EFFICIENT SITE DESCRIPTION, TECHNOLOGY DESIGN AND EVALUATION: GUIDELINES FOR ON-FARM RESEARCH WITH A FARMING SYSTEMS PERSPECTIVE (OFR/FSP)

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INTRODUCTION

"Farming systems research and development (FSR & D) is an approach to agricultural research and development that (1) views the whole farm as a systems, and (2) focuses on the interdependencies among the components under the control of members of the farm household and how these components interact with the physical, biological and socio-economic factors not under the houshold's control. The approach involves selecting target areas and farmers, identifying problems and opportunities, designing and executing on farm research and evaluating and implementing the results. In the process, opportunities for improving public policies and support systems affecting the target farmers are also considered." (Shanner et al p. 214).

The FSR approach is comprehensive but on the other side, the resources and staffing for FSR in most national programs is very limited. Personnel assigned to an FSR research site frequently are few in number, relatively junior, in experienced (a high turnover of staff exists) and are working with very limited budgets.

This dilemma is partially resolved when one remembers that FSR attempts to quickly and economically identify, adapt and test or verify suitable technologies, that will be rapidly adopted by

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a large number of farmers and as a result raise their standard of living.

Farming systems research is comprehensive but it is also meant to be cost effective.

The question remaining however, is how to implement cost effective FSR.

This note attempts to set down quidelines for efficient site description, technology design and evaluation for OFR/FSP. These are as follows;

For Site Description

1. Being clear on the objective of site description (at a certain point in time) and focusing on collecting the data required to meet the objective.
2. Usingan interdisciplinary research team to collect indepth information on a number of farm enterprises.
3. Employing a number of techniques for gathering information for site description, which together allow relatively fast and efficient data collection.
4. Placing a large emphasis on farmer and wife feedback on all phases of the FSR process.

For Design

1. Making the most of existing knowledge
2. Establishing criteria for setting research priorities
3. Focusing the on-farm trials

For Economic Evaluation

1. Timeliness
   - Use partial budgeting to assess economic viability
   - Initially use informal methods ta assess technical feasibility

Compromise on:

a. Quantity of data required and

b. Data sources

2. Validity

- Use unbiased data when comparing input and output levels of improved and farmers' practices.

  Establish the prices, wage rates, interest rates etc. actually faced by farmers

  Use farmer feedback

  Improve the analysis as more knowledge is accumulated about farmer circumstances

GUIDELINES FOR SITE DESCRIPTION

A number of reasons for carrying out a farming systems research site description are frequently given. Although there are some similarities, in the data required to meet the various site description objectives, there are differences. There are also differences in the importance of timeliness and accuracy.

The attempt to collect all the data required to meet all the objectives, of site description, with one long survey, is not recommended. Rather site description should be seen as an interactive process continuing thru the testing phase of the FSR process.

When planning a site description it is best to keep in mind what the specific objective of the effort is and what the requirements for timeliness and accuracy are.

OBJECTIVES OF SITE DESCRIPTION

Site description is initiated immediately after the FSR team has selected the research area or site.

The reasons frequently given for carrying out a site description include the following:

1. Provide information for planning on-farm trials;
2. Develop a hetter understanding of the farming systems followed;
3. Provide a benchmark (or to provide a measurement of the farmers' situation before the initiation of work);
4. Identify superior practices followed by some farmers which could be advantageously used by others;
5. Collect information useful for extrapolation (or for extending the experimental results to other areas); and, as an additional benefit,
6. Help choose agronomic and/or economic cooperators.

Site Description For Design

One of the primary objectives for carrying out a description of a research site is to provide information useful for focusing research and for planning the trials to be carried out.

Biological, physical and socio-economic data are collected in order to stratify (or categorize) the site into relatively homogenous groups of farms having similar land types, irrigation availobility, farm sizes etc. The farms within a group should be similar in respects important in determining the suitability of new technology.

The collected information are then used to identify and understand the problems farmers face in economically: (1) increasing yields; (2) growing more crops per year; (3) growing new crops or (4) increasing the productivity of the livestock or other sectors; all within each stratum. (This is known as the diagnostic stage).

Once the problem farmers face are identified and tentatively understood, attempts are made to suggest possible aolutions. Suggestions or hypotheses arise from previous research findings or from what the FSR team members know of the environment, the people and the possible solutions. Generally the hypotheses include new techniques of production and new crops or livestock.

To help assure that the suggested solutions or hypotheses are potentially suited to the farmers in their situations the hypothesized improvements must meet three criteria. They must be potentially

Biologically feasible,

Technically feasible and

Economically viable.

Biological feasibility means that the crop yields or levels of livestock productivity are high enough to be locally acceptable. Biological feasibility is assessed by matching the physical requirements of a crop, a cropping pattern or an animal with the physical conditions of the relevant stratum in the site, as determined by the data collected in the site description.

Technical feasibility of a pattern or animal, is determined by the degree a farmer of a certain category, can execute it with the resources that are available (or potentially available) to him. Technical feasibility is assessed by relating the requirements of the cropping pattern or animal to the expected availability of such resources as labor material inputs, traction power, credit and produce markets. The availability of these resources is ascertained with data collected in the site description.

The economic viability of a pattern is determined by its costs and returns in relation to the costs and returns attained from the farmers' cropping patterns. For and "improved" cropping pattern to be economically viable it must give higher net benefits than the farmers' practices. The data required for the estimates of the costs and returns achieved with the farmers' cropping patterns and/or livestock enterprises, are attained in the site description.

In other words "site description" provides useful guidelines for focusing the research program and aids in the identification of within site differences (strata or domains) which may determine the suitability of various technologies (Morris. 1980).

For design, site description has to be carried out rapidly for its results to be useful in planning the initial on-farm trials. Cropping pattern and other trials are frequently initiated a few months after a research site is selected. Thus the results of the initial site description must be available within a few weeks after the start of the description work.

Since the site description for the initial design of trials is carried out quickly the results are necessarily "tentative," "first impressions," "best guesses," etc. Subsequent site description work must be carried out to (1) verify the results of the initial description efforts (2) follow up on problems identified, are (3) develop a more comprechensive and in-depth understanding of farmers' circumstances.

Site Description For Developing A Better Understanding Of Farming Systems of Farmer Circumstances

Site description is an iterative process and continues through the testing phase of the FSR process. A number of small narrowly focused surveys can be carried out to address problems identified in the initial descriptive efforts or during the early design and on farm testing. Efforts can continue to improve and refine the early impressions of the research site and the farming systems followed.

Surveys and other techniques of collecting information can be used to better understand:

1) What farmers do;
2) What the interrelationships between the various farm enterprises are;
3) How farmers do what they do;
4) Why farmers do what they do; and
5) What are the goals, preferences and priorities of the farmers and how are decisions made.

(Hildebrand 1978. Shaner. et. al., 1981)

Efforts can also be directed towards further refining and defining the initial farmer stratification or classification.

