent's willingness to supply the desired information.
6. respondent's recall ability
7. congenial relationship between the farmer and the enumerator
8. effective field supervision
9. adequacy of field preparation

We shall concentrate on five problem areas:

1. obtaining cooperation from the village leaders
2. obtaining cooperation from the farmers
3. scheduling and designing field work

4. supervising the enumerator
5. special problems in field implementation
1. Obtaining cooperation from village leaders:
 - Strangers may be treated with a great deal of suspicion and curiosity.
 - It may be necessary to get approval from the local officials - depends on the country.
 - Inform village leaders
 - a) nature and purpose of survey
 - b) make it clear that the information is used for research only and will not be made available to government officials, the tax officer, etc.
 - c) introduce the proposed research schedule.

2. Obtain cooperation from the village farmers:

Farmer cooperation is vital to get true answers and can be influenced by several factors.

- a) Village orientation, i.e., researchers' knowledge of the village and farming situation before beginning the interview increases their sensitivity and understanding of the problems faced by the farmers and their local customs.
- b) Farmers' beliefs about the purpose of the research (stress that information is confidential).
- c) The time the interview is conducted
 - should be conducted at the farmers' convenience
 - best time is when there is little agricultural work in progress
 - always make sure that you arrive at the agreed time
- d) The enumerator's behaviour:

The quality of the answer given is also influenced by the respondent's feelings towards the

interviewer. Should try to maintain a good relationship with the sample farmers as well as the others.

e) Incentive payment:

This aspect is of questionable value for obtaining reliable information.

If the enumerator discovers during the course of the interview that the respondent is giving false answers, then there may be a need for probing. During probing, do not suggest or hint at the answer, and make sure that you do not annoy the respondent. Instead, repeat the question within its framework but using your own words so that the respondent is willing to give an answer that is more correct.

3. Supervision of Enumerators

- very important
- unless errors are identified and corrected at the early stage, they will be repeated throughout the survey; (useless data, re-interviewing each respondent).

Attention must be paid to both methodological and logistical details

Methodological details

Supervision of the enumerators is considered vital for many reasons.

1. To re-emphasize the difficult aspects of the questionnaire.
2. To assist in handling problems, such as refusal to answer.
3. Checking the questionnaire for errors, omissions, and illegal answer. do not leave any space blank.
4. To provide moral support.
5. To ensure that the enumerator is actually interviewing the farmers.
6. To ensure that the enumerator's relationship with farmers is good.
7. To collect the completed questionnaire:

- Whenever problems and errors are observed, immediately explain and instruct the enumerator how to avoid repeating the mistake.
- A careful review also encourages the enumerator to be more careful in recording the data.

Logistical support:

- an adequate supply of questionnaires
- an adequate supply of pencils, papers, and other special items
- good means of transport
- pay enumerators at regular or predetermined intervals
- make sure that they are getting the basic living facilities

Visiting the interviewer frequently will not only improve the quality of data collected, but also increase the supervisor's knowledge of the local farming area.

The questionnaire is the most important tool in any survey; therefore great care must be taken to see that it is filled in correctly and fully. As soon as possible after leaving the respondent, the enumerator should go through the questionnaire for incomplete answers. It is very important to have all the blank spaces filled in and to leave no question unanswered.

The researcher should develop a program to follow up and confirm whether the enumerator has done the job or not. The supervisor should collect the completed questionnaire as soon as possible, ideally on the same day. Problems can then be identified and corrected early.

Field work design

Many factors which can influence the design of field work.

1. Sample size and geographical distribution
2. Number of enumerators
3. Time required for each interview
4. Number of farmers interviewed per day
5. Number of supervisor/researchers available

6. Total number of days available to complete the survey and prepare the subsequent survey report.
7. Accommodation and transport
8. Total fund available to complete the survey

Field work should be arranged in such a way that the enumerators have sufficient time to complete the number of interviews assigned. The work should be planned so that the researcher/supervisor can move around freely to spend sufficient time supervising the enumerators. It will be even better if the researcher can carry out one or two interviews with the enumerator.

It is important for the enumerator to know the location of the farmers selected. Otherwise time and resources can be wasted looking for various farms. Farm visits should be scheduled in such a way that farmers will not be waiting a considerable amount of time for the enumerator to turn up. If the scheduling has been poorly organized, there is a danger that farmers may be present in groups. This can obstruct the farmer being interviewed, as some visitors might answer or suggest and answer before the person being interviewed replies. Farmers may listen to the first farmer being interviewed and repeat the same answer. Avoid keeping farmers waiting while the other farmer is being interviewed.

Special problems in field implementation

1. Rewording a question - paraphrasing the question in their own words (read the questions as they are written).
2. Question order - may bias farmers' answers.
3. Speeding the interview - accuracy rather than speed is the primary objective. Make sure that each interview takes approximately the same amount of time by instructing the enumerator, using a starting and finishing time on the first page of the questionnaire. Interviewers should never be paid according to the number of schedules completed.
4. Inappropriate respondent (sampling unit):
 - selected the wrong person during sampling. In such cases the interview should be terminated and a replacement selected. Termination of an interview is very difficult. Be diplomatic and natural.
5. Refusals: After being contacted the respondent may refuse to be interviewed.

Reasons for refusal:

- farmer may not be clear about the objective
- interviewer was disrespectful
- previous bad experience with some enumerators or researchers

Every effort must be made to explain things to the farmer. If the attempt of the supervisor fails then select another respondent. If the farmer is forced to cooperate by village leaders, the quality of the interview will be poor.

6. Missing respondents: The most critical nonresponse problem arises when the interviewer cannot locate the selected farmers.

- If the farmer is not available interviewer should never complete the interview by asking the questions of any available person.
- Attempts should be made to find out about his/her future availability (date and time).
- Failing that, logistical problems may dictate finding a replacement. This is one of the reasons for having a larger sample size than needed.

SOURCES OF INACCURACY IN FARM SURVEYS

1. Inadequate details in collected data to do the job.
2. Sampling error.
3. Nonsampling error or enumeration bias.

Causes of Nonsampling error

1. Respondent does not have the information asked for but provides an answer in an effort to save face or to be helpful.

Source: 1) Type of information required is simply not known in the study area, i.e., measurement of area, weights, income.

