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# PRODUCTION SYSTEMS RESEARCH: SOME METHODOLOGICAL CONSIDERATIONS

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## ABSTRACT

The major limitation of traditional station-based research is its failure to account for the multiplicity of socio-economic and ecosystemic variables that determine the success or failure of the farmer. Production systems research however focuses on the farm and the farmer using station-based research to complement the farm-based work. This paper deals with the issues involved in the ex-ante analysis of the factors affecting farm profitability. These considerations result in the identification of research opportunities vis-à-vis cost of research and the definition of the domain of recommendations. The instruments used in this exercise are identified and briefly discussed. The ex-post analysis of the results of the research efforts using economic evaluation criteria lead to the selection of alternatives or modified systems which may improve the farm. Some of these economic criteria are discussed. The paper recognises the tremendous virtues of production systems research but notes the factors (political, social, economic) which influence the adoption of alternatives.

## RESUMEN

La mayor limitación de la investigación tradicional-en al sede (estación experimental) – es la falta de considerar la multiplicidad de variables socio-económicas y ecosistemáticas, las cuales determinan el éxito o el fracaso del agricultor. Sin embargo, la investigación de sistemas de la producción, concentra sus miras en la finca y en el agricultor utilizando, investigación-en la sede para complementar el trabajo en la finca. Este informe trata de puntos involucrados en el análisis "ex-ante" de los factores que afectan las ganancias de la finca. Estas consideraciones resultan en la identificación de oportunidades de investigación en lo referente a, el costo de la investigación y la definición del "dominio de recomendaciones." Las técnicas y métodos utilizados en este ejercicio se identificaron y discutidos brevemente. El análisis "ex-post" de los resultados de la investigación, utilizando un criterio económico de evaluación, facilita la selección de alternativas o sistemas modificados, lo cual mejora la finca. Algunos de estos criterios de la investigación de sistemas de producción, pero apunta los factores (políticos, sociales, económicos) que influyen la adopción de alternativas.

Keywords: Production Systems Research

The differences between conventional research (station-based) and on-farm research are significant. Experiment station-based research, the research strategy which most of us are familiar with, focuses on specific components of the farm e.g. selection of new varieties, herbicide trials, fertilizer trials, soil amelioration, animal breeding, energy nutrition, pasture germplasm etc. Usually these components are selected for emphasis because, in the judgement of the researcher, the specific components are the most limiting factors in improving farmer productivity.

The other important assumption of the researcher is that when the selected component is ameliorated farm improvement will necessarily result i.e. all other conditions will remain more or less the same. Those familiar with the experiences of farmers in their ongoing interaction with the sociopolitical systems and the agroclimatic variables will appreciate that the improvement of one component of the farm system, no matter how important, may not necessarily lead to increased productivity. In fact the dislocation created by the new improved component may well lead to a deterioration in farm profitability.

It is the importance which the researcher attaches to the whole farm system vis-à-vis its components that distinguishes on-farm research, farming systems research, production systems research or whatever it may be called from conventional experiment station type research.

The rest of this paper will focus on the tools and strategies used in production systems research to accomplish its major objectives:—

the improvement of the productivity of the whole farm given the social, economic, political and agro-climatic circumstances of the farm or farmer.

**Steps in production system research.** The logical steps (approach) in the production systems research are not unique to it but are much more critical to the success of production systems research than they are to that of station-based research (Fig. 1). Briefly, production systems research methodology consists of characterization, design and testing activities all leading to the selection of alternatives adjudged to be capable of improving farm productivity and/or profitability within the recommended domain.

**Farm characterization:** Characterization provides data for the ex-ante analysis which identifies the opportunities for research and the limitations. The aim of characterization is to take into account the circumstances of the farm or farmer which influence the factors limiting productivity and their possible solutions and to enable the researcher to take into account the variability among the groups of producers or farmers in order to make the investigation more efficient. These circumstances of the farm include:—

- (1) Farmer's goals and his resource constraints.
- (2) Markets for both products and inputs.
- (3) Institutional issues such as land tenure, credit, extension.
- (4) Governmental policies.
- (5) Natural factors (climate, pests, diseases, weeds, soil etc.)