It is strongly felt that developing a good understanding of farmers circumstances and the farming systems followed, allows the FSR team to be much more effective in identifying, designing, testing and recommending improved technology suited for small farmers.

Baseline or Benchmark Surveys

In FSR, measurements of the changes or improvements made in a research site, from autonomous adoption by farmers of technology tested in farming systems trials or from a pilot production program, may be desired. A benchmark or baseline survey which measures the situation of the site before the initiation of research (or during the first year of research) will be helpful in attempts to measure the changes that occur (Van Der Veen 1983). The benchmark survey is followed by another survey towards the end of the project, and the relevant variables are compared.

Data in FSR baseline surveys are commonly collected on:

1. Present cropping patterns;
2. Present crop varieties;
3. Levels of input use and costs;
4. Crop yields;
   a) grain;
   b) plant residue;
5. Household income; and
6. Community income, employment levels, tax revenue collected etc.

The baseline survey should be carried out before FSR changes start to occur, as the result of the program. However the survey need not be completed before the initiation of on-farm trials and the processing and analysis of data is not urgent.

Site Description For Identifying Useful and Superior Practices

The farmers themselves can be a source of information on techniques of production or on new crops or animals that can be adopted in a target area. In almost every village there seems to be a few farmers who harvest higher yields than the rest, have more productive livestock, and are more familiar with improved farming practices. These farmers have already tested innovations on their farms and have selected practices which are suited for them in their circumstances.

Attempts can therefore be undertaken to identify the improved practices followed by the superior farmers. Efforts must also be undertaken to understand why the superior practices are followed on certain farms and not on others (i.e. are the improved practices technically feasible and economically viable on all categories of farms).

Studies of this type can take place during the first year or two of the testing phase of FSR.

Site Description For Extrapolation or Extension

A FSR research site is chosen to be representative of a target area or subarea(s). Improved FSR technology -- identified and verified in the research site -- is expected to be appropriate within the relevant subarea(s) or recommendation domain(s). The improved technology is also expected to be relevant to areas lying outside the initial target area but with similar natural and socio-economic conditions.

The site description can be used to verify the similarities in the conditions between the research site and the target subarea (s) (or recommendation domain(s)) as attempts are made to move promising patterns into surrounding areas (Morris, 1980).

Further, the site description describes the conditions which should be present as improved patterns are field tested in other locations and recommended to farmers (Morris 1980).

This site description activity should be completed before starting the preproduction phase(s) of the FSR methodology.

Site Description For Choosing Cooperators

Agronomic or economic cooperators should be chosen to represent farmers of a certain category, stratum or domain, During the initial site description, the relevant strata were tentatively identified and the average characteristics of farmers in each stratum were estimated. this information helps ensure that the chosen cooperators are relatively "typical" of their category.

During the site description process, farmers may have been interviewed who fit the requirements of cooperators. A list of the names of such farmers can help in the identification and selection of agronomic or economic cooperators.

Conclusion on Objectives

A number of objectives or reasons for conducting a site description have been given. Although the data requirements for meeting the various objectives overlap, there are differences. There are also differences in how critical the timing and speed in data collection and analysis is. Data for planning initial on-farm trials are needed quickly; data for meeting the other objectives can be collected later during the FSR process.

It is not recommended to collect all the data required for all the objectives with one large survey.

Site description should be an iterative process. Initial site description efforts should be focused towards meeting the minimum information needs for research design. Continued efforts in site description take place throughout the testing phase of FSR to increase the knowledge of the farmers' situations and to meet the other objectives.

MULTIDISCIPLINARY SITE DESCRIPTION

All to often, site description has been left up to the soio-economists. This can be a big mistake if the objective of site description is to provide information useful for the design of on-farm trials. Biological scientists (agronomists, soil scientists, entomologists, animal scientists etc) are clearly needed in the: (1) site stratification; (2) production problem identification; (3) tentative diagnosis of the problems; and (4) in the collection of data for the assessment of the biological feasibility of proposed or hypothesized solutions. The agricultural economists are more useful in identifying and diagnosing socio-economic problems and in assessing the technical feasibility and economic viability of new technology.

The need for an interdisciplinary team is just as great in the site description as in any other phase of the site description effort.

COMBINING DATA COLLECTION TOOLS

It is being increasingly recognized that a large farmer survey is not the most appropriate technique for gaining initial information about farming systems research sites. Formal farmer surveys are expensive to carry out and can be very time consuming; requiring many months for completion. Frequently, the results from large farmer surveys are not available in time to provide information for planning farming systems trials.

Fortunately, methods have been developed which allow the economical and timely collection of information useful for planning farming systems research.

The methodologies (called Initial Site Descriptions, Exploratory Surveys, Rapid Rural Assessments, Sondeos etc.) generally combine a number of data sources and techniques for information collection. These are among the following

1) Previous studies;

2) Secondary data;

3) Site reconnaissance or direct observation and

4) Direct measurements.

5) Key informant surveys

   a) Farmer

   b) Non-farmer

6) Informal farmer surveys

7) Group interviews

8) Narrowly foccused formal farmer surveys

A number of data sources and types of surveys are combined in Rapid Site Description (RSD) in order to fill in data gaps but also to allow cross checking.

Combining a number of these tools, for site description, can efficiently meet the needs for timely initial site description used for the design of on-farm trials. These same tools can also be used to collect the information required to meet other site description objectives.

FARMER FEEDBACK

Attaining farmer feedback on proposed on-farm trials can help in at least three ways:

1. Feedback can help us avoid implementing trials on technology which appears to be feasible and viable but which is not due to reasons the farmers can explain;
2. Feedback can help us avoid implementing trials on technology which may be socially or culturally unacceptable; and
3. Feedback can help us focus our research on the priorities of the farmers.

GUIDELINES FOR DESIGN

USING EXISTING KNOWLEDGE

This can be difficult to do well but is extremely important. Once the problems farmers face are identified and tentatively understood attempts are made to suggest possible solutions. Suggestions or hypothesis arise from previous research conducted at or near the site on government experiment stations or in universities; from governmental and university scientists or from the farming systems teams own knowledge of the environment, the people and possible solutions. The review of all relevant existing knowledge on possible solutions to farmers' problems, in planning on farm trials, can increase the chance that suitable technology is found.

There is also existing knowledge on ways to implement on farm trials. Taking advantage of this knowledge can help increase the cost effectiveness of the research and can help reduce critical comments by visiting scientists.

It can be extremely difficult for site (or district) staff to collect relevant information which may be needed. This is why it is important to

a) develop close working relationships between the FSR staff and staff at nearly experiment stations and universities;

b) distribute relevant research findings to the site staff periodically; and

c) undertake a concerted effort on the regional and national level, to collect and make available relevant reading materials

CRITERIA FOR PRIORITIZING ON FARM TRIALS

No national program has unlimited resources to devote to FSR Cost effectiveness in identifying, testing and transferring improved technology to target farmers is a major concern. Using good judgements, in setting research priorities, is one way to help assure FSR objectives are met.

