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FARMER-BACK-TO-FARMER: A MODEL FOR GENERATING ACCEPTABLE AGRICULTURAL TECHNOLOGY

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SUMMARY

Based on interdisciplinary post-harvest team[1] research experiences[2] at the International Potato Center (CIP), the paper presents a model that outlines an alternative approach to solving farm-level technological problems. The model stresses that applied research must begin and end with the farmer. A series of logical activities addressing specific goals are discussed and illustrated.

SUMARIO

Basado en las experiencias del equipo interdisciplinario de investigación en post-cosecha en el Centro Internacional de la Papa (CIP), este documento presenta un modelo que describe un enfoque alternativo para resolver los problemas tecnológicos a nivel de finca. El modelo destaca que la investigación aplicada debe empezar y terminar con el agricultor. Se discute e ilustra una serie de actividades lógicas orientadas a objetivos específicos.

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1 The CIP post-harvest research team consisted of anthropologists Robert Werge and Robert Rhoades and post-harvest technologists Robert Booth and Roy Shaw.

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INTRODUCTION

Among the proliferation of strategies in the 1970s to improve food production in developing countries has been an emphasis on interdisciplinary teams in the identification, generation, and transfer to farmers of appropriate technology (Consultive Group on International Agricultural Research, 1978). These trends are grounded in the growing realization that understanding agriculture requires the expertise of several disciplines. Farming is seen as more than ....

> .... simply a collection of crops and animals to which one can apply this input or that and expect immediate results. Rather, it 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 output from the inputs and technology available to him (CGIAR, 1978).

With the accepted view that agriculture is not merely a technological endeavor but a socioeconomic one as well, social scientists are generally seen as indispensable to any team effort to improve production. However, a review of the agricultural development literature shows that fully integrated, truly interdisciplinary teams involving both biological and social scientists have rarely been constituted.

With the exception of a Guatemalan case (Hildebrand, 1978), attempts at team research have been primarily *multidisciplinary* wherein members fulfill independent disciplinary roles and pass information to colleagues in the form of written or verbal reports. Typically, social scientists have served in the sometimes unpopular role of evaluating farmers' reactions or opinions toward a new technology after its design and introduction. When farmers reject an innovation or the consequences of the technology are socially or ecologically negative the social scientist becomes a bearer of bad news. This 20-20 hindsight has generally left biological scientists skeptical of any positive social science contribution in improving food production efficiency. In other cases, social scientists are asked to conduct feasibility studies prior to the implementation of a project but frequently this input does not carry through to the actual design and transfer stage.

In contrast to this piece-meal, multidisciplinary approach is an *interdisciplinary* perspective which rejects the fragmented, staggered roles of several specialists in favor of on-going, dialoguing and totally involved research teams working together toward the identification, design, generation, and evaluation of acceptable agricultural technology.

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The objective of this paper, therefore, is to describe a case of successful *interdisciplinary* research in international agriculture to derive a suggested model and guiding principles for teams working toward solving technological problems. The discussion will center on the philosophy as well as some of the nuts-and-bolts aspects of how to conduct interdisciplinary research, especially when social and biological scientists are involved as team members. Although the emphasis is on agricultural technology, the derived model should be of value to all efforts in interdisciplinary research dealing with appropriate technology and rural development.

THE CASE STUDY: POST-HARVEST TECHNOLOGY AT THE INTERNATIONAL POTATO CENTER

The International Potato Center (CIP) with headquarters in Lima, Peru has as part of its mandate to rapidly develop and expand the research and technological base to solve problems limiting potato production in developing countries. CIP's source research is organized around nine technical "thrusts" with objectives ranging from collection and maintenance of a world germplasm bank, control of diseases and pests, agronomy, seed production and distribution, to post-harvest technology. Also, CIP supports a Social Science Department which includes not only economists but anthropologists and sociologists. Experiences of the post-harvest team composed of biological scientists and social anthropologists provide the basis of this paper.

