# HAND BOOK FOR DATA COLLECTION AND BUDGETING

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# HAND BOOK FOR DATA COLLECTION AND BUDGETING

For Assessing The Economic Viability of
New Technology Tested in On-Farm Trials

by

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August 1991

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## ACKNOWLEDGEMENT

The hand book is the result of discussions held during the Workshop On FSR Trial Designs, Data Collection and Economic Analysis held in Faisalabad on 10-13 August, 1991. A part of the workshop was devoted to discussing and agreeing on practical and suitable methods for data collection and analysis for assessing the economic viability of new technology tested in on-farm trials. A simple hand book was desired to: 1) improve the research methods followed in the FSR program; 2) help standardize the methods followed in all the FSR target areas and 3) provide information to newly hired FSR scientists on how to carry on the work.

The instructors for the workshop, besides myself, included Dr. Roger Petersen, Statistician, Oregon State University, MART consultant, Dr. Bashir Ahmad and M. Aslam Chaudhry, Agricultural Economists from the University of Faisalabad.

The participants included one Agricultural Economist, one Animal Scientist and one Plant or Soil Scientist from each FSR target area. The participants are listed on the next page and I would like to thank them all for their contributions.

**FSR TRIAL DESIGNS, DATA COLLECTION AND ECONOMIC ANALYSIS WORKSHOP**
Faisalabad, August 10-13, 1991

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# INTRODUCTION

Farming systems research attempts to identify or adopt suitable agricultural technologies which overcome important agricultural production problems. The stress is placed on "suitable" because of the desire to increase the incomes of many small farmers thru the adoption of the new technology. Only suitable technology will be adopted by small farmers.

Five levels of suitability are considered when assessing improved technology. These are 1) biological or agronomic feasibility; 2) economic viability or the relative level and dependability of profits; 3) compatibility with the farming systems; 4) compatibility' with the communities' economic and social infrastructure and 5) socio-cultural acceptability.

A biologically feasible cropping pattern will grow in the target land type and subarea well enough to achieve locally acceptable yield levels. A biologically feasible pattern also provides acceptable levels of yield stability and sustainability.

What makes a cropping pattern biologically feasible or not are the physical, climatological, and biotic conditions in the area in relation to the requirements of the cropping pattern. These include the amount and distribution of rainfall and irrigation, landscape hydrology, temperature, soil conditions, etc. as compared to what the cropping pattern requires.

Compatibility of a new cropping pattern with farmers' farming systems is determined by the degree to which farmers can execute it with the amount of labor, power and cash or credit available to them.

Compatibility of the new cropping pattern with the community infrastructure is related to the degree to which the credit, input supply, output marketing, extension and irrigation services can meet the needs of farmers adopting the pattern.

The economic viability of a pattern is determined by its costs and returns compared to the costs and returns from the farmer's cropping patterns. To be economically viable, an "improved" cropping pattern must give higher net benefits than the farmers' practices.

Socio-cultural acceptability due to religion or other reasons, is another factor that needs to be considered to assess the suitability of technology for the target farmers. Generally, new crop technology that is not judged suitable, presently or in the near future, because of any of the five criteria listed above is not considered for on-farm testing.

One of the most important tasks of the farming systems researchers is to assess the economic viability of the technology being tested in on-farm trials. The adoption of new technology by farmers is unlikely unless or until it can be shown that it is economically viable.

This handbook gives simple guidelines on how to collect the data and carry out the budgeting required for assessing the economic viability of new technology tested in on-farm trials. The guidelines were established during the Workshop on FSR Trial Designs, Data Collection and Economic Analysis held in Faisalabad from August 10-13, 1991.

# BUDGET ANALYSIS IN FARMING SYSTEM RESEARCH

## Introduction

Two budgeting tools will be used to assess the economic viability of agricultural technology tested in on-farm trials. These tools are partial budgeting and enterprise budgeting.

Enterprise budgeting is used in farming systems research to calculate the costs and returns of growing crops, cropping patterns, sheep, poultry, milking buffalo or other enterprises. In farming systems research, enterprise budgeting is commonly used to compare the profitability of new or improved cropping patterns, being tested in trials, with each other and with the most common cropping patterns and practices followed by farmers.

Partial budgeting is the economic tool used to analyze the results of component technology trials in FSR. Partial budgeting is used to estimate the costs and returns of making relatively small changes to a crop or livestock enterprise and indicates if a change in a component technology (variety, weed control, animal disease control etc.) is profitable or not. Partial budgeting can also be used to determine the most profitable level of a component (or treatment) such as nitrogen fertilizer.

## Partial Budgeting

A partial budget indicates if a change in component technology is profitable or not. Only items affected by the change are included in the budget. Levels and costs of all unchanged inputs are not included.

**Table 1.** Partial budget to estimate change in annual net cash income resulting from some change in resource use.

| | | | |
|---|---|---|---|
| a. | Added cost Rs._____ | c. | Added return Rs_____ |
| b. | Reduced return Rs._____ | d. | Reduced cost Rs._____ |
| | Subtotal A Rs._____ | | Subtotal B Rs._____ |

Estimated Change B-A Rs. _____

For example table 2 shows a partial budget for hand weeding vs no weeding for transplanted IR36 rice. Added cost of Rs100 was due to hired labor for hand weeding and Rs.25 for additional harvesting costs due to higher yields. Extra returns were due to a one m.t./ha yield increase, valued at Rs500. The estimated profit change is Rs375.

