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GENERAL REVIEW OF A STRATEGY OR METHODOLOGY FOR AREA SPECIFIC AGRICULTURAL RESEARCH

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Introduction

The main purpose of agricultural research is the generation of improved agricultural technology for the advancement of agriculture. The effect of agricultural research manifestates after the improved technologies are adopted and put to action by the farmers as final users. Adoption depends on farmers' interest and on their possibilities, incentives and support given to them for the use of those improved technologies. Possibilities, incentives and support depends on the resource base managed by farmers, their knowledge to utilize those resources and the total socio-economic environment which shapes their activities and behavior; of primary importance, in this environment, is the existence and performance of extension, credit, marketing and other institutions created to give them the additional and necessary support and services.

Agricultural Research can be much more effective if all these considerations are part of its objectives and methodologies. The objectives should be the generation of improved but also appropriate and adoptable technologies. The methodologies should consider the existing technological and resource situation as well as the interaction with other institutions and the farmers themselves.

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The objective for this paper is to develop a line of thinking which could be used as guideline for agricultural research under the above considerations. For doing this, the whole process of technology generation - evaluation - validation and diffusion, as well as the resource and institutional environment in which this occurs, will be reviewed. This revision will be based on the rationalization of previous and actual experiences gained during the Small Farmers Cropping Systems Project in the Central America Isthmus. This Project has been carried out by CATIE in collaboration with the Agricultural Research and/or extension institutions in every country, under the financing of AID/ROCAP, since 1975.

Conceptual Framework for an Applied Agricultural Research Methodology

Identifiable among the institutions of every LDC, are those whose common objective is the improvement and advancement of the agricultural sector. In agreement with this objectives overlapping, the mandates of all those institutions include the coordination of their actions as a necessary requirement for improving their individual as well as combined performance. This is specially important when the human, physical as well as financial restrictions in the LDC are considered.

In practice, however, there exist a clear tendency to an individual and specialized action of every institution, in particular those of agricultural research. The diagnosis of this situation tends to identify as cause and/or effect the lack of effective communication and coordination among themselves.

A possible guide for better communication and coordination among the institution could be the identification of points of agreement. Among these points of agreement is the realization that one way of contributing to the improvement and advancement of agriculture is through the generation and effective diffusion of improved, appropriate and adoptable agricultural technologies. This in turn, have clear implication both for their individual actions and procedures as well as for their interactions during their work toward the common objectives.

Improved, appropriate and adoptable technology, the concept

The final objective of adoption of improved technologies by farmers imposes certain conditions to those technologies and to their generation process. Besides being improved the technologies have to be adoptable by farmers which implies that they are appropriate to their working conditions. The provision of these requirements will also facilitate the action and support of other institutions to the process.

Technology as concept implies two components; one of resource endowment (quantity, quality, type, cost) and one of knowledge (how to combine resources in space and time) which interact to produce a socially desirable good. Adoptable technology then, indicates a congruence or appropriateness between the resource and knowledge requirement of the improved technology and those existing at the farmer's level (the adopting subject).

The idea of improved technology indicates the existence and identification of an existing technology in relation to which the new one is "better" This

is related to the incentive the farmer sees for trying the adoption. In this respect the researcher should answer the question "improved in what respect?". What is better and attractive for the researcher may not be for the farmer. What is necessary is that the farmer perceives the new technology as improved and attractive.

The conclusion for this argument is that when the objective is to generate improved and adoptable technologies, the researcher needs to know the final users, their present technologies - this is their resources and knowledge - their aspirations, goals, and total environment to base his work.

The farm as framework for the generation, evaluation, validation and diffusion of improved and adoptable technologies

The requirement of knowledge about the farmer, his technology, resources endowment, knowledge, attitudes, goals and his total environment imposes a complex task. To handle this complexity, the researcher needs to identify a focal point which reflects the effect of all those factors, and a tool which allows him to understand it for the purpose of using it in the generation, evaluation, validation and diffusion of improved agricultural technologies.