The following are among the criteria that can be used to help set research priorities in FSR.

1) The seriousness of the problem as viewed by both the farmers and society (Shaner);

2) The availability of technology or innovations to overcome the problem(s) identified which would be adopted by farmers;

3) The relative FSR importance of a land type, farmer category or component technology in the target area;

4) The ease of implementing the results (Shaner);

5) Government and/or policy makers priorities and

6) Farmers interests

Seriousness of the Problem

Problem seriousness has three dimensions; (1) severity (2) frequency and (3) general prevalence. Severity relates to the degree a crop yield or net income is reduced due to the problem; 5, 50 or 100 percent. Frequency refers to how often in, for example, a 10 year period the problem occurs; once, twice or every year. General prevalence refers to how common the problem is, within the relevant part of the target area. For example is the problem found on 10% of the rainfed wetland in the target area or on 100%

The more serious problems; those that are more severe frequent and prevalent would tend to have a higher research priority than the less severe.

In Nepal it was found that the shortage of plant nutrients was one of the most serious problems in increasing yields and cropping intensity The farmers were mainly relying on compost or farm yard manure for plant nutrient supply. Only about 10 kg of plant nutrients were applied per hectare peryear with the use of commercial fertilizer. The problem severely affected yields per year occured every year and existed in a very large proportion of the target areas (Van Der Veen 1981).

How to increase the supply of plant nutrients and how to make more efficient use of plant nutrients became an important part of Nepal s FSR program.

Crop yields in Nepal were also low because traditional crop varieites were widely grown

Availability of Suited Technology

After serious problems have been identified in the diagnostic phase of the initial site description, or in later survey work, the biological scientists attempt to identify suitable technology to overcome the problems. Technology suitability is judged by 4 criteria:

1) Agronomic or biological feasibility;
2) Level and dependability of profits or economic viability;
3) Compatibility with the farming systems (resource and socio-cultural compatibility) or technical feasibility on the farm; and
4) Compatibility with the communities economic and social infrastructure (Flinn et al 1982).

Under the heading of biological feasibility, the FSR team investigates such questions as: (This is adapted from Shaner et al).

- Do the physical and biological conditions in the research area provide opportunities to solve the problem?
- What information on potential solutions is available from experiment stations, farmers in the research area and in other areas, and the technical literature?
- Do the proposed technologies fit into the farmers' existing system?

Under economic viability, the team tries to determine

- Whether the benefits of potential improvements in the farmers' system offer sufficient incentives to interest family members (Note : incentives include coverage of the costs of purchases and any additional labor by the family and provide some crop or livestock surplus to offset the risk and effort of change)
- Whether the potential solutions increase or decrease the stability of the farmers' production and earnings
- Whether the potential solutions change the farmers' perception of risk through changes in the stability of production and requirements to obtain credit.

Under the heading of compatibility with farm resources, the team examines

- Whether available resources are adequate to meet the resource requirements
- Whether potential solutions reduce the employment of scarce resources
- Whether the employment of under-utilized resources is increased
- Whether farmers are able to apply the new technology.

Under household sociocultural compatibility or acceptability, the team tries to determine

- Whether the community's social and cultural values, norms, and customs help or hinder the acceptance of the proposed solutions
- Whether the farmers' perceptions, beliefs, knowledge, and attitudes facilitate or make more difficult the acceptance of the proposed solution

- Whether field team members have social or cultural values that hamper their working with certain groups or types of farmers
- Whether farm family goals are served or altered if the proposed solutions are successful.

In Nepal, improved varieties of leguminous, nitrogen supplying crops, which yielded better than the traditional varieties were not available. Also, means of supplying significantly more nutrients with compost, which would be readily adopted by farmers, had not been idenfified. Therefore the early FSR placed priority on the efficient use of commercial fertilizer in meeting the plant nutrient problem.

However there were modern varieties of rice, maize and wheat developed by the Nepalese experiment stations, which potentially could yield much higher than the traditional varieties grown by the farmers. Early FSR in Nepal placed a priority on identifying and testing the suited modern varieties of rice, maize and wheat in the six farming systems research sites.

The Relative Importance

FSR should be focused towards improving the welfare of a large number of target farmers, on a large part of the target area and/or towards reducing the costs or increasing the efficiency of a crop component that makes up a substantial part of the cost of production.

In Nepal, cropping intensity (in a certain location were unusually high levels of run off water was available) was found to be low because a long duration traditional rice variety was grown. The rice-fallow or R-W cropping pattern was changed to a R-W-M cropping pattern with the use of modern varieties and very high yields were harvested.

However less priority was given to this research when it was discovered that only small amounts of this particular type of land existed in the target area.

Ease of Implementation

Relatively small or marginal changes in the farmers' existing farming systems may be easier to implement than dramatic changes. For example once the farmers become convinced that a new rice variety is superior to the varieties presently being used, adoption can occur very quickly once seed becomes available. More difficult to implement would be a program like that in an Indonesian river shed program where (1) extensive terracing; (2) planting grass and other fodder crops on the terrace face; and (3) the replacement of the traditional crop of cassava with other annual or pre-annual crops which give better ground cover may be needed for erosion control.

In general, the FSR program would probably place higher priority on the technology which meets the farmers' needs but which is also easier to implement and carry out or which is more practical.

Government Priorities

Each countries' government, probably has its own set of priorities for FSR, and these should be taken into account in setting priorities for on-farm trials. For example, some Asian countries are interested in crop diversification and in increased production of crops other than rice because there is a rice surplus. Consequently, FSR is focused more towards dryland (upland) crops grown before or after rice and towards non-rice crops grown on the dryland (upland).

Many countries see FSR as a means of helping meets the needs of the smallest farmers and landless laborers in their country. Consequently, research priority should be given to technological innovations that the small farmers are willing and able to adopt and which will improve their welfare.

Farmers' Interest

"More importance should be given for the objectives the farmer has for his production activities. The fact that he has a few pigs scavenging around the house, does not mean that he necessarily should become a commercial swine producer, who would depend on the availability of commercial concentrates and the presence of a veterinarian. Such a change may destroy the original objective of his keeping a few pigs as a low risk, low input activity on which he can fall back in times of need. This does not mean his pig production methods cannot be improved. Improvements must, however, fit the objectives the farmer has with his enterprise. For research purposes, these objectives have to be expressed in terms of limitations on cash and labor inputs (including by whom) and productivity and risk criteria". (Zandstra 1982).

FOCUSED ON FARM TRIALS

Not all aspects of farming systems must be addressed in on farm trials for the activity to be considered farming systems research (Shaner et al). Research on a sub-system can be considered part of the FSR process if the connections (interrelations) with the other sub-systems are recognized and accounted for (Gilbert et al). Thus commodity research, cropping systems research or goat production research could all fall under the FSR umbrella.