**Table 2.** Partial budget to estimate the change in net income from no weeding to handweeding.

| Added costs | | Added returns | |
|---|---|---|---|
| Labor for handweeding | Rs. 100 | One ton yield increase | Rs. 500 |
| Labor for harvesting | Rs. 25 | | |
| Reduced returns | nil | Reduced costs | nil |
| Subtotal A | Rs. 125 | Subtotal-B | Rs.500 |

Estimated change B-A Rs 375

Partial budget or marginal analysis can also be used to determine the most profitable level of a component (or treatment) such as nitrogen fertilizer. This is achieved by following a number of steps.

1. List treatments in order of increasing costs 2. Only those costs that vary over treatments need be considered. Table 3 shows the treatment levels, costs, and benefits due to different nitrogen levels.

**Table 3.** Partial budget or Marginal analysis

| Treatment | Costs that vary | Net Benefits |
|---|---|---|
| 0 N | 0 | 400 |
| 40 N | 30 | 460 |
| 80 N | 60 | 485 |
| 120 N | 85 | 490 |

3. For each adjacent pair of treatments, calculate a marginal rate of return (MRR) for adjacent pairs of treatments. The MRR is defined as

$$MRR = \frac{\text{increment in net benefits}}{\text{increment in costs that vary}} \times 100$$

This is shown in Table 4 for the same example.

**Table 4.** Marginal analysis

| Treatment | Increment in costs | Increment in benefits | MRR |
|---|---|---|---|
| 40 N | 30 | 60 | 200% |
| 80 N | 30 | 25 | 83% |
| 120 N | 5 | 25 | 20% |

4. Estimate a minimum rate of return required for investment. This may be seen as a critical level or threshold level that must be exceeded in order for farmers to make an investment. Normal values for this minimum rate of return are 50-100% per year.

The most profitable treatment is the one with a) the highest net benefits and with b) a MRR higher than the minimum rate of return. (The MRR calculation is performed with respect to the adjacent less expensive treatment).

The most profitable treatment is N= 80, because the MRR earned by continuing to N = 120 is only 20% - lower than the critical or minimum level of 50%. Note that n=N =80 captures most of the benefits earned by N= 120, but at a much lower cost.

An example of a partial budget used to evaluate the economic viability of flushing and deworming of ewes is shown in ANNEX A-1

The International Wheat and Maize Research Institute (CIMMYT) has developed the procedures for using partial budgeting for analyzing on-farm component technology trials. These procedures are explained in Perrin, P.K., D.L. Winkelman, E.R. Moscard, and J.R. Anderson, 1976. From Agronomic Data To Farmer Recommendation. CIMMYT Information Bulletin 2.

Partial budgeting is probably the simplest analytical tool listed, to use. The data and calculations required are minimal and the results are easy to understand. Partial budgeting can give the same results as more complex tools such as enterprise budgeting or production function analysis as long as the change in the enterprise is small and only one component is changed at a time. Partial budgeting is the preferred analytical tool as long as it can meet the research objectives.

Partial budgeting is not suited for assessing the economic viability or technical feasibility of CPTs or in determining optimal enterprise mixes on farms. This is especially so when strong interactions exist between components and enterprises.

## Enterprise Budgeting

Enterprise budgeting in contrast to partial budgeting, where only one component of an enterprise is studied, focuses on individual crops, cropping patterns or livestock enterprises. Enterprise budgeting is used to calculate the profitability, the cost s and returns, of specific but complete farm enterprises.

In cropping systems research, enterprise budgeting is used to compare the profitability of experimental cropping pattern tested in CPTS and the most common cropping patterns and practices followed by farmers. An enterprise budget is calculated for the experimental cropping pattern and then for the patterns and practices most commonly followed by the farmers in the site (and within the relevant land types). The returns above variable costs (RAVCs) and rates of returns to scarce factors are then compared.

All of the variable costs for an enterprise: labor, power, material inputs, irrigation, interest or capital costs as well as all the produce (grain as well as crop residue) are considered in enterprise budgeting.

Gross return is the level of production per hectare times the product price(s).

Total variable costs (TVCs) is the total of all variable inputs into the enterprise, times their respective prices. An interest rate or cost of capital charge, for material inputs, is also included in TVCs.

Returns above variable costs (RAVCs), sometimes called gross margins, are gross returns minus total variable costs.

Experimental cropping patterns which do not provide a RAVC substantially higher than farmer existing patterns are economically unviable and probably would not be adopted by farmers.

The returns to scarce resources such as cash is also calculated in enterprise budgeting. If the level of material inputs used can be a proxy for cash costs, the return to material costs is gross returns minus all variable costs, except material costs, divided by the material costs.

An experimental cropping pattern which has a return to material costs substantively lower than the farmers' cropping patterns, may not be accepted by farmers with very limited amounts of cash or credit.

## Marginal benefit-cost ratio (MBCR)

A new technology offering higher RAVCs generally implies additional inputs on which the rate of return may be low. In this case an additional test can be used, based on the marginal benefit-cost ratio (MBCR). The MBCR evaluates among several alternatives, the pattern that is most likely to replace an existing pattern. The alternative patterns (with similar RAVCs) that offer the highest MBCRs may be more attractive to farmers.