The identified focusing point is the farm. A farm is an organized decision making unit in which crop and/or livestock production is carried out for the purpose of satisfying the farmer's goals. In doing so, the farm interacts with the physical, biological and socio-economic environment in which it has to operate, and may change in structure over time.( )

The tools being developed to handle this complexity are mainly based on the "system approach" ( ). The system approach visualizes the farm as a system. As such a farm system, whole farm system or farming system is a complicated interwoven mesh of soils, plants, animals, implements, workers, other inputs and environmental influences with the strands held and manipulated by a person called the farmer who, given his preferences and aspirations, attempts to produce outputs from the inputs and technology available to him.( )

Any research which views the farm in a holistic manner and as a framework for guiding and evaluating research could be included under the generic term "Farming System Research". The last review of this type of research, done in Nairobi in May 1978 during the "Workshop on Farming Systems Research", includes under such heading; crop systems, cropping systems, livestock systems on whole farm systems research.

The same workshop defines Farming System Research as one which:

(1) Is conducted with a recognition of a focus toward the interdependencies and interrelationships that exist among elements of the farm system, and between these elements and the farm environment;

(2) Is aimed at enhancing the efficiency of farming systems;

(3) Focuses on enhancing the relevancy of agricultural research;

(4) Facilitates the generation of innovations, and,

(5) Facilitates the testing of innovations for their applicability to the farm.( )

It is obviously clear that a holistic research approach can not be carried out with efficiency under the tradition of researchers acting independently under the focus of thier own disciplines. What is needed is the concurrence

of concensuses from different disciplines to form multidisciplinary group tending to act as an interdisciplinary team. These teams should include experts from the different agronomy and animal husbandry branches as well as from the social sciences.

In the same manner it is easy to realize the necessity for effective coordination among the different institutions which participate in the process generation-adoption of improved agricultural technologies.

A general methodology for cropping systems research for small farmers

The methodology to be discussed pretend to guide researchers to: the generation of improved technologies for cropping systems practiced in small farms of specific areas and to evaluate and validate those improvements. Furthermore it is expected to show how the different phases of the methodology will provide ideas and guideline for an effective diffusion of the improved technologies.

The phylosophy backing the approach requires to include the farmer, extension agents and other institutions agents collaboration and knowledge in the process. What this implies is that most of the work should be carried out in farms of selected areas. It also implies that the work should be carried out by a multidisciplinary team. A multidisciplinary team needs a manner to integrate action. The strategy is to focus attention in the cropping systems framed by the characteristics of the farm and total environment, guided by the system approach. The system approach implies that cropping systems should be studied for improvement in any of their components, in any of the interactions

among their components or in any of the interaction among their component or the whole cropping system with other farm and environmental factors.

To be consistent with the final "adoption" objective of agricultural research, the methodology to discuss includes the following interacting phases:

a) Area Selection.

b) Initial characterization of farms and cropping systems of interest, the farmers and total environment.

c) Identification and ordering by priority of: problems or limitations requiring solution within the scope of work, and criteria for evaluation, validation and diffusion of research results.

d) Identification an modelling of technically and socio-economically feasible and adoptable solutions to priority problems within the scope of work.

e) Field experiments, agronomic and economic evaluation of proposed solutions, at farm level and interacting with farmers. This phase may need supporting work in experimental stations or other environment controlled situation.

f) Validation of most promising cropping systems modifications on alternatives, under the strict management of the farmer.

g) Adequated and attractive "final product" presentation both to farmer and to other agricultural supporting institutions.

Everyone of these phases will be discussed in more detail showing the constant feed and feedback process among them.

AREA SELECTION

The objective of generating improved and adoptable technologies requires a clear identification of the farms and farmers who are supposed to adopt the results. At a country level, farms and farmers vary a lot and for many reasons. The implication is that for obtaining a client definition a farm and farmers classification procedure is needed.

The most common classification, in censuses or other type of studies, group farmers per area and per stratum whitin each area.

For this paper the stratum of interest enclose those farms of restricted resources or small farms.

To think of a low or restricted resources farmer is commonly associated with farms which are small in surface land in relation to the productive potential in the area. However, a strict definition of a small farmer ought to include his limited access to political power, to the productive services, to all productive factors including land, as well as to the income stream of the whole society. What this implies is that a exact and useful for identification definition will depend on the working area. In this manner the area selection is a key action for focussing a research effort as the one in discussion.

The area selection process should include the research team, the research financing institution and the government criteria. These criteria ought to include considerations ranging from the pure technical ones to the socio-political ones. A possible ordering for these criteria could result in the following classes: A. Priority Aspects; B. Team's possibilities to provide research results appropriate to the priorities and C. Projection of the results domain in time and space.