Storage in the Andes: Diagnosing and Understanding the Farmer's Problem

To understand the contribution and role of each discipline of CIP's post-harvest team, it is necessary to carefully study the interaction which occured overtime between the members. Initially, the anthropologist set out in the Mantaro Valley of the Central Peruvian Andes to study post-harvest activities, primarily storage problems facing highland potato farmers. Biological scientists at first restricted their activities to conducting research on both consumer and seed potatoes on the experiment station located in the same region. However, from the beginning the institutional arrangement encouraged a dialogue between members.

In the course of time, the social scientist and technologists found themselves engaged in an intra-team debate over the concept of "storage losses," The potato as a vegetable tuber, unlike the grains, is a highly perishable item. The storage specialists were logically concerned with how to design a storage system to reduce both pathological and physiological losses since these are major technological problems. The anthropologist based on a two months informal village-level survey, argued that Central Andean farmers did not necessarily perceive small, shrivelled

or spoiled potatoes as "losses" or "waste" (Werge, 1977). His evidence revealed that *all* potatoes were utilized by farm families in some form. Potatoes that could not be sold, used for seed or immediate home consumption were fed to animals, mainly pigs, or processed into dehydrated potatoes (e.g., *chuño, papa seca*) storable for as long as 2 to 3 years. In addition, some wives informed him that in culinary quality the shrivelled, partially spoiled potatoes were sometimes preferred.

These observations were, as one of the biological scientists put it, "the beginning of understanding a reality, namely, that we scientists often perceive technical problems through different eyes than farmers. Losses to us were not necessarily losses to farmers."

Still, after further investigation and exchange of ideas, the problem turned out to be more complex than either anthropologist or storage specialists had realized. One of the team's technologists in reflecting back on the experience explained:

> I was not totally convinced of the anthropologists' argument, although he certainly made me think about what I was doing. We (biological scientists) hadn't even really talked to a farmer about the problems we were working on. We were doing research *about a problem* from a distance, not research to *solve a problem*. When I finally went with him to visit farmers I could see he was right, but only partially. (Rhoades et.al. 1981).

Common Definition of the Problem: Seed Storage

It turned out that "real losses" in storage were indeed perceived by many farmers. Since small producers in the study area stored most of their potatoes (whether for consumption, sale, or seed) in dark rooms, they did not automatically offer information to the anthropologist on different activities related to potatoes destined for different purposes. Through interaction with the biological scientists on technical aspects of storage, the anthropologist was able to sharpen his questions to farmers. He learned from his colleagues that seed potatoes stored in darkness produce long sprouts that are generally removed before planting. Asked specifically about this activity, farmers complained of cost in time and labor associated with desprouting. Thus, farmer "losses" were not merely physiological problems but social and economic ones as well. The team now appeared on common ground with the farmer. By drawing knowledge from farmers and both disciplines, a commonly agreed upon problem was defined: *seed potato storage* with specific emphasis on reducing sprout length and improving seed tuber quality.

Interdisciplinary Team Research: Seeking a Solution

With the problem more narrowly defined, the team faced the research task of solving the technological challenge in a way acceptable to farmers. The anthropologist continued field research on seed storage,

constantly feeding his findings to the technical scientists who had intensified on-station experiments with seed potato storage using a known scientific principle: natural diffused light reduces sprout growth and generally improves seed quality (Dinkel, 1963). This principle was thought by CIP scientists to have a practical application in developing countries but exactly how and under what circumstances was not clear.

On-station experiments involving seed stores proved successful in terms of reducing sprout elongation, improving seed quality, and yield (Tupac Yupanqui, 1978). However, the engineering behind the experimental seed stores was still from the biological scientists' point of view. The anthropologist was concerned whether the design related to farmers' conditions. Was it acceptable? He had been doing research on the architecture and uses of farm houses and buildings in Andean villages and was concerned with how the seed stores might be adapted to local conditions. It did not seem possible to introduce diffused light into dark, traditional multipurpose stores. Diffused light produces "greening" in potato tubers which renders them inedible and unmarketable. Only potatoes destined for seed could be stored in indirect light. Also, due to security and convenience needs, any physical storage changes had to blend into existing farm compounds.