 2) Divided responsibilities in decision making result in respondent not knowing the answer.

2. Respondent claims that he/she does not have the information or deliberately misleads.

Source: 1) Mistrust of survey objective.

 2) Fear that sensitive personal information may be known to the community.

 3) Noncooperative attitude, feels survey is a waste of time.

3. Respondent has forgotten the event or cannot recall the details with accuracy.

Source: 1) Time lag.

 2) Information not well registered or difficult to register.

 3) Respondent was not directly involved in the event.

 4) Respondent has a poor memory (for example, of harvest, labour, expenditure, etc.).

 5) Respondent is tired, distracted, or in a hurry during interview.

4. Enumerator asking the question improperly, thus missing the focus.

- Source: 1) Enumerator is inadequately trained in content and use of interview form.
- 2) Language problem between researcher and enumerator or enumerator and farmer.
- 3) Interview form is inadequate (not sufficiently explicit, not properly translated).
- 4) Enumerator may be tired, in a hurry, or just sloppy.
5. Enumerator does not ask the question at all.

- Source: 1) Interview is not done due to enumerator absence, disability, transport problem, or dishonesty.
- 2) Question is obviously redundant or unreasonable so he does not want to embarrass himself or annoy the respondent.
- 3) Enumerator expects a particular answer on the basis of earlier responses patterns, thus records it without confirmation.

6. Respondent misinterprets the question.

- Source: 1) Questions are inadequately translated into local idioms.
- 2) Question too complex and confusing.
- 3) Respondent is relatively dull or sick.
- 4) Enumerator conducting interview too rapidly.
- 5) The respondent is tired, distracted or in a hurry.

7. The enumerator misunderstands the response.

- Source: 1) Lack of fluency in the local language.
- 2) Enumerator unfamiliar with survey area and research problems.
- 3) Enumerator is rushed or distracted.

8. Questions and responses identify quite unintended information.
- Source:
- 1) Insufficient understanding of local institutions and idioms.
 - 2) Failure to ask supplemental questions to confirm the information, e.g., crop sales.
9. Enumerator misrecords information on the questionnaire.
- Source:
- 1) Confusing layout of the interview schedule - entry points not clearly delimited, ordering not uniform, type, unit, number, etc.
 - 2) If the interview schedule is precoded, enumerator is confused in the use of codes.
 - 3) Inconsistent assignment of codes for the same item among different interview forms.
 - 4) Poor quality of duplication of the schedule.
 - 5) Use of conventions not familiar to enumerator, e.g., decimal points.
 - 6) Inadequate enumerator training.
 - 7) Enumerator is rushed or careless.
10. Completed schedules are damaged or lost.
- Source:
- 1) Pencil entries smear (using soft lead).
 - 2) Paper falls out of schedule.
 - 3) Schedule booklet lost in travel between interview sites.
 - 4) Completed schedule left with the enumerator too long.
 - 5) Theft.
 - 6) Enumerator holds data as a 'hostage' in salary 'negotiations'.
 - 7) Not enough support, i.g., raincoats, umbrellas, etc.

11. Errors introduced in converting from local units into units required for analysis.

Source: 1) Necessary equipment is not available, e.g., scales, tape measures.

2) Lack of competence in the use of measuring equipment.

3) Respondents may not permit measurements, e.g. of harvest weight.

12. Errors in summarizing and transferring data.

1) Clerical error - copying data onto code sheets.

2) Computational errors - introduced when aggregating data. Errors from preparing data for computer processing.

Source: 1) Poor quality of initial entry.

2) Damaged forms.

3) Poor arithmetic skills of field or office personnel.

4) Confusing schedule layout.

5) Inattentive or sloppy work of office personnel.

Most of these nonsampling errors could be minimized through adequate training of enumerators and close supervision of the field survey.

FARM SURVEY TECHNIQUES FOR LESS-DEVELOPED AREAS

CONCEPTUALISATION		RECALL	
Type of Data	Method of Investigation	Type of Data	
GOOD -		-GOOD	
market prices		-inventory of title land	
inventory of title land		-inventory of major permanent crops	
inventory of major permanent crops	'single-shot'	-yield of cash crops with limited-period harvest	
inventory of livestock	questionnaire		
yield of cash crops		-market prices of cash crops	
yield of major subsistence crop (rice)		-yield of major subsistence crop (rice)	
area under major subsistence crop (rice)	BOUNDARY (1)	-area under major subsistence crop (rice)	
inventory of minor permanent crops (e.g. fruit)	single-period investigation (questionnaire plus observation)	-inventory of minor permanent crops (e.g. fruit)	
inventory of (uncropped) non-title land	BOUNDARY (2)	-inventory of (uncropped) non-title land	
labour input to major activities	periodic reporting	-yield of cash crops with continuous harvests (especially rubber)	
labour input to minor (routine) activities	BOUNDARY (3)	-labour input to minor (routine) activities	
yield of minor crops (fruit, maize, vegetables, etc.)	periodic observation and measurement	-yield of minor crops	
inventory of minor crops		-inventory of minor crops	
yield of jungle produce		-yield of jungle produce	
food consumption rates		-food consumption rates	
POOR		POOR	

items appearing lower on recall spectrum than on conceptualisation spectrum: the appropriate method of investigation for these is that indicated by their position on the recall spectrum.

DATA ANALYSIS AND PRESENTATION

By the time a survey is completed we have some information or observations (both qualitative and quantitative) that are unorganized. Before a data set can be used for decision making the data should be summarized, analysed, and the pertinent information extracted. Data analysis and presentation is an important step in the diagnostic process. Data should be analysed and presented within the shortest time possible and used to plan on-farm experimentation.

We shall briefly discuss data preparation, methods of data analysis, common methods of data presentation, and common analytical (statistical) tools or techniques used in analysing survey data.

Need for data analysis

1. To summarize the data collected from the respondents.
2. To interpret the data collected and to derive some meaningful conclusions or inferences.
3. To present the data in a way that communicates the results of the study successfully.

Types of data

In order to make the data analysis efficient and easier to use, it is useful to differentiate the various types of data collected.