A. Priority Considerations

The most basic priority in selecting an area for applied research purposes relates to the number of persons involved and their necessities. Therefore areas with greater population density will likely be of first priority. High population density indicates greater necessity and demand for agricultural products as well as greater pressure on agricultural resources. These are social and technical considerations.

Priority based on population may be acentuated because of low quality, deteriorating or badly distributed resources; a defficient agricultural technology in relation to the country's technical possibilities or a defficient marketing structure or performance.

A general priority picture could be constructed considering the different possible combinations among population, resources, technology and marketing structure priorities. A simplification of this picture is presented in Table 1, where (+) indicates a high priority and (-) a lesser priority for the different criteria heading each column.

No doubt one should expect great interactions among these criteria; i.e. the agricultural technology for an area reflects the influence of population density, resources quality and the lack or existence of a good marketing structure. These interactions should be taken into account.

This general priority picture could be modified by present and short run governmental plans and policies. Rural development investment plans, be then in general infraestructure or in institutional structure, will have to be taken into account for the generation of improved or new technologies appropriated to the area considering the whole potential for the farmers under the new plans.

Table 1. Priority picture for an area, based on population, resources, technology and marketing structure considerations.

Priority Type	Population	Marketing Structure	Resources	Technology
a	+	+	+	+
b	+	+	+	-
c	+	+	-	+
d	+	+	-	-
e	+	-	+	+
f	+	-	+	-
g	+	-	-	+
h	+	-	-	-
i	-	+	+	+
j	-	+	+	-
k	-	+	-	+
l	-	+	-	-
m	-	-	+	+
n	-	-	+	-
o	-	-	-	+
p	-	-	-	-

\+ Indicates high priority based on the specified criterion.

\- Indicates lower priority based on the specified criterion.

The governmental investment plan could consider the opening of new or improved roads to key product markets; marketing terminal opening in selected areas; opening of key agricultural support institutions agencies such as credit; resource conservation investments etc. In other occasions those plans could incentive a specific type of agricultural enterprise (i.e. cooperatives) therefore their existence or the possibilities for their creation in a specific area will have more weight in the final area selection.

B. Team's Possibilities to Provide Research Results Appropriate to Priorities

The possibilities of providing research results in agreement with the area conditions and priorities are determinant of the research specific objective identification and result evaluation criteria identification. They are also related with the "impact" possibilities in the area for the research group. This impact possibility is not only a necessary consideration for the research group but is also of interest for the farmers and other institutions involved in the process.

To the research team, the possibilities for obtaining beneficial results of some impact will be greater if the existing technology allows improvements. In general however, the impact possibilities through technological advancement depends on actual technology situation but also on resource conditions, resource distribution among producers and marketing structure in the area.

These considerations require again to keep in mind the researchers possible interaction with other institutions operating in the area. Doing this will also help to avoid cases of selecting an area where the solution to the priority

problems are beyond the teams capabilities.

Generally speaking the impact possibilities for a research team in a given area depend on the a) production and improvement possibilities provided by the environment and the b) farmers possibilities to take advantage of those possibilities.

Production and Improvement Possibilities

The production and improvement possibilities for farmers on an area depend on physical, biological, social and economics environmental factors.

The physical and biological environmental factors are mainly related to the general climate and soil characteristics (resource productive quality). They also relate to the products which can be produced in the area and the biotic component such as mammals, insects and diseases of economic importance for the area.

The socio-economic considerations are mainly related to market. As such the researcher should be able to have a grasp of both the "visible" market (i.e. what is known to exist as market for the area; products, absorbing capacity) and the potential market (i.e. products which are not produced in the area, can be produced and there is market for them; a broader market for the products already in production). Other socio-economic considerations include those of income level and distribution as well as those of resource tenancy and distribution.

Farmers' Possibilities to Take Advantage of Environmental Potential

The farmers' capacity of taking advantage of the production and improvement possibilities offerd by the environment depend mainly on their technology. Technology in general, includes resource and knowledge components. Good resources could be wasted by lack of knowledge and viceversa a good technological knowledge is not enough without the endowment of appropriate resources.

In general, the agricultural research work will tend to be more self contained when the limitation to work is knowledge. When this limitation is mainly resource, quantity or quality, the solution might be out of the team's possibilities or could require more interaction with other institutions.

Projection of the Results Domain in Time and Space

Once a research is finished and results obtained for an area, the necessary investment becomes fixed. The efficiency of such investment depends not only on the number of farmers or surface affected in the selected area but also on the possibilities of using the research results in other areas in the present or in the same and different areas in the future.