The MBCR of the prevalent pattern (F) and any potential replacement (E) for it may be

computed as:

$$\text{MBCR} = \frac{\text{gross returns (E) - gross returns (F)}}{\text{total variable costs (E) - total variable costs (F)}}$$

OR

$$= \frac{\text{additional returns from adopting the experimental cropping pattern}}{\text{additional costs in adopting the experimental cropping pattern}}$$

To calculate the MBCR, the following example is provided.

Example:

Costs and returns for the experimental patterns, and the farmers' prevalent pattern(s), are arranged in order of increasing RAVC per hectare and presented in a table.

The gross returns and total variable cost for rice-fallow (the farmer's prevalent pattern) rice-mungbean and rice-rice (two experimental patterns) are presented in Table 5. The notations A1 to A3 and B1 to B3 are used to refer to either the total variable cost or the gross returns for each pattern, and will be discussed in the next table.

**Table 5.** MBCR pattern acceptability of alternatives for rice-fallow in land type 1.

| Cropping pattern | Total variable cost (A) (Rs./ha) | Gross returns (B) (Rs/ha) |
|---|---|---|
| Rice -fallow (F) | 800 (A1) | 2000 (B1) |
| Rice-mungbean (E) | 1100 (A2) | 2500 (B2) |
| Rice-rice (E) | 1200 (A3) | 2700 (B3) |

**Table 6.**

| Returns above variable cost (C)=(B-A)(Rs/ha) (C) | Additional cost (Rs/ha) (D) | Additional returns (Rs/ha) (E) | MBCR* for replacing rice-fallow Rs/Rs (F) = (E)-(D) |
|---|---|---|---|
| 1200 | | | |
| 1400 | 300 (A2-A1) | 500 (B2-B1) | 1.7 |
| 1700 | 200 (A3-A1) | 700 (B3-B1) | 3.5 |

Given the information in Table 5, Table 6 shows the steps in calculating the MBCR. Column (D) and (E) show the additional costs and additional returns of the experimental when compared with the farmer's prevalent pattern. Thus, the additional costs in shifting from rice-fallow to rice-mungbean is M300/ha, calculated by subtracting the total variable cost of rice-fallow (A1) from the total variable cost of rice-mungbean (A2) or 1100-800.

The additional returns are calculated in a similar manner but this time the numbers in the gross returns column are used. Thus, 500 is calculated by subtracting B1 from B2 or 2500-2000.

We can get the MBCR in this example by dividing the additional return by the additional cost for each pattern. Thus, the MBCR in shifting from rice-fallow to rice-mungbean is 1.7.

This means that for every Rupee increase, in variable costs from changing from R-F to R-17, Rs.1.7 was returned.

The MBCR of an experimental cropping pattern, must be higher than 1.0 to be economically attractive to farmers. A pattern with a MBCR of 1.0 or less is not economically viable.

If the MBCR is equal to one, there is no increase in RAVC/ha/year from adopting the new cropping pattern. And the rates of return to cash, labor or power are only 1.0. Only the input costs are recovered. There is no increase in net income. If MBCR is less than one, the new cropping pattern is less profitable than the farmers'.

A rule of thumb or guideline that has been used is that the MBCR should be 2.0 or more for an experimental cropping pattern to be attractive to farmers. However, a rule which accepts a technology because the MBCR is equal or greater than 2.0 is fairly arbitrary and a technology with MBCR slightly below 2.0 may be acceptable to farmers.

In FSR, the entire cropping pattern is considered the enterprise. Gross returns, TVCs and RAVCs are calculated for the cropping patterns as a whole and not just for individual crops in the pattern.

This is because interactions commonly exist between crops in a cropping pattern. The performance of one crop is influenced by the type and management of the preceding crop. Thus individual crop RAVCs may not reflect the total net contribution of a crop in an entire year.

We know for example that the yield of one crop can be influenced by the preceding crop or by how the preceding crop was managed. In Nepal, the optimum planting date for wheat is Nov. 15, such that wheat yields decrease at least 15 kgs (depending on variety) for each day the crop is planted after November 15. Late planting of wheat is generally due to delayed harvest of the succeeding rice crop due to the use of long duration rice varieties or to late transplanting. There is a trade off between growing high yielding late planted or long duration rice crops and attaining high wheat yields when planting on time.

The fertilizer requirements for a rice crop can be determined in part by the amount and type of fertilizer applied to the preceding crop. In Nepal, if 60 kg/ha of $P_2O_5$ is applied to the

wheat crop in a rice-wheat cropping pattern, phosphorus generally need not be applied to the following rice crop.

Maximizing the net returns from an individual crop may not lead to the highest net returns to a farmer on his parcel of land for an entire year. In Nepal an improved maize variety was rejected in a rice-wheat-maize cropping pattern even though the improved variety gave much higher yields and returns above variable costs than the local one.

The improved variety was rejected by farmers because it took more days to mature. This resulted in later harvesting, delayed and consequently reduced yield of the rice crop and the abandonment of the wheat crop. Although the yields and returns from the improved maize crop were high, yields and returns during the whole year were much reduced.