- Cardinal values, i.e., quantitative measures
- Ordinal values, i.e., qualitative measures
- Verbal or descriptive answers
- Yes and no answers
- Dates (e.g., timing of operations)

Each type of data should be handled differently in preparing for the analysis.

Methods of data analysis

The method of data analysis should be decided upon during the planning stages of the formal survey. Important considerations are the size of the sample, length of the questionnaire, and time and resources available. One could use any one of the following methods.

1. Simple tabulation

- a) Tabulating from questionnaires:
Questionnaires are grouped by target group. For each variable, frequencies or averages are

calculated by hand calculator. This is done separately for each target group.

- b) **Tabular sheets:**
Using large sheets of lined paper, transfer data from questionnaires. Questionnaires are also grouped according to target group for ease of comparison.

Advantages are that the method is simple to learn, quick, and the researcher develops a feel for the data. Disadvantages are that the method is time consuming with large samples and unsuitable for complex analysis.

2. Sorting strips and cards

This method is more sophisticated than tabular sheets. The strip or card holds only one row of data for one farmer. The strips/cards can be arranged for columns to coincide for all farmers or target groups. One advantage of this method is that strips/cards can be reordered to place farmers in different groups or subgroups. The method is also fairly easy and quick though it is unsuitable for complex analysis.

3. Computers

This method involves use of microcomputers or larger main frame computers. Depending on presurvey design the following steps may be necessary:

- a) postcode data
- b) transfer data to data sheets
- c) punch data into terminal, cards, or tape
- d) apply statistical programme

If a precoded questionnaire is used, data can be entered directly from the questionnaire onto the computer, cards, or tape.

The advantages of computer analysis are:

- a) easier handling of large data sets
- b) capability for complex analysis
- c) access to diverse range of analytical techniques

Some important disadvantages are:

- a) needs expertise and experience
- b) computers are expensive
- c) computers are unreliable where spares, power sources, and service facilities are poor
- d) a suitable statistical programme may not be available

Computer analysis may be desirable when:

- a) the sample size is more than 100, or if you get above a 3000 cell matrix.
- b) the study area is rather complex and the analysis requires a large number of cross-tabulations.

The choice basically depends on the availability of computer and technical skill. Irrespective of the method used, the data must be prepared for analysis.

Preparation of data for analysis

The first step in data preparation is coding. Coding consists of assigning a symbol (code - usually a number) to a response. During coding all important information from the questionnaire has to be transferred onto coding sheets. Coding data is usually done by preparing a so-called 'code book'.

We need to code information

- a) Because the easiest way to collect information from farmers is to use worded questions and worded answers but it is difficult and cumbersome to analyse worded answers directly.
- b) For analysis we need to organise information not in terms of questions and answers but in terms of variables and numbers.
- c) to go from worded questions and answers to variables and numbers we need to code the data. We need to transform the answers of the respondent into a standard form that matches the questions formulated in the questionnaire.

When do we code the information

- a) We can precode our questions so that we make the transformation from worded answers to numerical data as we administer the questionnaire.
- b) Or we can postcode the worded answers that we have recorded after we get the questionnaires back into the office.

Some information does not need pre- or postcoding (information that is given in numerical form, such as area of land cropped or quantity of bags of fertiliser purchased).

Should we precode or postcode?

There are advantages and disadvantages to either:

	<u>Advantages</u>	<u>Disadvantages</u>
Precoding	<ol style="list-style-type: none"> 1. Simplifies subsequent tabulation and analysis 2. Reduces time taken to create code book after survey 	<ol style="list-style-type: none"> 1. Questionnaire development is more complicated 2. Makes questionnaire more difficult to complete
Postcoding	<ol style="list-style-type: none"> 1. Simplifies the development and completion of the questionnaire 	<ol style="list-style-type: none"> 1. Requires more time and work between completing survey and tabulation and analysis

How do we code?

Whether we precode or postcode we need to keep track of how we transform the information the farmers give us from worded questions and answers to variables with numeric values. We keep track of these transformations by creating a code book. In the code book we relate questions to variable numbers and codes (or numerical values of variables). Thus the code book has three columns:

Question No.	Variable No.	Code No.
--------------	--------------	----------

The question number refers to the question on the questionnaire form and serves to remind us what the question was and what the variable is related to. The code is the numerical value assigned to a variable which tells us what specific answers were given to the related question for a particular farmer. Table 1 illustrates how the information from a questionnaire is transferred into a table using a code book.

Table 1

Questionnaires Code Book Data Table

Q1.	Did you grow hybrid maize last season?	Yes	QNo.	Variable	Code	FmN	v1	v2	v3	v4	v5
F			1	1	1=yes	1	1	1.5	1	3	1
A					2=no	2	2	0.5	2	M	M
R						3	2	1.0	1	1	M
M	Q2.	How many hectares of maize did you cultivate last season?									
E			2	2	No.						
R											
	Q3.	Did you apply fertiliser to your maize last season?	3	3	1=yes						
1					2=no						
		if so what type(s) of fertiliser did you apply?		4&5							
		Urea			1=compound						
		Compound			2=ammonium nitrate						
					3=urea						
					4=other						

F	Q1.	Did you grow hybrid maize last season?	No								
A											
R	Q2.	How many hectares of maize did you cultivate last season?	0.5								
M											
E	Q3.	Did you apply fertiliser to your maize last season?	No								
R											
2		if so what type(s) of fertiliser did you apply?									
	Q1.	Did you grow hybrid maize last season?	No								
F											
A	Q2.	How many hectares of maize did you cultivate last season?	1.0								
R											
M	Q3.	Did you apply fertiliser to your maize last season?	Yes								
E											
R		if so what type(s) of fertiliser									
3											

Note:

During coding it is important to remember the following:

1. Every variable should have a variable name/or number, coding categories for each variable, and the column range.
2. It is useful to give variables names as well as numbers. The names help to quickly identify what question a variable relates to and reduces the amount of cross checking needed between questionnaire and code book.
3. Some questions have more than one variable related to them, e.g., Q3. The number of variables related to any question is determined by the number of possible answers any one farmer can give. Thus in Q3 farmers can give up to 3 answers so there are 3 variables related to Q3.
4. The actual answer given is assigned a code. Thus each variable may have a number of codes, depending on the number of possible different types of answer that can be given for that variable.
5. Answers given in numerical terms can be coded exactly as they are given. The code book information is still needed to determine which variable is assigned this numeric answer.
6. Sometimes data are not provided by farmer either because he does not know the answer, or more often because an answer is not applicable to him. For farmer 2, the second part of Q3 is not applicable. This data should be coded as missing. The form and the handling of missing value indicators depend on the software.
7. Each variable for any one farmer can only have one value. Thus if it is decided that farmers can give two answers to one part of any question, we need to create two variables to analyse the answers.
8. Qualitative or discrete data can be coded by using a number, e.g., source of seed.
9. In the process of coding the order of questions should not be changed - it should be the same order as appears in the questionnaire.
10. The coding of all variables from one questionnaire should be done in one step.