In fact, trials covering a large number of aspects of a farming system should probably be avoided, especially in the early (learning) periods of any FSR site.

Complex on farm trials may be beyond the capability of a relatively inexperienced FSR team.

Also questions about subsystems may have to be addressed, in commodity or subsystems trials, before whole systems research is implemented.

A recent paper on cro- livestock research (Van Der Veen 1983) suggested the following order of on farm research be followed:

1. Reevalue past cropping systems research by taking into consideration the value of plant by products for animal feed;
2. Implement cropping pattern trials placing more emphasis of the quantity, quality and timing of plant material, useful for livestock feed
3. Implement cropping pattern trials emphasizing fodder crops;
4. Implement perennial fodder crop trials on uncultivated lands;
5. Implement animal feeding and supplementation trials and finally
6. Implement whole farm crop-livestock research some years after first initiating on farm research

Trying to cover to much work at a research site at once, is probably not the best way to carry out efficient and effective FSR.

GUIDELINES FOR THE ECONOMIC EVALUATION OF TECHNOLOGY

INTRODUCTION

If economic evaluation of agricultural technology is to be useful (and cost effective) in FSR, the results must be valid and timely.

Timely economic evaluation of technology can: (1) help set on-farm research priorities; (2) help design the technology used in on-farm trials; and (3) help set recommendations used in extension.

Biological and other scientists, of a FSR team, appreciate inputs by economists which help avoid errors in decisions concerning on-farm trials and recommendations. For example the weed scientists would be interested in which weed control practices are (potentially) economically viable. Or a cropping systems agronomist would like to be informed on the technical feasibility of a certain triple cropping pattern.

All to often, however, the economic analysis comes too late. If the results are late, economists do not help in decision making and can only point out, ex post, where the agronomists or others "went wrong" This is not only ineffective and inefficient economic analysis but can result in misunderstanding and poor relations between FSR team members.

Effective economic evaluation in FSR must be valid as well as timely.

The role of economics in FSR is largely to determine the acceptability of new or improved agricultural technology.

Acceptability is assessed, by economists, thru comparing relative net benefits, risk levels, degree of feasibility or compatibility, farmers preferences etc. of the new technology against the technology the farmers are already using.

Invalid economic evaluation, in FSR, is when wrong conclusions are drawn about the acceptability of a new technology: (1) when a new technology is assessed to be "very profitable" and "acceptable" when in fact it is not or (2) when a new technology is assessed to be not suited when in fact it is.

In most cases, the first type of error is made in FSR. There is frequency is a bias in favor of new technology. The new technology is assessed to be suitable and acceptable when in fact it is not.

Efforts must be taken to maximize the validity of economic analysis to help assure the cost effectiveness of the FSR effort.

VALIDITY IN THE ECONOMIC EVALUATION OF TECHNOLOGY

Correct conclusions about the suitability of new technology for farmers can be increased if:

1. Unbiased data are used when comparing inputs and outputs of farmer practices and new practices;
2. Prices, wage rates, interest rates, etc. faced by farmers, are determined and used in the economic calculations.
3. Farmer and wife feedback is relied upon and
4. Economic analysis is improved as more understanding of farmers' circumstances is developed.

Biases In Cropping Systems Research

According to Zandstra (1982), "analysis of the reasons for the rejection of new technology by farmers reveals that they are generally because:

- claims made about the benefits of technology are not realistic, because yields are lower, costs are higher or product prices and acceptability are lower than those assumed by the researchers.
- infra - structural support is lacking because of lack of political will, or poor management by the institutional support programs (credit, input availability marketing)"

Conducting cropping pattern trials on farmers' fields allows researchers to gain more realistic assessments of the suitability of new technology. However, unless care is taken in collecting data required to determine economic viability, the economic evaluations of new cropping patterns can give misleading results. The comparison of new cropping patterns with farmers' present patterns is essential in evaluating economic viability in cropping systems research. However, those collecting Input-Output data on the cropping pattern trials (the agronomists) are generally different than those collecting data on the farmers' existing cropping patterns (the agricultural economists). Generally, the agronomists and the economists use different methodologies for collecting input -output data. These differences can and have resulted in biases*, generally in favor of the new cropping patterns (i.e. the RAVCs of the new cropping patterns appeared to be much higher relative to the RAVCs of the farmers' patterns than they actually were; in other words the relative RAVCs of the new technology were exaggerated).

A related but separate problem is that carrying out whole farm record keeping (WFRK), on a fairly large number of farms (20-40), has been the method employed to collect input-output data on farmers' cropping patterns in cropping systems research. WFRK can be a very effective and efficient means of collecting large amounts of reliable and relevant data. However, the requirements for data: collection, checking, processing and analysis, in many cases is beyond the means of national cropping systems research programs. Because of this, some national programs ceased collecting data on farmers' practices because it is too time consuming and expensive. In these cases the economic viability of new cropping patterns can not be evaluated. Others have attempted to employ alternative methods to WFRK for collecting input-output data on farmers' practices. However because of lack of experience, and because no alternatives to WFRK have been given in the cropping systems "methodology" some of these attempts have not been completely satisfactory.

Finally, even if WFRK is employed, misleading (biased) results can arise unless adjustments or corrections (calabration) are made to the data to allow comparisons with the data collected by the agronomists. It can be difficult to know how to make these needed data adjustments or calabrations without prior research.

Possible Sources of Biased Data

Introduction

As will be discussed later, the economic evaluation of cropping pattern trials, is commonly limited to partial budgeting

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* Bias results from the collection of evidence in such a way that one alternative answer to a research question is favored (Selltiz et al).

and the calculation of the RAVCs, the MBCR and the rate of returns to scarce resources. These calculations are supplemented by farmer feedback to: confirm the results; assess farmers reactions about risk, food preferences, objectives etc. and to identify on or off farm constraints to adoption (Zandstra 1982).

The major categories of data required for partial budgeting are outlined as follows:

Cropping pattern trial	Farmers' cropping pattern(s)
1. labor inputs	1. labor inputs
2. power inputs	2. power inputs
3. material inputs	3. material inputs
4. crop yields	4. crop yields
5. prices, costs, wages and interest rates and	5. prices, costs, wages and interest rates and
6. parcel or plot size	6. parcel size

Biases in CSR, can arise when different methods are used to collect information on the trials and on the farmers practices. The following section describes the methodologies generally used to collect the data in cropping pattern trials.

Data Collected On The Trials

During their cropping pattern monitoring, the agronomists collect information on crop yields, labor and power inuts for each activity carried out on the trial plot, and on material inputs used. Yield estimates are made thru crop cuts and the moisture content of the grain, at the time of harvest, is taken inoto account.

Labor and power input data are collected by twice a week field visit and (at IRRI) by frequent farmer interview. In some cases the labor and power input is measured by observation and stop watch. Only operations carried out on the plot are recorded. This excludes the time required to raise seedlings on another parcel.

rest time and the time required to walk to and from the plot. In some cropping systems sites and some national programs, the power and input data for cropping pattern trials are not collected or not collected adequately.