Testing and Adaptation of the Proposed Technology

The anthropologist, anxious to begin on-farm trials inspected farm buildings with his technical colleagues and talked with potential farmer cooperators. The inner court yard of many Andean houses has a veranda with a roof that allows for indirect light. With farmer cooperation, the team thus decided to set up experiments under the veranda using conventional "seed trays" taken from the experiment station stores. In other words, no new store structures were built, but rather the wooden trays in which the seed had been stored on the experiment station were stacked under the veranda in such a way to allow indirect light to reach the seed.

These on-farm trials yielded positive results similar to those obtained in the on-station experiments. Farmers expressed interest in the new storage technology, but concern over unavailability and cost of seed trays. As a result of this feedback from farmers, the technologists designed simple collapsible shelves constructed from locally available, roughhewn lumber which were used in a second series of on-farm trials (CIP Annual Report 1979). Again results in terms of improved seed tuber quality and increased yields similar to those obtained on the experiment station were obtained. Due to lower cost and familiarity with materials and rustic design, farmers were now able to relate more closely to the diffused light stores. The technology now appeared ready and thus entered the final phase of farmer use, adaptation, and diffusion.

Farmer Evaluation: The Last Judgement

The validity of the research findings and process of the post-harvest team rested on whether farmers were willing to test and use the technology

at their own expense and time. Thus, a follow-up evaluation was necessary, not only to validate or negate preceeding research phases, but to seek new directions in improving the technology. Central to this evaluation was need to obtain information on farmers' behavior as they began to experiment and use the technology on their own.

The job of understanding the farmer's evaluation was not relegated to the team's social scientist, as is the case in multidisciplinary research, but carried out by *both* social and biological scientists. It is clear, however, that just as the biological scientists took the lead in the physical design of rustic stores, the social scientist assumed more responsibility in the farmer evaluation.

Interestingly, the first opportunity for farmer evaluation came not in Peru but in the Philippines. In 1978, a CIP post-harvest technologist worked closely with national potato program workers to diagnose storage problems in the Philippines main potato producing region. At that time, the technologist served as his own social scientist by drawing on the Andean experience with anthropologists. A series of farmers meetings and informal interviewing lead to the suggestion that diffused light storage may be relevant to the region. As a consequence, the farmers in a small community decided to erect a small demonstration seed store using municipal funds. This was followed by 5 more demonstration stores built in a Philippine Potato Program-CIP joint effort at strategic points on the national road leading through the potato production area. In 1979, the post-harvest team working with potato program workers conducted a survey (Rhoades et.al. 1980) that revealed that at least 40 farmers in the area had made alterations in their seed storage practices, mainly by allowing for diffused light. By 1980, the number of adopters increased to over 120 and the innovation appears to continue spreading.

In Peru, the opportunity for farmer evaluation came a year later, after the Peruvian research and extension service supported by a small CIP contract, began establishing demonstration stores. Follow-up studies showed that farmers on the coast and in the highlands had started making changes in their storage practices. The Peruvian patterns of adoption and adaptation were strikingly similar to those in the Philippines. Initially, farmers took a cautious, wait-and-see experimental attitude toward the technology. They often experimented, jointly or singly, with small amounts of seed before making large-scale changes. To gain flexibility, some utilized the diffused light principle for part of their seed but continued to follow traditional practices for the rest. A positive propensity to adopt was found in close-knit communities or with voluntary farmer associations, often involved in active seed improvement programs.

Investigations of farmer response revealed that in both countries, the new technology was continuously being refined and altered by farmers. In other words, adaptive research --but this time almost exclusively through the initiative of farmer-- continued well after the scientific

team had finished its major adaptation and testing activities. Farmers rarely copied exactly the prototype store designs. They blended the new ideas with local architecture and, if a new store was constructed, made changes to suit their own concepts of space and design. Farmers were proud of these changes, and the CIP post-harvest team is convinced farmers will be more likely to accept changes if they actively participate in this final research process.