11. It is important to stress that the code book is constantly needed during data analysis to check:
- which variable needs to be analysed to answer any specific question; and
 - to translate the codes back to real answers.

Presentation of data:

The presentation of data is dictated by the purpose for which data is collected:

- to simply reproduce and summarize the data collected
- to establish some relationships/or facts

Normally information is presented in the form of:

- Tables (including crop calendars)
- Pictures; histograms, box charts, box plots, scatter diagrams, graphs
- Mathematical relationships

We shall discuss these in detail in the subsequent sections

Simple Analytical Techniques used in Survey Data Analysis

- Descriptive statistics for various variables include: means, mode, range, proportions, frequency counts, histograms, standard deviation, box plots.
- Analysis of functional relationships between various variables: cross-tabulations, scatter grams, graphs, correlations, regression analysis. Chi-square χ^2 t-test

Descriptive statistics

Mean: The arithmetic mean is the simple average value of a set of data

$$X = \frac{\sum X}{n} \text{ where } X = \text{the actual observation of value}$$

n = the number of observations

Mode: The value that occurs with the greatest frequency. It may not exist or may not be unique

Median: Is the middle value or the arithmetic mean of the middle values of a set of data. The median divides the observations into two equal halves or parts. The values that divide the observations or histogram into 4 parts are called quartiles.

A mean is sensitive to extreme values. A few extreme values have little or no effect on the median. For skewed data median may be more useful.

Proportions: Refers to the relative magnitudes of differences that exist between parts, a part and a whole, etc. One could use either percentages or proportion.

Range: Is the difference between the largest and the smallest value
 $\text{Range} = X_H - X_L$

where

X_H = the highest value of the observation in the set, and

X_L = the lowest value of the observation in the set

Standard deviation: The extent to which a single observation varies about the mean is measured by the standard deviation. This is the most popular method of measuring variability.

$$= \sqrt{\frac{(X_1 - \bar{X})^2 + (X_2 - \bar{X})^2 + \dots + (X_n - \bar{X})^2}{n}}$$

Simple frequency distribution

Here the overall range of values in our data set is divided into a number of classes, and the number of observations that fall under each class or category is counted. A tally chart is often used to construct the frequency distribution of any variable under consideration.

Histograms

A histogram is simply a graphic presentation of a frequency distribution and is constructed by erecting rectangles on the class intervals. Along the horizontal axis we record the values of the variables within the class intervals. Along the vertical axis we

have the frequencies. The height of the rectangles are equal to or proportional to the frequencies of each class. There are as many rectangles as classes. The following histogram shows the distribution of number of plots per farmer in one location in Tanzania.

Histograms are useful in indicating the nature of the underlying frequency distribution.

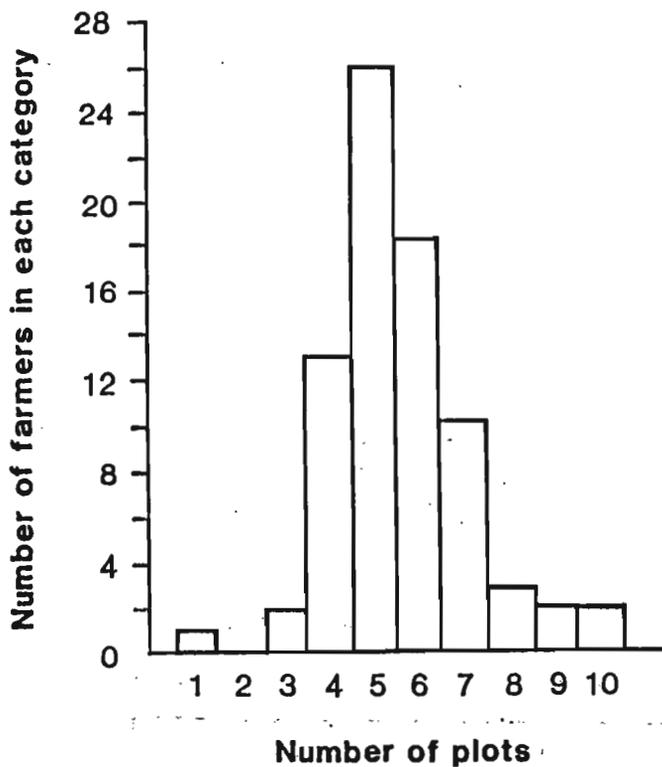


Figure 1. Sample farmers (Tandai and Amini):
Distribution of plots per farmer, 1979/80

Cumulative frequency

At times a researcher may be interested in knowing the number of observations whose values are less than a given value. This could be expressed in the form of cumulative frequency.

Ogive

An Ogive is a graphic representation of a cumulative frequency distribution. The horizontal axis once again

represents the class boundaries and vertical distance equal to or proportional to the frequencies of each class.

Charts

Charts are useful in presenting multiple measurements. There are different types of charts, including pie charts, bar charts, and percentage bar charts.

Pie Charts

When data are classified into percentage groups, they can be effectively represented by pie charts (also known as sector charts). The diagram is a circle divided into sector by radii, and each sector corresponds to a case illustrated.

In a pie chart, normally the largest sector is placed on the top and the smallest to the bottom. The sum of all the sectors, i.e., 360 degrees, should account for 100%. Therefore one percent would mean 3.6 degrees.

The pie chart below gives the land use patten in two villages in Morogoro District, Tanzania.