For specifying material inputs, type, quantity, percent active ingredient, method of application and the area of the plot to which each input is supplied is recorded. Plot size is measured by measuring tape. (Zandstra et al).

Other data required for the economic evaluation of cropping pattern trials must be collected by the economists (Table 1) and this is what can cause problems.

Table 1. Data collected (√) and data missing (x) from cropping pattern trials for economic evaluation.

Cropping pattern trial			Farmers cropping patterns		
1.	/ or X	labor inputs	1.	x	labor inputs
2.	√ or x	power inputs	2.	x	power inputs
3.	√	material inputs	3.	x	material inputs
4.	√	crop yields	4.	x	crop yields
5.	x	prices, costs wages and interest rates	5.	x	prices, costs, wages and interest
6.	√	parcel or plot size	6.	x	parcel size

Potential Comparison Problems:

Land Area

Costs, returns and RAVCs are all calculated on a per hectare basis. For accurate calculations of these variables, land size should be known. Size of the plot devoted to the CS trial (usually 1,000 sq. m.) is measured by tape. A measurement error can occur, however, in estimating the size of farmers' parcels. Farmers frequently do not know the exact size(s) of their fields. Farmers' estimates are, at times, based on local measures such as the amount of seed used, the number of harvesters employed or on the time required for plowing. Farmers' estimation of the size of their farm are seldom based on land title.

Philippine farmers have tended to overestimate the sizes of their farms (and parcels) and the overestimation seems to be larger on smaller farms than on the large.

Using farmers' estimates of parcel size could result in an under estimate of crop yields depending on the method employed to estimate crop production. Crop cut estimates of yields would be unaffected by farmers' estimates of parcel size. However yield estimates, based on the harvest of the parcel, as determined by FRK or farmer interview, would be biased downwards if the parcel size is over estimated.

Costs of material inputs, labor and power requirements, per hectare, could also be underestimated if farmers' overestimated parcel size figures were used in the calculations

Even if farmers have accurate data on farm and parcel size, allowance has to be made for the area taken up by bunds. But in most cases farmers have a hard time estimating the part of their land taken up by bunds.

The size(s) of the parcel(s) of the economic cooperators may have to be measured to help assure that biases in the calculation of costs and returns, per hectare, do not occur.

Crop production

Yields of cropping pattern trials are estimated with crop cuts and weights are adjusted according to moisture content.

Yields of farmers' cropping patterns, as estimated by FRK or farmer interviews, are generally the total amount produced, in each parcel, as measured (generally), by volume and no adjustments are generally made for moisture content.

Problems in comparing these two types of data can arise.

There can be difficulties in converting volume measurements into weight.

1. The units for measurement of volume may not be uniform in size (basket sizes may differ);

2. Grain can very in weight per unit of volume depending on quality i.e. (oats weighing 35 lbs per bushel is of higher quality and receives a higher price than oats weighing 30 lbs) and

3. Moisture content is not taken into consideration

Even if the weight of the harvest of farmers yields are estimated correctly Harrington (1983) mentions that farmers often do not receive the same yield as researchers, even if they use the same treatment. The causes of this are as follows:

1. Management: Researchers can often be more precise and timely than farmers in applying a given treatment, e.g. plant spacing, timing of planting, fertilization, and weed control, etc.

2. Harvest date: researchers often harvest fields at "Physiological maturity" whereas farmers tend to let their crop dry in the field. Even when the yields of both researchers and farmers are adjusted to a constant moisture (e.g. 14%), the researchers' yield is higher -- because of fewer yield losses to insects, birds, rats, ear rots, or shattering.

3. Form of harvest: at times, mechanized harvest by farmers leads to heavy field loss if the crop has lodged or if the rows were planted unevenly. In these cases, a careful manual harvest by researchers will lead to yield levels that farmers cannot obtain.

4. Storage losses; if the farmer stores his harvest for home consumption or for later sale, and thereby incurs insect or rat damage, his effective production is less than that predicted by researchers on the basis of experimental

data. (Note: storage losses should not be counted if they were already included in the "storage cost" used to calculate field price).

5. Plot Size: Even when researchers are careful to use harvesting techniques that reduce border effects, yields estimated from small plots tend to be higher than yields taken from an entire field. IRRI data has also shown that crop cut data is generally higher than farmers estimates (Roxas et al.)

Adjustments (calabration or calculation of net yield) in the data would probable have to made, to avoid biases, when comparing crop cut data (used to estimate yields in cropping pattern trials) with farmers' estimates of production (commonly used to estimate yields of farmers' cropping patterns). However the required adjustments may differ from place to place, from crop to crop and from year to year and many be hard to determine.

Another problem is that agronomists and other biological scientists, rightly or wrongly place little credibility on farmers' estimates of yield and therefore on any economic evaluation based on farmers' estimates.

One way out of the dilemna would be to take crop cut on the parcels of both the economic and the agronomic cooperators. Adjustments could be uniformly taken for moisture content. This could be an effective way to help assure that at least the relative yields of the agronomic and economic cooperators are measured correctly especially if the same team(s) of agronomists and socio-economists carry out the crop cuts for both the agronomic and economic cooperators. Then, the identical method, for collecting both sets of yield data, can be followed.

In one Indonesian CSR site, the bias in using crop cuts to estimate yields of cropping pattern trials and WFRK to estimate yields in farmers' cropping patterns was recognized during the first year of research. During the following years of CSR, crop cuts were also used to estimate the yields harvested by farmers (personal conversation with Indonesian cropping systems staff).

Multiproduct Concerns

A problem related to estimating crop yields in the estimation of the total production of an enterprise. Crops and provide straw and other substances for animal fodder as well as grain. Livestock can provide meat but also draft power, milk, dung for compost or fuel, hides etc.

Attempts should be made to measure or estimate all the dimensions of production of a technology. Then for example, the grain and straw yield of a tall traditional rice variety and a short statured improved rice variety can be compared.

Labor and Power Input

Labor and power input requirements for the cropping pattern trials are estimated by frequent interview and/or by stop watch. These same data are collected from economic cooperators (in most cases) with the use of WFRK.

An IRRI study showed that the farmers' reports of labor time for each field orperation (as determined by FRK) were consistently higher than stop watch estimates.

"The stop watch estimates of the required time for all operations generally fell between 55 and 70 percent of the farmers' reports (WFRK) of the time required. The range was from 22 percent in the case of peanuts (ground nuts) to 82 percent for glutinous corn. The farmers' inclusion of rest time and other disruptins probably accounts for much of the difference. However, the differences between estimates appear to be greatest on those operations which required the least time by stop watch estimate. This suggests that the inclusion of preparation time and walking to and from the field amounted to a considerable bias for operations of shorter duration" (Roxas et al.).