The intention of increasing this possibility should also be included in the selection of area. In this sense selected area should be representative of others or larger areas in relation to resources (physical and biological environment) and socio-economic considerations (markets, type of farm enterprises, land tenure, present and potential technological level, etc.). The

possibility of doing this will increase the chances for extrapolating results to other represented areas. Very much related to this, special consideration should be given to the existence of previous information about the area to guide work.

The ideal is to select an area with certain priority, representative of a larger ecological and socio-economic environment, and for which there is already sufficient basic and useful information.

The consideration of the future use of results might affect even the research strategy within the area. These considerations include resource conservation concern, selection of appropriate inputs and equipment, necessary investment levels and specific experimental site selection with possibilities for simulating other environmental conditions. They are technical considerations as well as research logistic consideration. Sometimes will be most convenient to select a small, in terms of number of farmers or total area, site but accessible and representative. The site may also include enough environmental variability, to represent other environmental conditions. The variables to be consider for this selection are again of physical, biological, social and economic characteristics, i.e.

1. Water availability (rainfall, soil, topography).
2. Soil fertility (soil type, population density).
3. Natural energy (altitude, temperature, luminosity).
4. Infrastructure (input and product market).
5. Technological level (input use, energy and traction source, cultural base, etc.).

FARMERS AND AREA TOTAL ENVIRONMENT CHARACTERIZATION

The reference point to evaluate any technological development ought to be the farm. This is true even when the attempt is to improve something so specific as a given cropping system. Whatever change or improvement the researcher proposes for that given cropping system, it should result in a net benefit for the whole farm as well as for the cropping system.

When the objective is to develop applied research, the first steps should then include an identification and characterization of the target farms as well as the specific components i.e. cropping system, and its total environment. The details for this characterization will depend on the research objectives and teams information requirement to appropriately guide research. One thing to keep in mind is that the immediate user for the characterization results is the research team. For the same reason this phase should be planified and carried out as an interdisciplinary task by the team. This will result in a useful self-teaching experience.

The strategy for characterization will depend on already existing information about the area and the team composition and requirements. Framed by the system approach, the most logical guide for this characterization is to study the farms as a system with emphasis on the components of main interest i.e. cropping systems.

Conceptually the farm is composed of technical and human elements. Within each one of these classes there are factors existing and interacting within the farm (endogenous factors) and others existing outside the farm (exogenous factors) which interact with the internal factors.

Within the endogenous-technical factors one can differentiate among those of physical characteristics; i.e. land quality or quantity, buildings structure

and other resources, and those of biological characteristic i.e. crops and animals. The composition of the exogenous-technical factors includes physical ones such as climate and biological ones such as mammals, insects and diseases which could affect crops and animals in the area.

The endogenous-human factors include family labor, technical knowledge, farmer's attitude and goals, etc. The exogenous-human factors will then include the area general organization and infrastructure as well as all public and private institutions of support to the agriculture. This last group will also include government policies and plans which could affect the community picture. This conceptual picture of a farm is shown in Figure 1.

The general strategy to accomplish the initial characterization should start with a review of all available and pertinent secondary information for the area. This should include the reviewing of existing documents as well as the identification and interview of key persons with knowledge about the area; not including farmers yet.

If the existing information is not enough to give the team the necessary knowledge about the area, additional primary information gathering method should be planned. Those methods could include visits to the area and key farmers interviews by the team's members or appropriate personnel. Other procedure is the use of simple and short static surveys to small sample of farmers. The study of the farm dynamic could be attempted through few farms case studies, exploratory experiments or specialized monitoring studies in agronomy, sanitary aspects or socio-economic farm behavior. The way to follow will depend on human, logistic and time resources. In this manner part of the characterization plan could continue parallel to the development of other

phases to be discussed.

It should be stressed again that the purpose of this characterization should be to provide the team with an understanding of: what the farmers are doing in the area?, how they are doing things? and why they do those things the way they do it? In the case of cropping system research the idea is to identify the main cropping systems, describe their cycle, structure and management, evaluate their agronomic and socio-economic performance and get explanation for that.