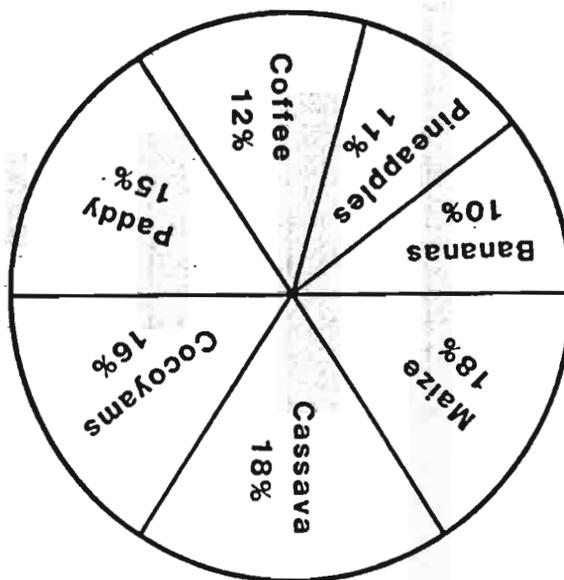


Figure 2. Sample farmers' (Tandai and Amini) land use pattern, Morogoro District, 1979/80

Bar Charts

A simple bar chart is an easy and effective form of depicting data. Each bar represents one

variable and its height represents its distribution. Bar charts can also effectively be used for comparisons.

The following bar charts show the proportion of farmers growing different crops in two different locations in Morogoro District, Tanzania.

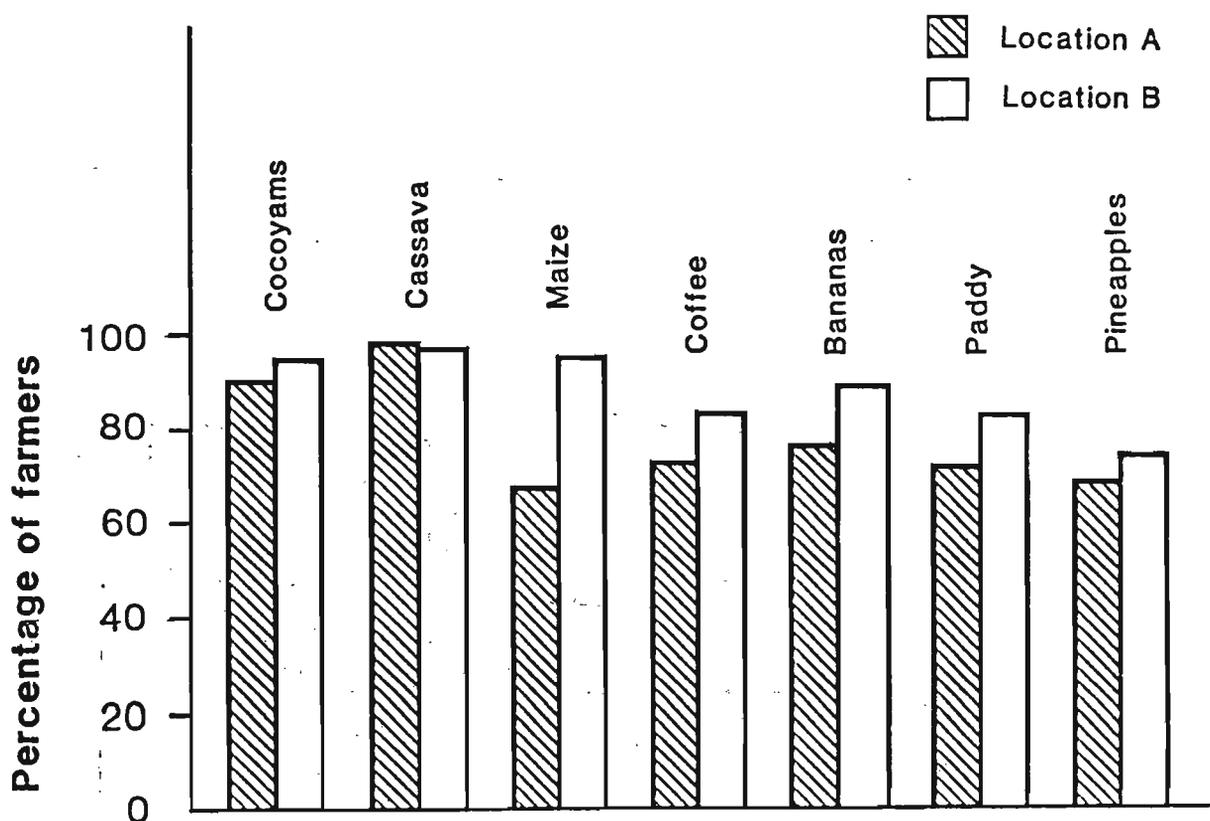


Figure 3. Proportion of farmers growing different crops in two locations, Morogoro District, 1979/80

A Percentage bar chart

This type of diagram comprises rectangles of different lengths or heights joined to form a single bar that is either horizontally or

vertically placed. The sum of all the squares should account for 100%.

The following percentage bar chart illustrates the utilization of Leucaena in Arusha region.

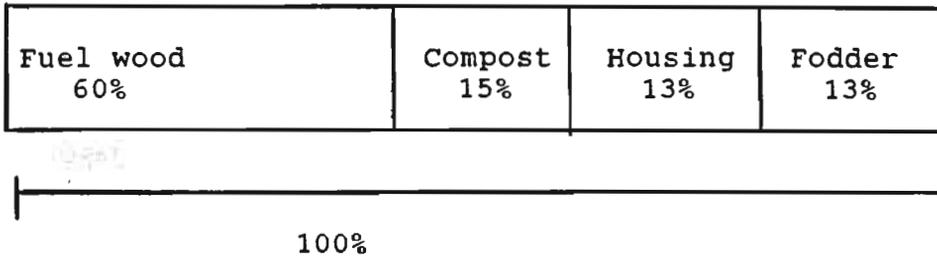


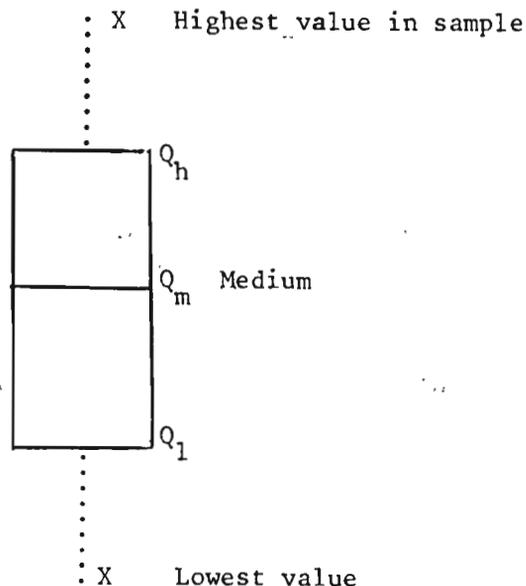
Figure 4. Utilization of Leucaena in Arusha region.