The IRRI researchers felt that the farmers estimates were a better measure of the actual time required to carry out their cropping activities. They also felt that the stop watch estimates could be adjusted or calabrated to correspond to more realistic labor requirements. For this the following formula was suggested (the units are mondays):

Farmer's report or the more realistic assessment

= 0.33 + 1.67 (stop watch estimate)

As in the case of adjusting for net yields, the adjustment factor probably differs from place to place and from crop to crop and would require local research to determine.

Cost, wages, prices and interest rates

These are not collected by the agronomists so the problem of bias due to comparing data collected in different ways does not occur. The task for the economists is to determine how to periodically collect relevant price, cost, wage and interest rate data in an effective and efficient way.

The need to collect information on the prices, costs, interest rate, etc. actually faced by farmers is discussed later in this paper.

Summary on Biased Data

It is easy to see how a 78 percent underestimation of power and labor requirements (in CPTS) due to the use of a stop watch instead of farmers estimates a 30 percent overestimation of yields (in CPTS) as well as an overestimation of farmers' parcel size can lead to misleading economic evaluation of cropping pattern trials.

Most of the difficulties, in collecting the data used in economic evaluation, arise because different methods are used to collect the relevant information on the agronomic and economic cooperators and not enough effort is devoted to reconcile the two sets of data This is probable why Zandstra (1982) has stated that the "comparisons should be based on as similar a data collection scheme as possible for both sets (agronomic cooperator and economic cooperator) of information.

Prices, Wages, Rates and Interest Rates

Improved agricultural technology frequently involves higher levels or purchased inputs than the technology followed by farmers. The costs of the purchased inputs, to the farmers have to be carefully determined so as not to overestimate the relative net benefits derived from using the new technology.

Prices and Costs. Prices of inputs and outputs, costs and value of production may be expressed using farm-gate and field prices. When using farm-gate prices, inputs such as fertilizer, the cost of transportation (from the dealer to the farm) must be added to the price paid to the dealer. If dealers are nearby, transport cost can be ignored.

Price of material inputs expressed in this way are also known as money field price which refers to money values such as purchase price or other direct expenses. In contrast, the opportunity field prices refers to non-money value of inputs which must be given up. The opportunity price is the value of the input in its best alternative use.

When the farmer gives up benefits by using investmer capital (value of purchased or owned inputs) in the farm for a period of time, he incurs a cost of using investment capital, or simply, cost of capital (Perrin et al 1980). This cost may be a direct cost (e.g. interest charges paid by the farmer when he borrows money to buy material inputs), or an opportunity cost.

The cost of capital may be very important to farmer's decisions particularly those in less developed countries (LDC) where interest charges are high. Local money lenders often charge interest in the vicinity of 100% per year, which effectively doubles the price of inputs purchased with such loans.

Even in government agricultural programs which include extending of low cost credit, service charges and insurance fees can result in interest rates which are much higher than those announced by the loan agency (e.g. rural banks, development banks). Not only is the direct cost of capital high for LDC farmers, even the opportunity cost of capital is quite high. Since most small farmers have very little capital of their own, they would want to invest it in only those inputs which yield high returns.

When recommending cropping patterns, therefore the researcher must remember that a farmer would need to recover his investment and earn a minimum rate of return (MROR). This MROR includes the direct and opportunity costs of capital (including risk premium), and is estimated to be 50-100% per year or around 40% per crop cycle. If the cost of capital is not considered, the input costs are underestimated and profitability of the farm is overestimated particularly for those cropping patterns which require expensive inputs (Perrin et al 1980).

When the field price of an input is multiplied by the quantity of that input, the result is the field cost; which may be expressed as money field cost or opportunity field cost, or perhaps both, depending on the input. The sum of field costs for all inputs which are affected by the farmer's decision is the total field cost or total variable cost.

Similarly, the price of products may be expressed using prices the farmer can obtain if he sells it at the farm at harvest time; if products are usually sold at a market and if transportation costs are substantial, they should be explicitly considered and deducted from the market price to obtain the farm-gate price.

The simplest method of obtaining realistic product prices is to survey prices weekly at nearby market centers during the harvest period of the crops in experimental and farmers' patterns. The farm-gate price by period can then be estimated by subtracting the cost of transportation to market.

Products may also be reported using field price of output which refers to the value of an additional unit of production in the field, prior to harvest. Farmers who sell all or part of their grain will be concerned with money field price while those who consume the entire crop will be concerned with opportunity field price.

Money field price is the market price of the product minus harvest, storage, transportation and marketing costs, and quality discounts. Opportunity field price is the money price which the farm family would have to pay to acquire an additional unit of the product for consumption.

Wages

Estimating appropriate wage rates is a problem when calculating the profitability of an enterprise. Since labor is a major production input, the wage rates assumed are an important determinant of alternative enterprise profitability. In this section, we discuss the wage rates that may be used in partial budgeting. There are the standard agricultural wage, task wage, seasonal wage and seasonal task wage (Price 1984).

Standard agricultural wage is the easiest to compute and use. It is a single value given all agricultural labor a given time at one site. Ways to identify the hourly standard wage rate include: information from government sources or statistical services, survey techniques, and taking key informant surveys.

If surveys do not indicate there is a general agricultural wage rate, it may be necessary to determine task-specific wages; weight these by percentage of total annual labor required for each task and sum the results.

Wage rates may differ by operation or task. and the task wage rate is used for a particular task regardless of when it is performed. This wage rate can be identified through simple survey techniques.

Often, farmers at a site follow similar crop schedules and they prepare the land, weed and harvest about the same time in the present cropping systems. This causes seasonal variations in labor demand and supply, and in agricultural wages. The seasonal wage rate should be computed to reflect the amount of work performed at specific wage rates observed in all labor transactions at a given time. If harvesting is the principal activity in a given month, the seasonal wage for that month will primarily reflect the harvesting wage. Even labor employed in weeding activity is valued at that wage.

The seasonal task wage combines features of the seasonal agricultural wage and the task wage. It reflects labor conditions faced by farmers most accurately. Also it responds to seasonal differences in overall labor requirements and availability and reflects task differences that determine wage rates. However, this wage rate is difficult to measure because it is difficult to obtain sufficient off season observations for all jobs.

The seasonal task wage rate is the most rigorous and is most likely to reflect the conditions farmers use to choose technology. However, because this rate is so difficult to estimate the seasonal agricultural wage is recommended for use. It is probably accurate and easy to estimate.

Farmer Feedback

As previously mentioned, farmer feedback can help avoid errors in assessing the suitability of new agricultural technology. These errors can come about thru faculty assessments of yields (differences were overestimated or residue was not considered) prices or costs. Errors can also arise because the farmers goals concerning food preferences and security of production etc. were not fully taken into account. Also simple economic analysis does not consider cultural and social factors important in determining adoption. Attaining farmers' views on the new technology and on farmers willingness to adopt, can increase the probability of correct conclusions.