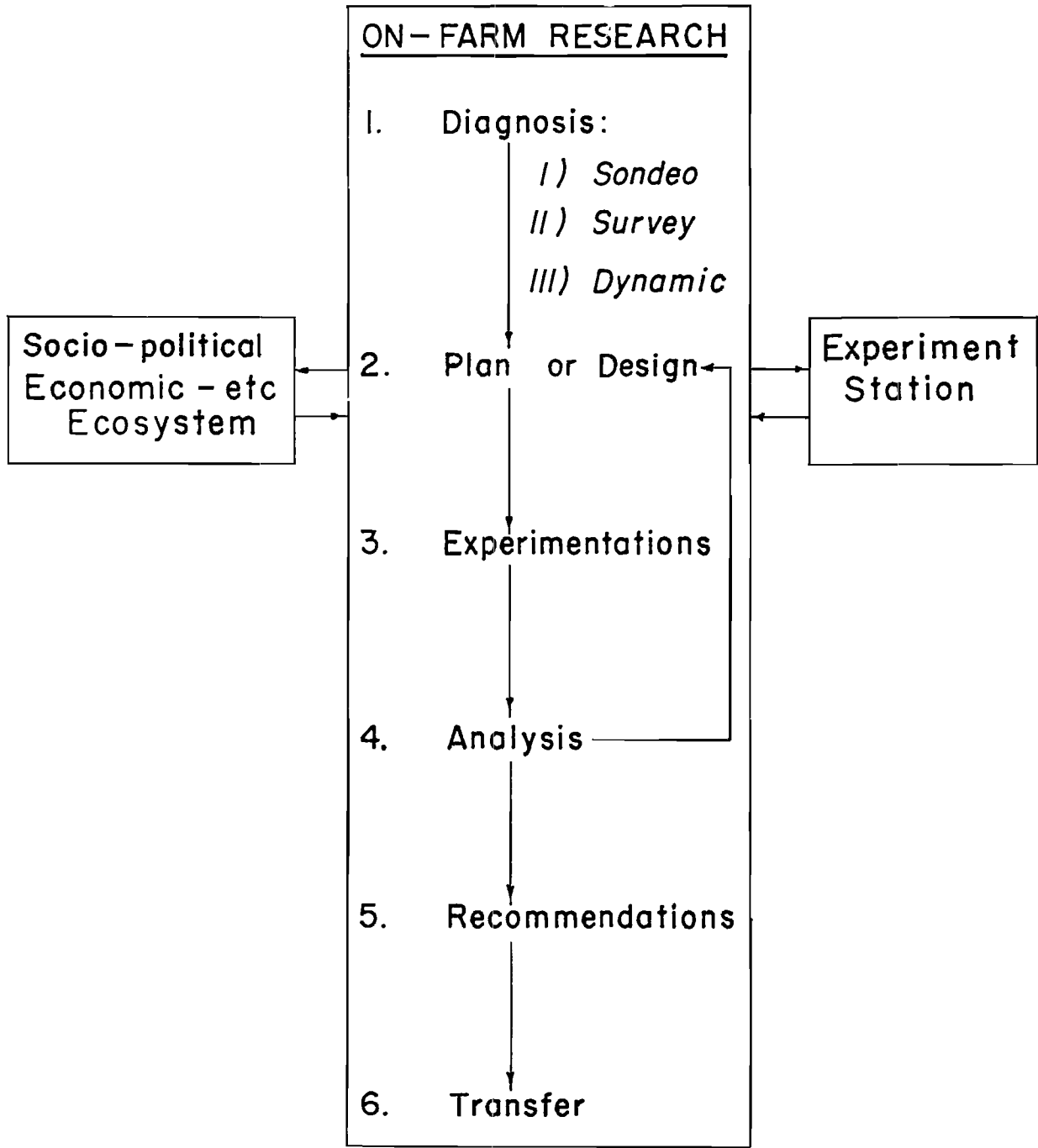


FIGURE 1: Schematic of Research Strategy

The researcher attempts to define the circumstances of the product as perfectly as possible. In this he uses a number of diagnostic strategies:—

- (a) Sondeo )
- (b) Survey ) (static diagnosis)
- (c) Monitoring studies over time (dynamic diagnosis)

These diagnostic approaches should not necessarily be seen as phases in the methodology, but as they should be, as aids in the investigation.

The Sondeo is an informal survey usually by a multidisciplinary team without the use of formal questionnaires. The Sondeo is a reconnaissance survey. Other sources of static diagnostic information are published and unpublished information from e.g. census, government publications, interviews with officers (vets, extension etc.) in the region of interest. Because all these sources of information refer to the farmer's circumstances at one point in time they are referred to as static diagnostic data.

The dynamic diagnostic information is obtained by gathering data on the relevant or specific aspects of the farm of interest over a given length of time. By so doing the changes on the farm due to voluntary or involuntary reasons are picked up in the farm system. This type of diagnosis indicates the importance of factors identified in the static diagnosis. Dynamic diagnosis also provides data for doing economic analysis where flow or time are important.