When a bar chart is to be used to represent the magnitude of two or more variables the bar may be shaded in different ways.

Box plot

Much information could be combined in what is known as a box plot, which is graphic comparison of different samples of the same population, i.e., different target groups can take the form of a box plot.

For each sample a narrow rectangular box is drawn starting from the lowest quartile (Q_1) to the highest quartile (Q_h) and the box is divided by two by the median Q_m . In addition the lowest and highest value in the sample are dotted in and marked with an X (see Figure below). These dotted lines are sometimes called 'WHISKERS'.



The box plot can tell many things simultaneously:

1. Skewness of the sample
2. The range of the value
3. Can also identify the 'outliers' or extreme values in the sample

Box plots can be used both for symmetrical and skewed data to give a good graphic presentation of sample data.

Presentation and analysis of functional relationships

Tables

Very often information can be summarized in tables, which are the most common format for presenting data. Quantitative and qualitative results are best displayed in the form of a table both for convenience and comprehension. The table should have a suitable and meaningful title, as the table should be self explanatory. Depending on the objective, a table can be a general purpose table or a special purpose table. A general purpose table is constructed either to present a summary overview or to present a large amount of primary data in a convenient form.

Special purpose tables represent a more advanced stage in the analysis. They are chosen to illustrate some specific point or points about the data forming part of the logical investigation of the research objectives.

In addition to their purpose, general or specific tables can be classified according to their dimensions. The dimension of a table specifies the number of variables according to which the data in the table are classified.

Thus a one-dimensional or one-way table includes data classified according to only one variable, while in a two-dimensional or two-way table two variables are used for classification, and so on.

Relationships between two variables can be given in the form of cross tabulation, i.e., a table with two variables. The following table is meant to illustrate the relationship between the time of planting and oxen ownership in the study area in Zambia.

Table 1 Sample farmers' source of power and time of planting of maize , Kabwe Rural District, Zambia, 1983

Planting date	Source of draft	
	Hire oxen (no. farmers)	Own oxen (no. farmers)
Early	7	12
Late	9	3

Source: Diagnostic Survey 1983.

A special type of table we often see in diagnostic reports is the crop calendar, which basically illustrates the timing of various cultural practices performed at the farm. The following table is the crop calendar for a group of farmers in Kilosa District, Tanzania.

Crop calendar for major crops, sample families, Kilosa, Tanzania, 1980

	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Local maize		-----	-----	-----						
Ilonga composite maize			-----	-----						
Sorghum		-----	-----	-----	-----	-----	-----	-----	-----			
Cotton		-----	-----	-----	-----	-----	-----	-----	-----			
Rice			-----	-----	-----	-----	-----					
Bean				-----	-----	-----	-----	-----	-----			
Sunflower		-----	-----	-----	-----	-----	-----	-----	-----			

Key: _____ Land preparation and planting
 ----- Weeding
 Harvesting

Graphs

The relationship between two variables is very often presented in the form of a graph. In a graph the horizontal line is the 'x' axis and the vertical line the 'y' axis; they are also called 'abscissa' and 'ordinate', respectively. Their point of intersection is the zero or point of origin.

Generally the independent variable is plotted on the 'x' axis and the dependent variable plotted on the 'y' axis. This presentation is appropriate when there is continuity in the data so that points representing paired observations of the two variables may be connected by a line.

Scatter diagram

If one wishes to examine the relationship between two variables, then one could use a scatter diagram. It is a graphic device which displays actual relationship between two variables by spot markings. A scatter diagram is obtained by plotting the pairs of values of x and y where y is measure along the vertical axis and x along the horizontal axis. Scatter diagrams are appropriate when it is wished to show the extent of association between two variables in the data but when no clear continuum exists.

If y tends to increase as x increases then the correlation is said to be positive, and if y tends to decrease as x increases (slope of the line is negative) then the correlation is said to be negative. If the points lie closer to a curve other than the straight line, then the correlation is said to be nonlinear; may be positive or negative.

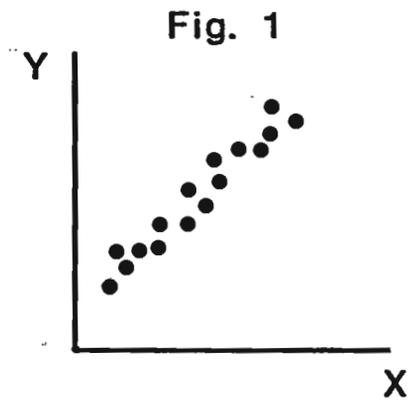
Correlation

The correlation technique is another way of identifying the relationship between variables. Thus, correlation can be regarded as a measure of the association between the two variables, that is to say a correlation is a measure of the extent to which the variables vary together systematically.

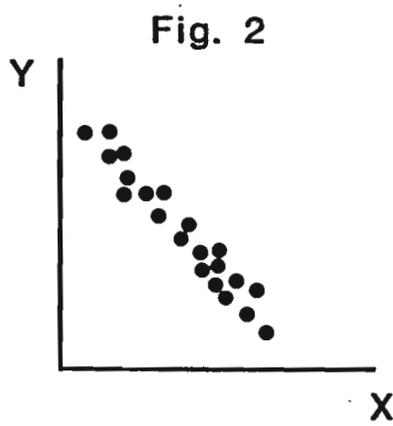
When only two variables are involved, we speak of simple correlations, whereas if more than two variables are involved we speak of multiple correlation. The relationship is estimated by calculating the correlation coefficient. The correlation coefficient (r) is a measure indicating the degree of relationship between the two variables. The (r) value ranges from -1 to +1.