Improving Economic Analysis as Learning Occurs

As mentioned above, the initial site description is carried out quickly so that information is available for planning the first year's on farm trials. Information from a rapid site description is necessarily tentative. first impressions, best quesses etc. and probable nieve and simplistic.

This early knowledge is improved: (1) with continued site description efforts that continue for some years and (2) with first hand experiences gained by conducting on-farm trials with farmers.

Hopefully. by the time recommendations are made for extension, enough knowledge and understanding exists, about farmers' circumstances. to reliably assess the suitability of new technology for target farmers.

TIMELINESS IN ECONOMIC EVALUATION OF TECHNOLOGY

Economic assessments of improved technology can be more timely if: (1) partial budgeting is used to assess the economic viability of new technology; (2) informal methods are used to assess technicl feasibility (at least initially) and (3) compromises are made on the quantity of data collected and on data sources.

Partial Budgeting

Partial budgeting (PBA) is generally used as a first step in assessing the economic viability of a new technology once biological or agronomic feasibility is confirmed.

Partial budget analysis is a form of marginal (incremental) analysis designed to show, not profit or loss for the farm as a whole, but the net increase or decrease in farm income resulting from the proposed changes. In PBA, one does not evaluate the technical feasibility of adoption. Technical feasibility is addressed in further analysis once economic viability is demonstrated.

Partial budgeting is particularly well-suited to FSR when small changes are made to the farmers' systems. For many of the proposed treatments farmers will make small incremental change to the way they farm. these changes apply to only a limited number of activities; the rest of the farmers' activities remain the same. PBA is not only appropriate under these conditions, it is the pre ferred approach. The reason for the preference is that the analyst needs to concentrate on only the changes to the farmer's sytems, not the whole farm. By lessening the workload the researchers are able to focus their attention on a relatively few factors which help improve the quality and timeliness of the analysis. These changes refer to the differences to the farmers' system with and without the proposed change in technology. Interrelations between enterprises, in PBA, are taken into consideration by valuing inputs (when appropriate) by opportunity costs and by placing values on all output (compost, plant residue, etc).

When strong interactions exist between enterprises (for example draft livestock and crops) PBA could be used to analyze both activities together. Outside inputs and final products are used in the budgeting; intermediate crop or livestock inputs are not.

A number of performance criteria are calculated with PBA. These are: returns above variable costs (RAVC), returns to scarce resources, benefit cost ratios and rates of returns.

RAVC

1. Returns above variable costs - It is also known as gross margin, computed as Gross return - total variable

costs. 'Simply put, RAVC is the difference between the value of all the crops produced in a cropping pattern and the variable inputs including those not purchased in the market place) - used to grow these crops (Zandstra et al 1981). Sometimes, the term 'Net Returns' is used interchangeably (although inaccurately), with gross margin, as in Barlow (1980).

Two components (Flinn, 1984)

a) Returns above cash costs - Gross benefits - total variable cash costs.

This measurement does not include family labor opportunity cost, and measures the return accruing to the tenant for his and his family's labor and management skills. The RAVC (cash) is a <u>residual</u> return to the land a farmer cultivates (over and above the landlord's share of the crop as rent), and a return to fixed assets (carabao, plow etc) used to produce the crop.

b) Returns above full cost = Gross revenue - opportunity cost of household labor.

This net return is the return to the household's management skills, capital and a residual to land.

(N.B. When proftability of competing activities is being compared, the opportunity cost of family labor should be deducted from the gross revenue in the same way as cash costs. The two enterprises are then compared by returns above all variable costs).

<u>Returns to scarce resources</u>:

Other authors (Dillon and Hardaker 1980, for example) use the term 'Returns to limiting factors'. Net benefits are usually calculated per unit of land. However, land may not be the most limiting factor. As a result, it is also useful to estimate returns per unit of labor and capital. In irrigated areas, it may be sensible to estimate benefits per unit of water applied. The following formulas may be used to calculate the resources identified to be most limiting.

Returns per unit of land = net benefit - value imputed to the farmer's management skills. (?) The household's management skills are usually regarded as part of the opportunity cost of family labor.

Returns per unit of labor = net benefit plus family labor opportunity cost and actual outlav for hired labor divided by days of labor

$$\text{Returns to family labor} = \frac{\text{net benefit (NB)+family labor opportunity cost}}{\text{family labor input}}$$

$$\text{Returns to peak labor (day)} = \frac{\text{NB + family labor opportunity cost}}{\text{family labor input (of the task)}}$$

or

$$\text{Returns to labor} = \frac{\text{Gross returns - material input costs}}{\text{total labor hours}}$$

$$\text{Return per unit of capital} = \frac{\text{gros benefits}}{\text{total variable costs}}$$

or

$$\text{Returns to cash} = \frac{\text{gross returns - labor and animal costs}}{\text{material inout costs}}$$

Return per unit of cash cost-constraint requires that the period when cash is most scarce be identified. This is normally at planting time.

Benefit-Cost Ratios

The calculation of benefit-cost ratios and marginal benefit-cost ratios (MBCR) lead to some confusion because some authors use and interpret the two terms interchangeable while others do not. This formula is widely used:

$$MBCR = \frac{MVP}{MVC} = \frac{\text{Gross return (E) - Gross return (F)}}{\text{Total variable costs (E) - TVC (F)}}$$

where

E = experimental pattern

F = farmer's pattern

However, another criterion, the rate of return on total variable costs computed as gross returns/total variable costs, is often called the benefit-cost ratio (Ranta and Jayasuriya 1984).

Gomez and Gomez (1983) use the following definitions:
Benefit - Cost ratio (BC) is computed as:

$$BC = AV/AC$$

where

AV is the added value of output over the farmer's practice computed as

$$AVa = Va - Vf$$

and AC is the added cost over the farmer's practice computed as

$$ACa = Ta - Tf$$

(One notes that their BC ratio is the same as the MBCR that is more commonly used).

Rates of Return

Aside from the MBCR, another term used and calculated interchangeably with BC ratio is the rate of return (e.g. Banta and Jayasuriya 1984). However, the rates of return that are probably more useful in FSR economic evaluation are those suggested in the CIMMYT manual, viz, marginal rate of return and minimum rate of return.

The marginal rate of return is calculated similarly with the MBCR except that while the latter uses changes in gross returns, the marginal rate of return uses net benefits or returns, e.g.

$$MRR = \frac{\text{net returns}}{\text{TVC}}$$

It may also be calculated by subtracting one from the MBCR and expressing the MRR in percentage.

The minimum rate of return (MRDR), expressed in percentage, is a criterion that takes into account scarcity of capital and risk. This is discussed in more detail in a later section.

As a final note, the amounts of any additional investment in a new cropping pattern should be scrutinized. The more costly a new technology per unit area is, compared with the present technology, the more cautious farmers will be in adopting it despite a quite favorable RAVC or MBCR. However, high cost per unit area is not a deterrent if the MBCR is high, for clearly a farmer may simply make a marginal investment over a smaller land area. Indeed small plots of high cost-high return crops (tobacco, garlic, tomatoes, and other vegetables) are often observed on otherwise low-input farms.