Both static and dynamic diagnosis provide information which enables the researcher to design or select alternatives aimed at improving farm productivity or profitability.

Information from diagnosis is used to identify the factors limiting production, their causes and possible solutions. Diagnostic information also helps in the planning of investigations. Solutions are first sought from existing knowledge (literature) and only when existing knowledge cannot provide solutions should experimentation be initiated. It is therefore obvious that adequately planned production systems research ensures that research resources are efficiently utilized and that duplication of research is kept to a minimum.

Simple statistical procedures like means, simple frequencies, cross tabulations and mean comparisons of two sub-populations (students t-test) are used in handling survey data to enable the researcher to identify factors that limit production or income and the interaction between these factors and the farmers current practice.

**Domain of recommendation:** A domain of recommendation is a group of farmers or producers whose circumstances, social or economic or ambient are sufficiently similar such that the same recommendation is appropriate for all of them.

Domain of recommendation does not necessarily indicate zones; region of adoption or adaptation does.

The domain of recommendation is very important for the researcher and is within his competence to define. The domain of recommendation helps him (the researcher):

- 1) to identify groups of producers who have the same problems of production

- 2) To identify appropriate solutions for those problems
- 3) To select representative sites for experimentation
- 4) To analyse experimental data
- 5) To make recommendations for the use of a well-defined group of producers.

**Criteria for selecting priorities for research:**

- 1) The activities selected must be of great importance in influencing the income of the farmer
- 2) The activity selected must use important quantities of the scarce resources of the producers (land, labour, capital)
- 3) The problem or factor limiting productivity should be identified within the selected activity or potential source of loss and/or important to income
- 4) The problem or limiting factor should be common to a relatively large group of producers, or the domain of recommendation should be sufficiently large.

**Selection of possible solutions:** will involve consideration of:

- 1) The technical factors involved
- 2) Yield
- 3) Risk
- 4) Compatibility with the production system
- 5) Cost of the research.

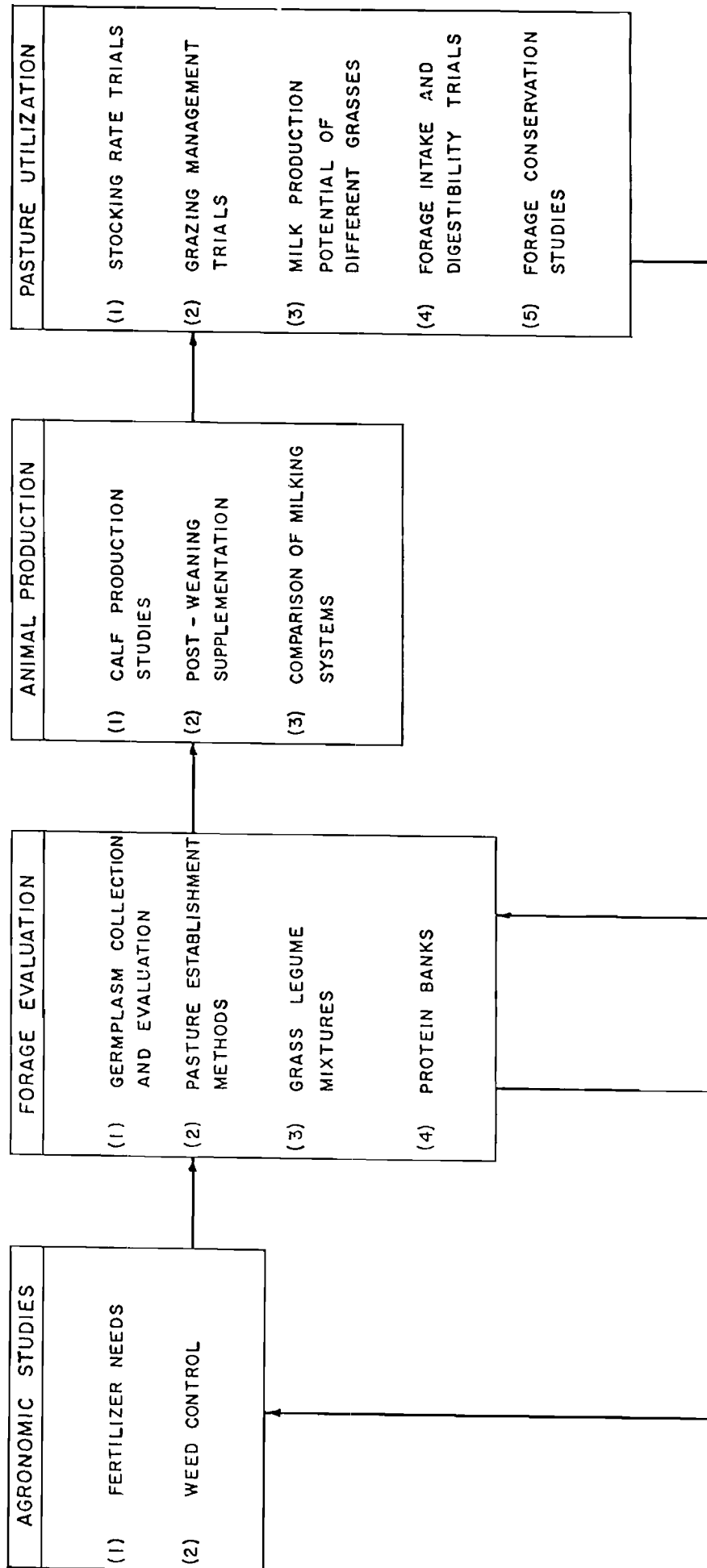
**Design of alternatives:** Farm characterization results in a clear definition of the existing system of production on the farm, the identification of the factors limiting production and their potential possible solutions. Knowledge of all the above enables the researcher to design possible alternatives to the existing systems on the farm. The alternatives could be subjected to economic analysis (ex-ante) before the alternatives are tested to indicate their potential benefits or the opportunities for research. At this stage mostly simple economic analysis e.g. partial budgeting techniques are used to estimate the net benefits of the alternatives *vis-à-vis* the existing system(s).