In cropping pattern trials, the yields, costs and returns of all the crops grown on a parcel of land are considered. The yields, costs and returns of the cropping pattern(s) being tested in the trial are compared to the yields, costs and returns derived by farmers from their own cropping patterns and practices.

Enterprise budgeting is generally the first tool used in the economic analysis of cropping pattern trials. Enterprise budgeting is used to assess the economic viability of new cropping patterns.

Enterprise budgeting is also appropriate when the interactions between the cropping system, livestock system and other systems are not strong. Thus, a partial, not whole farm analysis may be used.

Partial or enterprise analysis is less demanding of data than whole-farm budgeting, and is generally simpler than whole-farm analysis.

When systems interactions are strong, enterprise analysis can also be used as a first step leading to whole farm analysis. The information required for enterprise budgeting analysis can be used in the whole farm analysis. And the results from the budgeting analysis can be used to juage if the more difficult, time and resource consuming whole farm analysis is justified or not.

Annex A-2 shows the table to use when comparing alternative cropping patterns with the most common farmers patterns.

## ECONOMIC PERFORMANCE CRITERION TO BE USED

### Partial Budgeting

1. Change in net income = Financial gains-Financial costs

2. Benefit cost ratio = $\frac{\text{increment in net benefits}}{\text{increment in costs}}$

3. Marginal rate of returns (MRR)

$$MRR = \frac{\text{increment in net benefits}}{\text{increment in costs}} \times 100 \text{ for adjacent pairs of treatments.}$$

MRR is used to determine the most profitable level of input use. Treatments are listed in order of increasing costs. The MRR calculation is performed for each level with respect to the adjacent less expensive treatment. The most profitable treatment is the one: a) with the highest net benefit and b) with a MRR higher than the minimum or acceptable rate of return, which is dependent upon the cost of capital.

### Enterprise Budgeting

1. Return above variable costs (RAVC)

RAVC = Gross Returns - Total Variable Costs.

2. Returns to limiting inputs

Labor, in certain times of the year, cash, irrigation water or other inputs may be more limiting to the farmer than land. A farmer who is interested in profits will attempt to maximize the returns to his most limiting resource. For example if cash is a constraint, the comparison of the returns to cash, as reflected in the returns to material costs, between the improved practice and farmers practice is important. The calculation is:

$$\text{Return material costs} = \frac{\text{Gross returns - all other variable costs}}{\text{material input costs.}}$$

## DATA REQUIREMENTS AND COLLECTION METHODS

### Introduction

The data required for assessing the economic viability of a new or improved agricultural technology, tested in farmers' fields, varies according to the type of technology tested, the research design and if enterprise or partial budgeting is the analytical tool to be used.

In partial budgeting only the costs and returns that vary with the introduction of a new component technology need be considered. Enterprise budgeting requires information on all the variable costs associated with growing a crop, cropping pattern or animal including labor inputs. Different types of costs and products are associated with the growing of sheep than the growing of wheat. Additional information may be required if the trial is replicated across farms than if replication are within the same parcel of land.

In general however, the following types of data are required for budget analysis:

A. Levels and kinds of inputs used:

1. labor
2. power
3. machinery
4. seed
5. fertilizer
6. herbicide
7. insecticide
8. irrigation
9. feed
10. fodder
11. vaccine
12. medicine
13. parasite control
14. animals
15. land
16. etc.

B. Levels and kinds of outputs produced:

1. grain
2. straw or stover
3. green fodder including weeds.
4. fruit
5. other plant products-cotton sugarcane, tobacco etc.
6. weight gain
7. egg production
8. meat production
9. reproduction
10. milk production
11. wool production
12. hide production
13. etc.

C. Monetary values:

1. labor wage rates
2. tractor and machinery hire rates
3. irrigation rates
4. field prices of material inputs.
5. field prices of outputs
6. cost of capital estimates
7. transportation charges
8. etc.

Care must be taken to ensure that all required data are collected pertaining to the new component or patterns being tested as well as the control or most common farmers' patterns.

Care must also be taken to try to avoid biases in data collection. Biases can be reduced by using the same data collection methods for the new component or cropping pattern as with the control or farmers' patterns.

## Data Collection

### Wage rates

Wage rates can vary by season, task, sex or age and the most appropriate rates should be used in calculating costs of labor. Generally family, exchanged and hired labor is valued at the same existing wage rate, in the area, because the existing rate reflects the opportunity cost of labor.

Wages data can be collected monthly by the field assistants by using the form shown in ANNEX B.

### Farm tractor, machinery and bullock hire rates

Farmers have their own fixed capital assets such as water buffalos or ox, tractors, sprayers, water pumps, etc or they hire these services from others. It can be difficult to determine the costs of employing this capital in an enterprise. For simplicity, the existing rental or contract rate will be used to calculate the cost of using relatively fixed capital inputs into an enterprise.

In most agricultural areas, some farmers hire out their draft animals, tractor, thresher or irrigation pump to other farmers, for a price. This price can be on a per hour or per hectare basis and may include the operator.

It is important to determine if the wage of the operator is included in the rental or contract rates for the services of machines or animals. This prevents double counting the wage costs or missing an important inputs cost.

Owned or hired tractors, machinery or oxen are costed at the prevailing local hire rates when the operation is performed. These rates can be determined by the field assistants thru monthly interviews using the form shown in ANNEX C.