FARMER-BACK-TO-FARMER MODEL

With the rustic seed storage technology in a refinement and transfer stage, the post-harvest team decided to take a new look at the general problem of consumer potato storage. Before moving to this new problem area, however, the team critically reviewed its past activities in storage as well as an effort to design household and village-level potato processing equipment for the Andes (Rhoades, et.al. 1981). As a result of this review process, which aimed to extract principles tied to failure and success, a model called "Farmer-Back-To-Farmer" was formulated. Although not entirely novel to agricultural research, the model (Figure 1) offers a rarely followed but viable alternative to traditional applied agricultural research and extension.

The basic philosophy upon which the model is based holds that successful agricultural research and development must *BEGIN* and *END* with the *FARMER*. Applied agricultural research cannot begin in isolation on an experimental station or with a planning committee out of touch with farm conditions. In practice, this means obtaining information about and achieving an understanding of the *Farmer's Perception of the Problem* and finally to accept the *Farmer's Evaluation of the Solution* (Booth and Shaw 1981). Thus, research must strive to close the circle, from proper identification of the problem to farmers' acceptance or rejection.

In the diagram, the top circle labelled "farmers' problem" represents the totality of the farmer's practices and problems related to a technological area (e.g. post-harvest technology, production, insect control, etc.). Starting with the philosophy that the farmer's circumstance is the springboard of research, the model then logically consists of a series of task-oriented *GOALS* aimed toward achieving acceptable technological solutions to specific farmers' problems. These goals are linked in a circular form by a number of *ACTIVITIES* (labelled 1 to 4 in Table 1 and Figure 1). Although for purposes of presentation we have broken down these activities into separate stages, it should be kept in mind that activities may overlap in time and a frequent recycling of research through earlier stages may be necessary to arrive at an acceptable technology.