LIMITING FACTORS AND OTHER CONSTRAINTS TO CROPPING SYSTEMS BETTER PERFORMANCE, IDENTIFICATION AND PRIORITIES

The information obtained during the characterization should also allow a diagnosis about the present cropping system situation for the farms under study. This implies that the team should be able to identify the problems and limitations for the present cropping and farming systems better condition and performance.

Once these problems and limitation have been identified, they should be given a priority ranking. This ranking should be in agreement with the research objectives as well as with the farmers' goals, attitudes and restrictions.

The purpose is to select important and relevant research lines and objectives. They should be important and relevant for the farmers as well as for the researchers. In this manner the research will assure a better adaptability of results as well as better possibilities for their posterior adoption.

The possibility of identifying relevant problems for appropriate and applied research is one of the most attractive features of the methodology. It helps to improve the researchers efficiency in using time and resources provided for their work.

The diagnosis or conclussion obtained should be verified once more with the farmers. Some of the solution to the identified problems could be out of the team's scope of work or capabilities; those cases should be communicated to the appropriate persons or institutions which could act on them.

The problems within the team's capabilities, could be classified according to their type. They could result from physical problems or limitant, biotic or socio-economic. In the same manner one could observe if they are endogenous or exogenous to the system; this is to say whether the solutions depends on a direct action on the problem cause itself or in allowing for the system better adaptation to the constraint. This problem classification, by type, allows also to visualize their possible interaction permiting further sub-ciassification to facilitate their ordering and priority ranking.

The initial characterization, the problem identification, classification and priority ranking will also allow to identify useful research results evaluation criteria and guideline for their posterior diffusion.

This phase could be considered as one of explanatory hypothesis formulation, but it implies more than that since in many cases the team will have enough information to be certain about the problem identification and explanation.

Cropping Systems Modifications or Alternatives As Solutions; the Modelling

The problems identification, their priority ranking and the knowledge about the resources and total farm environment potential, should allow the team to identify appropriate, feasible and beneficial modifications or alternative to existing cropping systems.

This possible solutions identification process should incentive the participation of every team member. For this, all available information about technology development obtained by previous research efforts and farmers in the same or other areas should be considered. Such consideration will help to diminish the possibility of repeating research on a problem for which there already is a feasible solution.

The cropping system modification and proposed alternative feasibility, should be evaluated based on: the resources and total farm environment potential knowledge and reinforced by discussion with the farmers themselves. Many of the "new" modifications on alternatives"discovered" by the researchers might have been already tried and discarded by the farmers. To try them again would be a waste of time and resources.

The researcher should keep in mind that the farms structure and present technology is the result of an adaptation to the total environment through time and therefore the farmers have accumulated most of the experience and knowledge generated by such a process.

Furthermore, technically feasible solutions may not be feasible from a social or economic point of view and therefore their adoption is doubtful.

The present cropping system analysis during the characterization and the modelling of appropriate modifications or alternatives to solve identified prioritary problems, are the essential features of the system approach.

The possible solution identification finishes the "diagnosis" phase of the methodology. The team has arrived to certain conclussion respect to the starting situation, the problems of main priority and lines of research and action toward the solution of those problems. The phases which follow will allow the team to test, evaluate and validate the "models" or solution "hypothesis" developed up to this point. The team should make an effort to identify, among the solution "models", at least one with immediate potential for impact or with a minimal requirement for test and evaluation. This will be necessary to keep the interest and collaboration of farmers and other institutions including those which finance this type of research.

FIELD EXPERIMENTATION AND EVALUATION

Many of the identified as feasible solutions to the priority problems for improving cropping system in a given area, will need some testing and/or adjustments as well as evaluation before they are proposed as a improved technology output.

According with the idea of appropriate and adapted technology, most of the testing and evaluation should be done on collaborating farmers' farms. However, in many cases the traditional experimental station, laboratorie or green-house type of research will be a necessary support to the farm level work.

The on farm testing present several advantages as well as anticipate logistic and methodological problems. These problems have not been solved in their totality and more experience and studies are needed to facilitate the work.

Advantages include the possibility of advancing the evaluation of the technology in terms of; its adaptability to the environment, the farm management and structure; adoption possibilities and necessity for other institutional support for increasing those possibilities. The basic objective of agronomic and economic evaluation of the technology will also be more relevant when done on farm.