### Input costs

Field prices should be used for calculating the costs of inputs. For purchased inputs the field price is calculated by adding the costs of transporting the input from the market village to the farmers' fields (on average) to the purchase price. The same field price can also be used to value owned inputs such as seed.

Purchased prices can be collected by field assistants conducting monthly interviews using the form shown in ANNEX D. Transportation costs can be determined by noting the location and distance of the fields and by informally interviewing farmers.

## Output prices

In most cases, farmers do not receive the official government prices for their produce and the use of government prices can give misleading results.

All post-harvest costs, incurred by farmers, prior to sale, must be deducted from the sale price to estimate field price or the value of the crop to the farmer.

Post-harvest costs, which should be deducted can include costs of shelling, cleaning, drying, storing, threshing, hauling from the field to house, hauling from the house to the market etc.

In many cases, produce price depends on crop variety. If prices do vary with the crop variety, price data have to be collected for each major variety or variety type.

"When the farmers generally do not sell, an opportunity field price should be used, equal to the money price incurred to acquire an additional unit of the produce for consumption"

Often, the by-product of a crop has value and this should be determined. For example, in Northern Thailand, a rice farmer can earn up to 3,000 Baht/ha if he sells rice straw to the garlic farmers who use it for mulching. Crop residues are also a main source of livestock fodder in South Asia.

Plant residues can be bulky and may require storage. The relevant price is the value of the residue in the field at the time of harvest. Transport and storage costs must be deducted from the sale price if the farmer incurred these before the time of sale.

Information concerning the prices farmers commonly receive for their produce can be collected by the field assistants using the form contained in ANNEX E.

## Interest rates or cost of capital

Farmers have two main sources of loans to purchase agricultural inputs. These are from formal or institutional sources such as banks and cooperatives and non-institutional or informal sources such as merchants, money lenders, landlords, friends and relatives.

Most governments, in Asia, help provide institutional loans, thru banks or cooperatives to farmers at subsidized and relatively low rates of annual interest. However the costs of formal loans, to farmers, can be much higher than the interest rate charged.

The banks may charge attorney's fees and service charges in addition to the interest fees. Farmers must also incur the costs of transportation and waiting. The costs of waiting could be lost wages or a delay in planting a crop and a reduction of yields.

In general, institutional credit sources provide only a small part of the credit needs of the poorest farmers in Asia. Asia's small farmers generally rely on informal

credit sources for their credit needs. And the cost of this credit can be high, over 100% interest per year.

For budgeting purposes, the most common interest rate charged by informal money lenders for commercial loans (in contrast to interest free loans from relatives) should be determined. Also the length of time the loan is required for particular crop or cropping pattern should be estimated. This is generally from the start of land preparation to about one month after harvesting.

If farmers do not sell their output immediately after harvest and delay the repayment of the loans, additional interest costs can be incurred. However these are not due to the cost of production and should not be included in the enterprise budget.

For simplicity this"common" rate of interest is charged against all material inputs in crop production for each farmer, whether the farmers borrowed or not. This charge can be considered as the opportunity cost or the interest forgone by the farmer for not lending the amount of money, invested in material costs, out to others. This rate of interest charge is called the "cost of capital" by CIMMYT (1).

In Pakistan the cost of credit ranges from 20 to 30 percent but may vary from location to location, market to market and province to province. The credit availability status of the majority of the small farmers of a particular area and the direct or indirect methods used for charging credit must be considered when determining the costs of credit from non-institutional sources.

**Material inputs including irrigation**

The type, amount, and timing of application of material inputs, used for crop production, must be recorded for both the experimental and farmers' patterns. Examples include: seed, fertilizer, insecticide, herbicide, fungicide and others. The chemical content and % active ingredients of the pesticides used, as well as the mineral composition of the fertilizers should also be documented.

Timing, source, frequency, and amount (or duration) of irrigation supply to the plots should also be recorded, in part to be able to calculate irrigation costs. If farmers use their own pumps, fuel, repair and maintenance costs should also be documented.

The form shown in ANNEX F can be used to record the material inputs used.

**Labor**

Labor inputs for crop production include all time spent in the plots from land preparation to harvesting. This includes rest time, time devoted to monitoring pest or water conditions, irrigation control, etc but does not include lunch time and walking to and from the parcel and the house.

Also included are activities carried out outside the plots, required for growing the cropping patterns. This can include preparation and water hauling time for the spraying

of insecticide and herbicide. Also included could be the time devoted to seedbed preparation, seedbed care and the pulling and carrying of seedlings for the plot.

The time spent for hauling fertilizer or seed to the plot and output or produce to the house, harvesting, threshing, drying, etc. is excluded, because these costs are taken into account when estimating "field" or "farm gate" prices.

Generally, wage rates for hired labor vary through out the year, according to the task carried out and according to sex and age. In order to calculate labor costs, labor inputs are recorded according to week of year, task, sex and age. Labor inputs are also frequently categorized according to if it is family labor, hired labor or exchange labor.

The labor requirements for the experimental cropping patterns are collected from the 1,000 sq. m. plots devoted to CPTS. Labor data collected from plots substantially smaller than 1,000 sq. m. such as in research managed or super imposed trials are unreliable and probably biased and should not be used in assessing economic viability.