If $r = 1$ then there is perfect correlation between two variables.

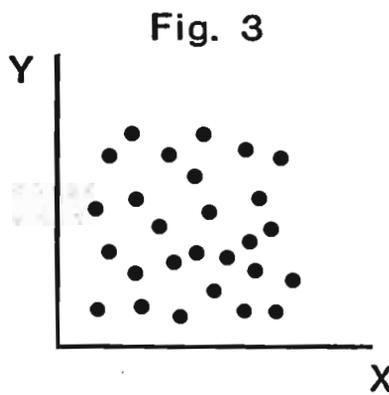
If r is negative then the relationship is negative.



b and r are positive



b and r are negative



No relationship

If r is positive then the relationship is positive.
 If r is 0 then there is no correlation.

In the following diagram, Figure 1, plotted points appear to 'cluster' around a straight line and it has a positive or upward slope. An upward or positive slope means that the value of b will be a positive quantity and r will also be positive, indicating a positive linear correlation. In Figure 2 the slope of the line is negative, so both the values of b and r will be negative indicating negative linear correlation. Figure 3 is presented to indicate what the scatter diagram is likely to look like when there is no linear correlation in our data.

A positive value means that as one value increases the other value also increases in the same direction. A negative value means that as one value increases, the other value decreases.

The following table shows the numerical value of r and the subjective evaluation

Numerical value for r	Evaluation of the linear correlation
1.0	Perfect
0.9 to 1.0	Very high
0.8 to 0.9	High
0.6 to 0.8	Moderate
0.5 to 0.6	Poor
0.0 to 0.5	Very poor
0.0	None

The above table shows only the positive values of r but the same evaluation holds for negative values that have the same numerical values as shown.

Regression

Clearly related to correlation is the regression technique. This procedure is used to make predictions based on correlated data. Using the data set one could estimate an equation that will explain the relationship and can also be used for predictive purposes. Here an equation form is fitted to numerical data to represent the structural relationship between variables. When we use the line to estimate the values of Y corresponding to values of X which were not in our data set, we refer to it as a regression line. The R^2 (the coefficient of determination) i.e., the goodness of fit will indicate the amount of variation of the dependent variables as explained by the independent variable (2) in the equation. The least square regression line of Y on X can be written as:

$$Y = \bar{Y} + b (x - \bar{X})$$

where b is the regression coefficient and

$$b = \frac{\sum (X_i - \bar{X}) \cdot (Y_i - \bar{Y})}{\sum (X_i - \bar{X})^2}$$

Once again we talk about simple regression when we deal with two variables (one dependent and one independent) and multiple regression when we deal with more than one independent variable.

In the following example it was assumed that the following factors influenced the gross cash income obtained by the farmers in Kibaoni village, Morogoro District.

Farm Size (in ha)	X_1
Labour available	X_2
Age of farmer	X_3
Years of formal education	X_4
Off-farm income	X_5
Farm operating expenses	X_6

We obtained the following equation:

$$Y_k = -4341 + 933 X_1, - 27.4 x_2 + 46.2 x_3$$

$$(2.08) \quad (-1.10) \quad (1.74)$$

$$+521 x_4 + 177 x_5 + 5.19 x_6$$

$$(2.80) \quad (0.27) \quad (2.31) \quad R^2 = 75$$

Size of farm, formal education, and farm operating expenses were found to be significant. These six factors also explained 75% of variation in gross cash income.

TESTING HYPOTHESIS

χ^2 - Chi square

χ^2 distribution could be used to carry out 3 important tests.

1. Tests of variance - sample variance and population variance

2. Tests of goodness of fit - observed frequencies and expected frequencies
3. Tests of independence of classification

The test most often used in diagnosis is testing of independence of classification.

Independence of classification:

Here we are testing the hypothesis about the relations between two attributes or variables. We may have N observations classified according to two criteria and we may wish to know whether the criteria are related or independent. Based on the observation one could formulate various hypotheses. For example:

1. Maize variety grown may be related to the cropping cycle, wet vs dry.
2. Maize variety planted may vary with the land type.
3. Weeding practices may also vary with the variety of maize grown.

The apparent relationship that one observes may be real or due to chance. A common way of testing whether this apparent relationship is true is by using χ^2 .

Let us consider an example. In one study area farmers were found to grow local maize and hybrid maize. The farmers used to practice different weeding regimes for these maize varieties. The survey results were tabulated as follows:

No. of weedings	Maize variety		Sum
	Local (no. of farmers)	Hybrid (no. of farmers)	
Weeding once	20 (15)	10 (15)	30 (R_1)
Weeding twice	3 (5)	7 (5)	10 (R_2)
Weeding thrice	7 (10)	13 (10)	20 (R_3)
Sum	30 (C_1)	30 (C_2)	60 (n)

This type of table is called a contingency table. This table is a 3x2 contingency table, the horizontal

classification containing three categories and the vertical one two categories. The table has six distinct cells. The frequencies belonging to each cell are called cell frequencies. The totals of the cell frequencies for each of the rows and columns are referred to as the marginal frequencies.

We wish to use the data set above to test the hypothesis that the two classifications are independent against the alternative hypothesis that they are not. In order to do this we need to compute the expected frequency of each of these cells.

The six frequencies 20, 10, 3, 7, and 13 of our table are termed 'observed' frequencies to distinguish them from the 'expected' frequencies. The expected frequency of a cell in the table is simply the frequency we would have expected to find if there were in fact no association between the two variables.

Computation of expected frequency

To compute the expected frequency of any cell in the table, multiply the value in the 'row totals' column in the same row as the cell, by the value in the 'column totals' row under the column which corresponds to the cell, and then divide the product by the total frequency.

$$E_{ij} = \frac{R_i C_j}{n} \quad \text{Where}$$

$$R_i = \text{Row totals}$$

$$C_j = \text{Column total}$$

$$E_{ij} = \text{Expected frequency of the cell in row } i \text{ and } j \text{ column}$$

For example the expected frequency of the cell 1

$$E_{11} = \frac{30 \times 30}{60} = 15$$

In table 1 the frequencies given in parenthesis are the expected frequencies.