The specific methodologies for experimental design, collaborating farmers selection, experiment location, number of farmers, etc. may vary. This variation depends on resources available for the team, requirements for impact in short time and farmers collaboration. Every one of these considerations as well as the team organization for the work require a special treatment. For example, the collaborating farmers could be selected based on their openess and willingness to collaborate and on the location of their farms. The selected farm could be the most accesible one or those located at different points of a environmental gradient. This will allow the team to observe the effect of such variable on the cropping system peformance.

Among the problems to anticipate is the lack of control of many variable which are controlable on experimental station work. Very much related to this is the lack of adequate and practical experimental designs to be used on farm. The most common "solution" to this problem has been to use the simplest designs with a minimum of treatments and replacing across farmers

repetition for those eliminated repetitions in any given farm.

The work at IRRI has made good use of simple technology treatments which are "superimposed" on the farmers own plot ( ).

PROMISING RESULTS VALIDATION

Due mainly to the LDC resources limitation, the generation of improved technologies in these countries should be short and efficient. For this reason all phases should be accelerated and one may begin even before the previous one completely finished. In the same manner at least in some cases the test on experimentation phase should be as short as possible. The ideal would be to be able to identify some alternatives on modifications for improving the cropping systems which are already tested and adapted to the conditions of the area. In areas with a low level of technology and favorable environment this possibility should be greater. Once a technology such this is identified or the most promising during the testing-evaluation phase is obtained, they have to be further evaluated and validated.

To validate the result means here that it should work and show its benefit within the farm under the farmer's management.

The validation criteria should include compatibility and congruency among the technology requirements and the farms resources, environment and farmer's management capability. Other consideration includes return to limiting factors, productivity, productivity and income risk, as well as acceptability by farmers. The acceptability criteria include those of congruency with farm structure and management, complexity, divisibility, communicability and attractiveness for the farmers.

The logical manner to accomplish this validation is allowing the farmers themselves use and completely manage the technology. The feed back given to the team by observing the technology performance and farmer's reactions, comments and modifications will allow a better adjustment for the final research product.

The number of farmers to participate in this phase should be larger. Their selection and location could also help to observe the technology within a given environmental variation which help to determine the final recommendation domain.

TECHNOLOGY DIFFUSION CONSIDERATION

The final phase for this methodology or strategy is, in a figurative sense, one of "packing", "promotion" and "selling" of the product or improved technology.

The objectives for this phase require to recall the "clients" (farmer) necessities, possibilities and expectations. This should allow to visualize what is the attractiveness that the product may have for the client and the existing effective ways on strategies for the "promotion and selling" of such product.

The client knowledge begins with the initial characterization and continues through every posterior phase. The technology is also known since it has been developed or validated by the team. The combination of those two type of knowledge should allow the specification of ways to present the improved technology to the farmers in an attractive manner.

The means and strategies for doing this may require more effort than those accomplished by traditional extension methods. These strategies could also

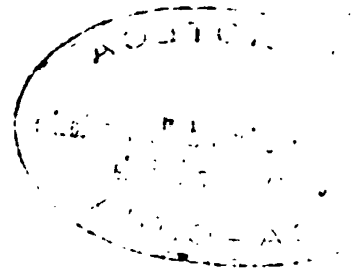
be identified during the research period. To do this should be easier when the team includes technology diffusion experts or extensionists. It is possible, however, that additional research efforts be needed for designing or identifying those strategies.

At this point a digression is appropriate. Some of the finally proposed improved technologies may be attractive for the farmers, meet the research objectives but they may still present problems for their adoption by the farmer. This could be due to a specific limitation which cannot be solved by the team. Sometimes such limitation could be eliminated by some authority on other institution's action. In such case the technology should also be "promoted" before such institution or entity.

What this implies is that in some cases there is more than one type of client for the research results. This is calling again to consider the necessary interaction of agricultural research with the farmers themselves and with other agriculture support institutions. For this phase, the key institutions are extension, credits and marketing.

Extensionists, because of their knowledge and experience in working with farmers should form part of the multidisciplinary team since the beginning. Their help could be most useful during the initial and final phases of this methodology.

Once the team has developed a first improved and appropriate technology product, a good and basic knowledge about the region is obtained. This knowledge could be updated, improved and used for further technology improvement research as well as for evaluating research, extension and/or production programs progress and effects.



Bibliographic Note

The Annual Crops Program library at CATIE has accumulated a good number of Farming System Research including Cropping Systems Research related documents. Some of them have been used for the present paper. For information however, a larger number of those related to the socio-economic aspects of such research are listed in the following pages.

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