The labor requirements for the farmers' cropping pattern and practices are collected from plots completely managed by the farmers. After one or two years' labor data have been collected, it may be possible to develop labor standards, for each crop operation, to be used for further budgeting.

Many farm management types of studies have already been carried out in Pakistan which determine the labor inputs used to grow various crops. To the extent possible these data should be used to estimate the labor requirements for the farmers common practices and methods in growing crops. Estimates will have to be made of the additional labor required in adopting the new crop or cropping patterns.

If adequate labor data are not available and if the research budget is adequate, labor input data can be collected by combining observation and frequent interview and using the form contained in ANNEX H.

**Plot or parcel size**

Enterprise budgeting, as used in farming systems research, is calculated on a per hectare basis. Therefore the size of the plots used, in the cropping pattern trials and used to determine the levels of inputs and outputs from farmers' cropping patterns, must be known to calculate costs and returns per hectare.

The size of plots devoted to cropping pattern trials is generally 1,000 sq. meter of net cultivable area. Bunds, field canals, paths etc. are excluded from the 1,000 sq meter area which is carefully measured by measuring tape.

Farmers frequently do not have accurate estimates of their plot, parcel or farm sizes. Farmers commonly rely on local measures, such as the amount of seed required, the amount of time used for plowing etc. to estimate parcel size.

Official measurements by government organizations include the area taken up by bunds, canals, paths, and home lots.

It has also been observed that farmers increase the number of bunds and field canals, in the dry season, if rice is to be planted and decrease them if a dryland crop is to be planted.

Measurement may have to be taken of the plots used to measure the input-output levels of farmers' cropping patterns, to determine the net cultivated area comparable to the cropping pattern trials.

**Recommendations on FSR trials: Livestock Group**

By Mr. Ghulam Hussain Soomro
Associate Professor, Agricultural University, Tandojam

1. Stages in FSR for designing trials of new technology should be given due attention. This should include base line survey on resources and climate. Identify technologies that might be developed or adopted to increase farm system productivity. Prepare whole year fodder calendar according to the fodder and feed supply in different seasons.

2. Describe and diagnose farm problems and choose appropriate technologies for on farm trial.

3. Aspects of livestock production to be studied should be growth, reproduction, location, health, nutrition, breeding, livestock management and poultry production.

4. Check-list of costs involved in ruminant production should be identified.

5. Check-list of benefits of ruminant production should be identified.

6. Prioritise the constraints and the most crucial intervention should be studied.

7. Designing of experiment should be done according to the species of animals involved in research and the nature of experiment.

8. Identify the variables to be measured in relation to the interventions on health, birth rates, size and growth, location etc.

9. For monitoring on-farm animal research a site assistant may be provided who may be trained in day to day data collection.

10. The researcher should prepare monitoring schedules and follow them strictly.

11. For data recording, the formats should be developed according to the types of experiment in consultation with livestock and economics experts.

12. Economic analysis should include budgeting, quantifying economic benefits, partial farm analysis, gross margin analysis, cost of production, input - output budgeting, benefit cost analysis and production function analysis, according to the requirements of research.

13. Before starting the trial, record the inventory of the flock/herd at least twice in a year firstly in the beginning and then in end of the year. Assign value of each at the time of recording inventory. These values must be based on the prevailing market prices.

14. Measuring estimates must be per 50 units (small stock unit) in small ruminants and per animal unit in large ruminants.

15. Period of research experiment should be according to the nature of experiment.

16. Appreciated value should be included in returns and depreciated value must be accounted for in cost.

17. The research should be cost sharing and the inputs involved in the test factors of intervention should be contributed from the research fund.

18 While analyzing the research result all implicit and explicit costs should be taken into account . The implicit cost should be calculated on the basis of opportunity cost principle valued at the market prices prevailing in the area.

19. Income from by-products should be accounted for and the use of farm perquisites should be valued at farm level prices and accounted for.

20. Sample size should be limited to study interventions but must envelope the objectives. It should be representative of the recommended domain. In large animals if the sample is very small then cross-over design should be followed.

21. For complete identification of animals, marks of identification of each experimental animal should be noted along with the ear tagging.

22. System interaction should be identified and incorporated into the research plans.

23. Impact assessment of an intervention should be given due consideration including the extent of adoption.

## Recommendations on FSR trials: Crops Group

By Dr. Mansab Ali, NARC

| | | |
|---|---|---|
| 1. | Problem Statement: | Must be defined clearly and title of the project must be comprehensive. |
| 2. | System Introduction: | Seasonal calendar (alongwith months) must be clearly given;<br><br>Existing system: Wheat-fallow-wheat improved system: Wheat-mungbean-wheat.<br><br>Give reasons why farmers keep the soil fallow after wheat. Climatic factors should be mentioned (Av. rainfall, temp. irrigation system & water quality etc). Soil classification must be mentioned. |
| 3. | Proposed Intervention: | It should be specific-whether new crop or new technology, e.g. fodder scarcity, Sadabahar a multicut fodder, late wheat planting, short duration variety. |
| 4. | Design with Treatments: | Select homogeneous group of farmers and soil series intervention to address only major problem.<br>Mention treatments; if more than two treatments, number of replication should be 4-6. For two treatments at least 6 replications. |
| 5. | Levels of Inputs:- | Should include all like<br>1. Variable inputs or treatment e.g. variety, scale or fertilizer.<br><br>2. Common inputs or treatments e.g. Ploughing, planting, planting method, fertilizer, irrigation, plant protection, harvesting, threshing |
| 6. | Data to be Collected: | (i) Grain yield & straw/stalk yield (all cereals)<br>(ii) Grain & stalk yield (sunflowers & sesames), cane & tops (Sugarcane)<br>(iii) Green & dry weight (fodder crops) grain & straw (mungbean) |

7. Sampling Size: 1 x 1 m for all treatments. It can be adjusted according to crops. No. of sample should be 3-5 and these should be randomly selected.