Estimation of χ^2

$$\chi^2 = \sum_{ij} \frac{(Y_{ij} - E_{ij})^2}{E_{ij}}$$

$$\chi^2 \text{ for each cell} = \frac{(\text{observed frequency of the cell} - \text{Expected frequency of the cell})^2}{(\text{Expected frequency})}$$

for example the χ^2 for cell 1

$$= \frac{(20-15)^2}{15} = 1.67$$

the χ^2 for each of the cells is given in Table 2.

Chi-square values

No. of weedings	Maize variety	
	Local	Hybrid
Weeding once	1.67	1.67
" twice	0.80	0.80
" thrice	0.90	0.90

The degrees freedom $df = (i - 1) (j - 1)$

$i =$ number of rows
 $j =$ number of columns
 $df = (3-1) (2-1) = 2$

Objective: To test whether this relationship is apparent or real.

Null hypothesis H_0 : the two classifications are independent.
Alternative Hypothesis H_A : The two classifications are related.

Test: Compare the calculated χ^2 with the tabular χ^2 of the corresponding degrees of freedom and desired level of significance (1%, 5%, and 10%).

Criteria used: If the calculated χ^2 is greater than the tabular χ^2 value, then reject the null hypothesis and accept the alternative hypothesis, i.e., the relationship is real.

In our example the calculated $\chi^2 = 6.74$

Tabular χ^2	at 1%	=	9.21	NS
(df = 2)	at 5%	=	5.99	*
	10%	=	4.61	*

Conclusion:

The calculated $\chi^2(6.74)$ is greater than the appropriate tabular value (5.99). Therefore we may conclude that at 5% level there does exist a relationship between maize variety grown and weeding regime.

Note:

1. Cross tabulation and χ^2 tests should be used with discrete rather than continuous variables.
2. Results of a χ^2 only test the probability that a relationship exists but does not indicate either the strength or the direction of the relationship.
3. In order for the χ^2 test to be powerful the minimum number of observation per cell should be 5.

Comparison of Means for Subpopulation (t-test)

The objective here is to compare the sample means for the same variable for two different subpopulations. We could use an example to illustrate this.

In one study researchers want to determine whether farmers using official credit use the same or a different dose of nitrogen on their maize compared with farmers who use their own funds. Information was collected from both groups. There were 12 observations from farmers who use credit and 10 observations from farmers who use their own funds. The mean fertilizer dose for credit users $\bar{X}_1 = 92$ kg N/ha. The mean fertilizer dose for non credit users $\bar{X}_2 = 76$ kg N/ha.

We want to know whether this apparent difference is real or is only due to chance. A formal test using the 't' statistics will enable us to answer the question.

Before we compute the 't' value we should formulate our hypothesis. In hypothesis testing we make assumptions about the population. These assumptions, which may or may not be true, are called statistical hypotheses. We have to set our null hypothesis and alternative hypothesis. First we formulate the null hypothesis, which is our theory concerning the amounts of fertilizer used whose validity we propose to test. We assume that there is no difference in

the amount of fertilizer used between the two groups (this is our null hypothesis and denoted by H_0). Any hypothesis that differs from a given hypothesis is called an alternate hypothesis.

In setting the alternate hypothesis

$$\mu_1 > \mu_2$$

) implies that we are interested
) only in extreme values on one
) side of the means - use one-sided
) test

$$\mu_1 < \mu_2$$

$$\mu_1 \neq \mu_2$$

implies that we are interested in
both sides of the mean - use two-
sides test.

For our purpose

$$H_0: \bar{X}_1 - \bar{X}_2 = 0$$

$$H_A: \bar{X}_1 - \bar{X}_2 \neq 0$$

Estimation of t

$$(1) \quad t = \frac{\bar{X}_1 - \bar{X}_2}{S_d}$$

When \bar{X}_1 = Sample mean of subpopulation 1

\bar{X}_2 = " " " " 2

S_d = Standard deviation of difference between the two means

$$S_d^2 = S^2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)$$

$$\text{Where } S^2 = \frac{(n_1 - 1) S_1^2 + (n_2 - 1) S_2^2}{n_1 + n_2 - 2}$$

Where S_1^2 = sample variance of subpopulation 1

S_2^2 = " " " " 2

N_1 = sample size of subpopulation 1

N_2 = sample size of subpopulation 2

$$\text{Degrees of freedom } df = (N_1 + N_2) - 2$$

$$\text{In our example } S_A = 17.8; S_B = 28.4$$

$$S^2 = \frac{(12-1) 17.8^2 + (10-1) 28.4^2}{12 + 10 - 2} = 537.2$$

Credit users = subpopulation 1 N_1

Non " = subpopulation 2 N_2

$$\therefore S_d^2 = 537.2 \left(\frac{1}{12} + \frac{1}{10} \right)$$

$$= 98.5$$

$$S_d = 9.9$$

\therefore The corresponding t value

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S_d}$$

$$t = \frac{92.7 - 76}{9.9} = 1.64$$

Criteria: If the calculated t is greater than tabular t then reject the null hypothesis and accept the alternative hypothesis.

At 20 df the tabular t values are

at 10 percent	=	1.325	*
at 5 percent	=	1.725	NS
at 1 percent	=	2.528	NS

At 10% significant level the calculated t is greater than the tabular value.

Conclusion: The subpopulation using credit does apply more N per ha than self-financed farmers at a 10% significant level.

Note:

1. A larger difference in sample means leads one to suspect a significant difference does in fact exist.
2. The larger the calculated 't' value, the more likely it is that the apparent differences between sample means are real.
3. We only get positive information from a test when we are able to reject the null hypothesis. Accepting a null hypothesis (H_0) is a negative acceptance, which means that we have simply failed to disprove the null hypothesis based on the evidence available.

In analysing functional relationships the type of test that is appropriate depends on the nature of the variables that are assumed to be related.

Both discrete variables	=	chi square
One discrete, one continuous	=	t test
Both continuous	=	correlation
One variable related to more than one other variable	=	multiple regression