Diagram

FARMER-BACK-TO-FARMER

A MODEL FOR GENERATING ACCEPTABLE TECHNOLOGY

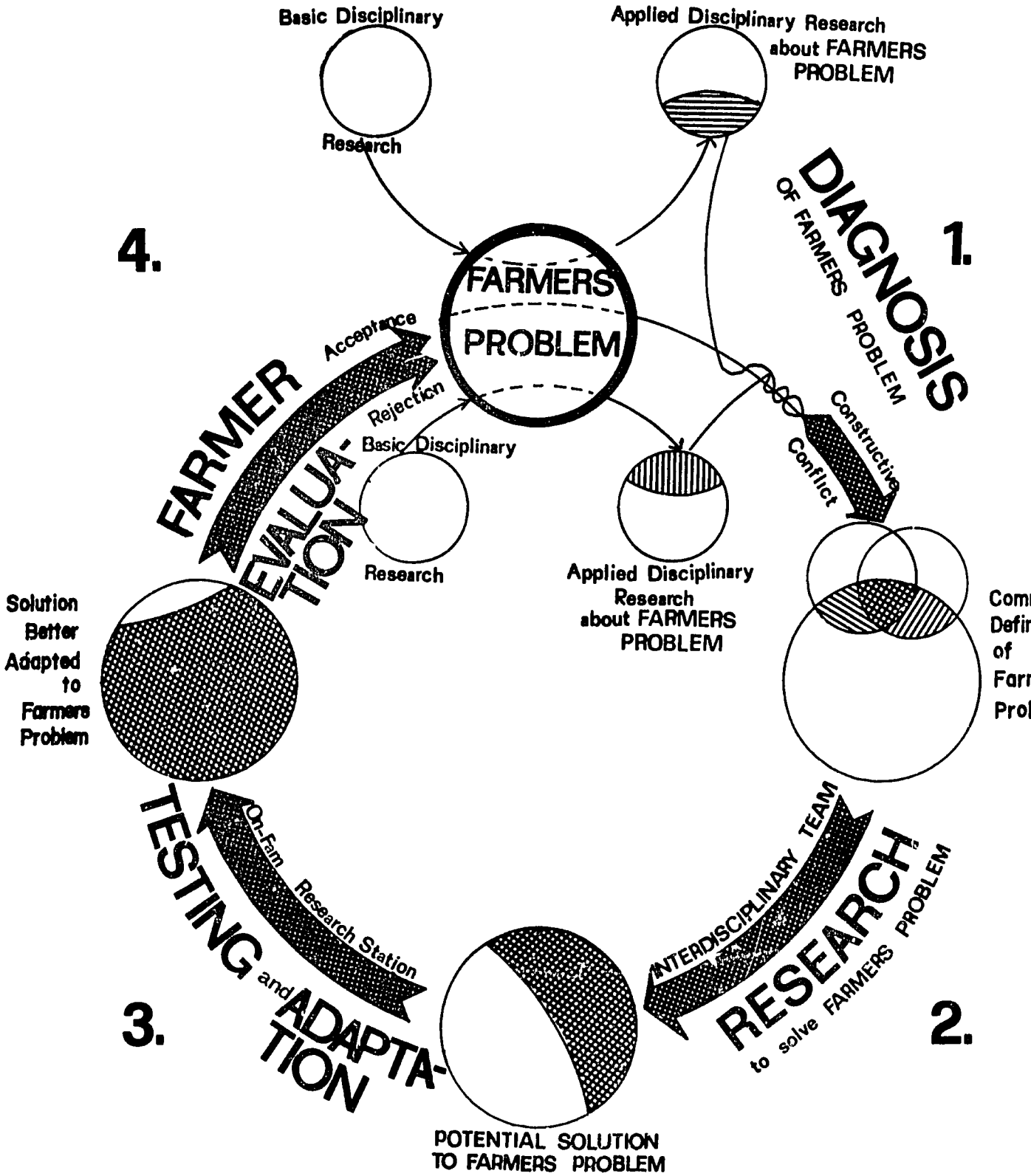

Table 1. Farmer-Back-To-Farmer: Activities and Goals

	ACTIVITIES	GOALS
1.	Diagnosis	Common definition of problem
2.	Interdisciplinary team research	Identify and develop a potential solution
3.	Interdisciplinary team testing and adaptation	Better fit the proposed solution to farmer's needs
4.	Farmer evaluation	Understanding of farmer acceptance or rejection

I. *Diagnosis to Arrive at a Common Definition of the Problem with the Farmer*

If a convincing case for change is to be made, the definition/identification of the farmer's perceived problem is fundamental. This is the springboard of research. Farmers frequently define their problems differently from change agents and an effort must be made to arrive at a specifically agreed upon problem for which there may be potential solutions.

Although integration of social and biological sciences facilitates the generation of acceptable technology, some degree of initial basic research by each specialist on the problem is commonly necessary to set the stage for dialogue. We should stress that methods of diagnosis should be flexible. In other words, in addition to formal or informal surveys some types of preliminary on-farm trials may be conducted simply as a means of better understanding the problem.

Biological scientists at this stage will most likely be concerned with fairly narrowly defined technical problems, i.e., focussing on technological or biological questions, while social scientists will most likely focus more broadly on perceptions, beliefs, social conditions, and economic rationality that may bear on the problem. Anthropologists, trained to interpret the farmer's worldview and behavior, can serve as a bridge between farmer and technologist regarding traditional and potential new practices.

It is important team members have a mutual respect, confidence and working knowledge of each other's disciplines. Technologists should appreciate the need to view the technology through the eyes of the farmer and recognize the importance of sociocultural factors. Similarily, social scientists should not fall into the typical syndrome of cynicism toward technological change or belief that farmers are already so perfectly adapted that no improvements can be made. The social scientist,

to some degree, should become knowledgeable about the technology as well. Both kinds of scientists must be open to the possible need to abandon or re-orient research if it is obvious that wrong directions have been taken. Under the assumptions of this model, social and biological scientists are equal partners in the design, generation and transfer of technology. Success or failure falls equally on their shoulders.