To adjust yield; deduct 5-10 % yield or produce according to the judgement of researcher. It can be increased or decreased by specifying a reason.

8. Statistical Analysis: Data must be presented with statistical analysis and mean comparisons.

## References

Parts of this handbook follow:

Marlin G. Van Der Veen and C.L. Gonzales Farming Systems Socio-Economic Research Training Course Training Materials, IRRI, 1986;

and

Marlin G. Van Der Veen, "Data Collection and Analysis For the Economic Evaluation of NTASP Field Trials With Annual Crops" - NTASP Report Number 24, AARD, June 1989, Kuping NTT.

## Evaluation of Flushing And Deworming Output of 100 ewes (Seasonal lambing)

| | Treated | Control |
|---|---|---|
| No. of ewes lambing | 95 | 80 |
| No. of sets of twins | 20 | 5 |
| Total lambs born | 115 | 85 |
| Lambs mortality | 15% | 20% |
| No. of lambs sold | 98 | 68 |
| Age of lambs when sold | 7 mo | 7 mo |
| Weight of lambs sold | 25 kg | 22 kg |
| Price per kg | 15 | 15 |
| Value per lamb (Rs) | 375 | 330 |
| Total value of lambs | 36750 | 22440 |

Extra Costs

Deworming

100 ewes at Rs 2.00 = 200
100 lambs at Rs 1.50 = 150
labor 50

Flushing

0.125 kg x 42 days
x Rs 2.0/kg x 100 ewes l= 1050
labor 2 hrs per day
Rs 30.0/8 hrs 315
Total extra costs = 1765

Other potential benefits

- Adult mortality
- Age of culling
- Weight/value when culled
- Wool production/value
- Age at 1st mating

Net benefit from additional lambs 36750 - 22440 - 1765 + 12545
Benefit cost ratio = 8.1
Break even extra 118 kg of lambs - say 5 x 24 kg

## Land Type Summary of Cropping Pattern Performance

Site: _____ Land Type: _____ Year: _____

| OBSERVATIONS | Pattern 1* | Pattern 2* | Pattern 3 | Pattern 4 | Pattern 5 |
|---|---|---|---|---|---|
| Fields tested (no.) | | | | | |
| Failures (no.) | | | | | |
| Gross returns | | | | | |
| Labor costs | | | | | |
| Power costs | | | | | |
| Material costs | | | | | |
| Costs | | | | | |
| Costs | | | | | |
| Total variable costs | | | | | |
| Returns over variable costs | | | | | |
| Returns to labor costs | | | | | |
| Returns to material costs | | | | | |
| Returns to costs | | | | | |
| Returns to costs | | | | | |
| MBCR 1 | | | | | |
| MBCR 2 | | | | | |

*First or first 2 patterns should be prevalent farmers patterns. Labor costs should include the value of all labor used, whether supplied by researchers, family, exchange labor, or hired sources. Costs and returns to other factors considered important, e.g. total cash requirements, costs of hired labor, harvest labor, insecticides, etc. MCBR 1 is the ratio in relation to pattern 1 and MCBR 2 is the relation to pattern 2.

ANNEX B

## LABOR WAGES OR SALARY

Location: _____ Year: _____ Source of information: Farmer____ Labor ____

Date of Interview: _____

| Operation | Crop | Date employed | Wage or Salary (2) | Units (3) | Comments |
|---|---|---|---|---|---|
| | | | | | |

1) Carry out these interviews from the time of land preparation to harvesting. Interview a few farmers who hire labor and a few laborers who work on other's farms. Try to collect wage or salary data for all major crops and tasks for which labor is hired..

2) Make sure the wage is the total wage. Add the cost of food, snacks, etc. to the cash wage. You must estimate the value of the typical non cash payments.

3) The units should be hours, 8 hour days, week, months, hectares, etc.

ANNEX C

## WATER BUFFALO, CATTLE, TRACTOR OR MACHINERY HIRE RATE

Location: _____ Year: _____ Source of information: Farmer____ Owner ____

Date of Interview: _____

| Operation | Crop | Dates employed | Hire Rate (2) | Units (3) | Land Type | Comments |
|---|---|---|---|---|---|---|
| | | | | | | |

1) Carry out these interviews from the time of land preparation sale of product. Include animals used for threshing and transport of inputs or produce. Interview a few farmers who hire their animals or tractor out. Try to collect data on all important tasks carried out by hired animals.

2) Make sure the rate is the total rate including in kind payments. Add the cost of the food, snacks etc. to the each payments. The cost of the person(s) driving the animals is included in the animal hire rate.

3) Indicate the number of animals considered in the hire rate and if it is on hour, perday.