Assessing Technical Feasibility

How do we determine on-farm technical viability?

A cropping pattern is compatible with the farming system if a farmer can execute it with a specified set of resources that is most likely to prevail during the production program phase. The technical feasibility of a certain pattern at a site is, therefore, determined by the availability of such resources as labor, power, cash, irrigation, etc.

Technical viability or compatibility of a cropping pattern for a farmer is a matter of degree. A cropping pattern could be viable on 100 percent of a suited land type or on only a part of it. For example in an irrigated area of Nepal, a Rice-Rice-Wheat

(R-R-W) cropping pattern was proposed in place of the tradition R-W pattern being grown by the farmers. With the R-R-W pattern and the crop varieties being proposed, a crop would be in the field 350 days per year leaving very few days between crops for land preparation.

Based upon the power and labor requirements for growing the crops, upon the power and labor availability on typical farms and in the community and upon the requirements on planting dates, it was calculated that the R-R-W cropping pattern could be followed on only about 20% of the suited land area of the farmers. Other cropping patterns such as R-potato or R-maize were technically viable on a much larger part of the land area because more turn around time between crops was available in these cropping patterns. (Van Der Veen 1979).

The following steps can be used as a guide for an approximate evaluation of technical feasibility (Zandstra et al 1981).

1. From the baseline, and later studies, prepare a list of crop management resources.
2. List the use of resources per hectare in the existing cropping patterns.
3. Set the present limits, assuming no additional production program support.
4. Set projected limits, conservatively considering production program support.
5. Evaluate the technical feasibility of the cropping pattern by comparing its estimated resource demands with the resources available. Where demands for certain resources are excessive at certain times, the pattern may be feasible only if it can draw on resources from other farm enterprises or from outside the farm's community.

During the first year, the component technology chosen for the cropping patterns will depend primarily on information from the environmental description, national recommendations, and previous research at the site or at similar sites. Over time more information on component technology will become available from research at the site and will increasingly form the basis for decision-making about the component technology levels to be used for the cropping patterns.

A difficulty in cropping pattern design arises in determining the on-farm resources available to the cropping pattern more precisely. For a single cropping pattern, the resources are most easily determined by substitution; the farming system's less used resources are added to the resources used by the cropping pattern that is to be changed.

To be feasible, a cropping pattern should not substantially increase the use of a resource during existing periods of peak requirement. A more rigorous treatment (as a resource allocation problem) requires linear programming or similar routines for optimizing the total cropping system, or, better still, the complete farming system. That demands knowledge of the performance of all the component activities of the system as a function of resource allocation and costs, which goes far beyond a rough estimate of cropping pattern performance.

A simpler economic procedure to assess technical viability is suggested by Banta (1982) using graphs and a 'simplified programming' approach known as program planning.

Graphs

Assuming that the new technology is more profitable, the next step is to find if there are any resource limits on its adoption. Graphs supply a quick and understandable method for studying resource flows over time. Cash, labor, and power usually limit adoption. A graph of the current resource flow of all activities on the farm is made first. Then, the net effect of subtracting the current technology resources requirements and adding the new technology resource requirement is added.

If the new technology uses the same or less resources, it is acceptable. If it requires more of a resource, a decision must be made. If the farmer has the extra resources, he may use the new technology. If the new technology requires more resources than he has, will he use a combination of the two technologies?

Program planning

Program planning, the final step in the proposed procedure, answers the farmers' question on using a combination of two technologies. Program planning is an approximation method for finding an efficient combination of resource use in an optimization setting. It uses a matrix similar to linear programming, but usually with not more than five rows and five columns. The matrix shows the limits identified in the graph, the resource use levels for each activity at those limit points, and any exogenous constraints considered important.

Program planning is based on price theory and marginal analysis and must meet the same set of assumptions that linear programming does. Several inherent weaknesses in program planning should be understood before it is used. First, there is no strict mathematical procedure to follow, which will ensure that an optimum is reached. Second, in the process of eliminating parameters to get the matrix to a workable size, critical parameters may be discarded.

Third, subjective decisions must be made in working the program so different solutions can be obtained from the same initial matrix. The efficiency of the solution depends upon the knowledge and skill of the researcher. Knowledge refers to an understanding of the processes and interrelationships that occur in the farming system. Skill refers to the subjective ability to make an efficient guess as to which parameters will become critical. Skill can be developed through practice. This procedure should be used only by researchers who have spent a considerable amount of time at the site under study.

Space does not permit a detailed explanation of program planning, but discussions with examples are found in several sources (Clarke 1962), Weather 1964, Rickards and McConnell 1967 .

Aside from graphs, labor profiles and charts may be used to identify labor constraints and later, these histograms may be used to identify cash and power constraints (Gittinger 1982, Hardaker and Dillon 1980).

COMPATIBILITY WITH THE COMMUNITY INFRASTRUCTURE

Farmers must not only be willing to adopt a new cropping pattern they must also be able to. The lack of seeds of new crop varieties, the unavailability of fertilizer or credit, and the uncertainty concerning marketing could all prevent the adoption of new technology.

The compatibility of proposed cropping patterns with the community infrastructure should be assessed in the design phase of FSR to help:

1) Reject obviously incompatible technology;
2) Make more compatible adjustments in component technology;
3) Set priorities; and
4) Identify potential problem (incompatibility) areas.

Since the information collected in the initial site description, on the community infrastructure is not detailed, only informal assessments of cropping patterns compatibility can be made during the first design meeting.

However these assessments must be more comprehensive and detailed before the pre-production phase of FSR initiated. For example, by the 2nd year of testing, detailed marketing and credit studies may have to be carried out.

Acknowledgments

This paper follows closely parts of the following:

IFSR-01	Overview of Farming Systems Research	M.G.Van Der Veen
SD-01	Description of the Farming Systems Research Site: An Introduction..........................	M.G.Van Der Veen
SD-10	Rapid Site Description...................	M.G.Van Der Veen
D-05	Designing Technically Feasible And Economically Viable Cropping Patterns (Ex-Ante)...............	C.M. Gonzales/ M.G.Van Der Veen
D-06	Setting Research Priorities: A Review.................................	M.G.Van Der Veen
D-07	Farmer Participation and Feedback In Farming Systems Research: Selected Readings..............	M.G.Van Der Veen
T-02	Data Requirements For The Economic Analysis of Cropping Pattern Trials..................	C.M. Gonzales/ M.G.Van Der Veen
T-10	Alternative Input-Output Data Collected Methods for Evaluating Cropping Pattern Trials..........................	M.G.Van Der Veen
T-11	Economic Evaluation of Cropping Pattern Trials..................	C.M. Gonzales/ M.G.Van Der Veen
T-12	Identifying Farm Resource Constraints To Adoption (Graphing Whole-Farm Resources).............................	C.M. Gonzales/ M.G.Van Der Veen

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