On the basis of the ex-ante analysis of the alternatives the following may happen:

- 1) The alternatives appear to be definitely better than the existing system indicating the need for testing of the alternatives
- 2) The alternatives are worse than the existing system indicating the need to study the farm system further to identify the most important limiting factors and their possible solutions. These will lead to the design of new and probably better alternatives. In this case testing or experimentation is clearly not indicated.
- 3) Certain components of the alternative need to be researched. This will directly lead to component research of the experiment station type. The results of these will be fed back and may lead to the retention of, or modification of, the alternative as now conceived (Fig. 2).

The number of options could well be several fold. The points made above have been selected to highlight the complexities of the analytical effort needed before a decision is made to undertake additional expensive experimentation.

FIG. 2. DETAILS OF COMPONENT RESEARCH ACTIVITIES



**Testing (Experimentation):** Having chosen the promising or potential alternatives, these are tested under the farm conditions obtaining in the domain of recommendation. The results of this testing may lead to the further modification of the alternatives and further testing. Above all, the testing activities will provide real data with which to do ex-post economic analysis, the results of which will enable the researcher to choose an alternative to recommend for adoption.

**Analysis:** The results of the testing activities have to be subjected to a number of analyses:-

- 1) Statistical
- 2) Economic

Here again lies a very important difference between farm-based and station-based research. While in station-based research there is an inordinate emphasis on statistical comparisons, the importance of these is diminished in farm-based research. Economic analysis assumes a much greater emphasis. The reasons for this are rather obvious. Farm-based experimentation does not lend itself to the clearcut choices of randomization, stratification, replication and uniformity.

The importance of economic analytical tools in production systems research is so great that the following section is devoted to a brief consideration of some of the analytical tools used in the evaluation of tested alternatives.

**Economic analytical tools:** Some of the economic tools available for the evaluation of alternatives include –

- 1) Partial budgeting (net benefit estimation)
- 2) Production functions aimed at optimization of production or minimization of costs.
- 3) Costs including opportunity costs, fixed and variable costs
- 4) Prices, both at the farm gate and at the market
- 5) Marginal analysis

- 6) Cash flow analysis including the use of the tools of internal rate of return (information for this will usually become available from the dynamic diagnosis exercise). Cost of capital etc.
- 7) Linear programming – mainly used to allocate resources and select products.

One or a combination of these economic tools should be used in the choice of alternatives. For example the use of partial budgets is further discussed below:

**Partial budgets** are designed to analyse the profitability of proposed changes in the operation of a farm where the change is relatively small. Only the changes in **costs** and **income** are included in a partial budget and the total of additional costs and reduced income are compared with the total of additional income and reduced costs to find the estimated change in profit (net benefit).

Partial budgeting can be a very useful and powerful tool for analysing the many small or marginal changes in farm plans which a manager may wish to consider. The partial budget is an alternative to the use of the production function analysis but it should be appreciated that it is easier but also less precise. The production function approach is particularly useful for the evaluation of continuous data for example in the estimation of optimum fertilizer rates.

This presentation has argued that the evaluation and choice of alternatives should be based on the results of objective criteria derived from, for example, the use of standard economic tools. After all the farmer's objective is to improve productivity and profitability.

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