## INPUT PRICES (1)

Location: _____ Year: _____ Supplier :_____
:_____
Location :_____

| Input (2) Unit | Source | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |

1) Obtain the data from each of the important suppliers of inputs to the farmers. If input prices differ from supplier to supplier interview a few to determine the most common prices.

2) List all major purchased inputs and describe them clearly (e.g. urea, furadan, etc.) and make sure the unit is clearly indicated (kg, liter, etc.).

ANNEX E

PRICES FARMERS RECEIVED IN THE DESA OR NEARBY AREAS

Location: _____ Date of data collection: _____ Year: _____

| Crop | Variety(S) | Price (2) | Unit | Date of Selling | Where sold (3) | Source of Information | |
|---|---|---|---|---|---|---|---|
| | | | | | | Farmer | Merchant |
| | | | | | | | |
| | | | | | | | |
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1) This form is used shortly before harvest and up to a month after harvest. Interview a few farmers who sold their produce, also interview a few merchants who purchased the produce. Collect price data on all crops in trials and in parcels used to compare with the trials. Collect this price data about once a week.

2) Payment in kind or barter can also mentioned.

3) At the farms, local markets (where), etc.

MATERIAL INPUTS USED
Location: _____

Location: _____ Date of data collection: _____ Year: _____

| Input | Type or A.I.* | Amount Volume | Date Applied | Method of Application | Cost per Unit | Local cost for parcel |
|---|---|---|---|---|---|---|
| Seed | | | | | | |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| Fertilizer | | | | | | |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |
| Herbicide | | | | | | |
| 1 | | | | | | |
| 2 | | | | | | |
| Insecticide | | | | | | |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| Manure | | | | | | |
| 1 | | | | | | |
| 2 | | | | | | |
| Others | | | | | | |
| 1 | | | | | | |
| 2 | | | | | | |

* A.I. = Active Ingredient

# LABOR AND POWER REQUIREMENTS FOR CROP PRODUCTION

Location:_____Farmers Name:_____Improve:_____Plot No.:_____Farmers:____

Date: _____

| Items | TASKS | | | |
|---|---|---|---|---|
| | Task 1 | Task 2 | Task 3 | Task 4 |
| (1) | (2) | (3) | (4) | (5) |
| Date task started (1) | | | | |
| Time task started | | | | |
| Date task ended | | | | |
| Time task ended | | | | |
| FAMILY LABOR | | | | |
| Number of adult females | | | | |
| Ave. Number of Hrs. | | | | |
| Total labor Hrs. (2) | | | | |
| Number of adult males | | | | |

| (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|
| Female rate | | | | |
| Female cost | | | | |
| Male rate | | | | |
| Male cost | | | | |
| Children rate | | | | |
| Children cost | | | | |
| Ave. number of hrs. | | | | |
| Total labor hrs. | | | | |
| Number of children (3) | | | | |
| Ave. number of hrs. | | | | |
| Grand total family labor hrs. (4) | | | | |

| (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|
| DROUGHT POWER | | | | |
| Number of animals | | | | |
| Ave. hrs. worked | | | | |
| Total drought power work | | | | |
| Hire rate | | | | |
| Total cost of drought power | | | | |
| EXCHANGE LABOR | | | | |
| Number of adult females | | | | |
| Ave. number of hrs. | | | | |
| Total labor hrs. | | | | |
| Number of adult males | | | | |
| Ave. number of hrs. | | | | |
| Total labor hrs. | | | | |
| Number of children | | | | |
| Ave. number of hrs. | | | | |

| (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|
| Total labor hrs. | | | | |
| Grand total exchange hrs. | | | | |
| HIRED LABOR | | | | |
| Number of adult females | | | | |
| Ave. number of hrs. | | | | |
| Total labor hrs. | | | | |
| Number of adult males | | | | |
| Ave. number of hrs. | | | | |
| Total labor hrs. | | | | |
| Number of children | | | | |
| Ave. number of hrs. | | | | |
| Total labor hrs. | | | | |
| Grand total hired labor hrs. | | | | |
| Grand Total Labor Hrs. | | | | |

ANNEX H

## Directions for using the labor and power requirements form

- These data should be collected by interviewing the head of household weekly, during the busy times of the crop season such as land preparation, seeding and harvesting and bi-weekly during slower periods such a during vegetative growth.

- Interview only for those plots devoted to improved or new cropping patterns and those plots selected for comparison and devoted to the most common farmers' cropping patterns and practices.

- Note that during an interview, a farmer may be in the middle of a task. This is indicated by leaving "date task ended" and "time task ended" blank. Only the hours devoted to the task, up to the time of the interview, is recorded.

- Then at the next interview, the date and time the task in question was completed is noted and the number of hours required to complete the task, since the last interview, is recorded.

- To carry out this interview correctly, the filled out interview form, used in the last interview, must be available at time of interview, to see if there were any uncompleted tasks at last interview.

- Total labor hours is obtained by multiplying number of workers times the average number of hours worked per worker.

- Children are 14 years old or less. Those who are 15 years old or more are considered as adult.

- When calculating grand totals, female and male labor hours can be considered as the same or 1.0 labor unit but children as 0.5 labor units.

- Write in all the tasks or field operations carried out on the parcel since the last labor and power input interview.