During the diagnostic stage it is likely, and even desired, that disagreements will arise between social and biological scientists over interpretation of the problem. We have labelled this stage *Constructive Conflict*. In dialogue with the farmer, scientists should engage in this process of interdisciplinary debate to arrive at a more comprehensive definition of the problem as well as propose hypothetical solutions.

The purpose of the diagnosis is to arrive at the widest possible concensus between farmer, social scientist, and technologist on a definition of the problem to be solved. In the case described above, the commonly defined problem centered on seed potato storage and more specifically on how to reduce sprout elongation and maintain seed quality. Without precise definitions and common agreements of the farmer's problem, laboratory or on-station applied research at this stage could be misguided, although general basic research in the problem area is essential. Applied research should become "task-oriented" as soon as the specific problem is defined.

II. *Interdisciplinary Team Research to Identify and Develop a Potential Solution*

With the problem in mind, the team can now proceed forcefully with on-station research guided by more farm-level information. In the storage case constant on-the-spot feedback occured between social scientist, farmers, and those testing basic information at the experiment station of diffused light and simple, low cost stores. This process of interchange should continue to be ongoing throughout the design stage. Compromises, changes, reversal of direction or even termination of projects may be required.

The purpose of the linked on-station and farm-level team research is to arrive at a potential solution (e.g., low cost, natural diffused light stores). This is illustrated in the bottom circle of the diagram. Note that a portion of the farmer's problem remains undefined. Proposed solutions are rarely complete since farm problems are immensely complex inter-related, and constantly changing.

III. *Testing and Adaptation to Make the Proposed Solution Better Fitted to Farmer's Needs*

Armed with a potential solution, the team now proceeds to a testing and adaptation activity. The objective is to fit, with the farmer acting

as advisor, the technology to the local circumstance. In most circumstances the testing and adaptation will occur first on the experiment station followed by on-farm trials. C_P's storage team began by building costly diffused light stores on the station followed by increasingly less costly designs as attempts were made to make the stores economically acceptable to small farmers.

During on-farm testing undertaken by scientists in cooperation with the farmer the potential solution should be compared, if possible, to existing farming practices. The testing and adaptation stage may require several recyclings to arrive at a technology ready for demonstration and independent evaluation by farmers.

IV. Farmer Evaluation: Completing the Circle

Technology should not simply be designed, introduced, and abandoned by applied scientists. Information needs to be collected on the technology's acceptance or rejection by farmers, the final judges as to the appropriateness of a proposed technology. Until this point, all scientific evaluations remain at the level of hypothesis. Unless the circle can be completed, unless research results reach the farmer, prior efforts may have been fruitless and research findings are shelved in science archives. And if the technology is rejected by the farmer, the research process can be repeated to determine the reasons and find ways to overcome them.

This final stage involves the actual evaluation and use of the technology by the farmer under his conditions, resources, and management. It is crucial not only to determine acceptability but to understand how farmers continue to adapt and improve the technology. Such informal research by the farmers is crucial to the successful transfer of the technology (Biggs, 1980).

CONCLUSIONS

In this paper, we have offered a model derived from a case study relevant to interdisciplinary efforts aimed toward solving farm-level technical problems. The Farmer-Back-To-Farmer model does not encompass specific methods for determining a ranking of constraints to, or priorities for agricultural production at local or national levels, but illustrates a philosophy and guidelines for effective interdisciplinary team research in the design, generation and transfer of technology appropriate and acceptable to farmers.

This interdisciplinary model offers an alternative to multidisciplinary approaches in which several scientists fill specialized and separate roles and attempt to communicate across disciplines. Where

separate disciplinary specialists are not available, other team members should strive to substitute for the missing perspective. For example, if no social scientist is available the biological team members should endeavor to understand the socio-economics of the problem.

The model may also serve as a training guide and as an aid for research administrators to conceptually pinpoint the progress of an applied research activity. For example, strictly disciplinary research *about* problems but not yet orientated to *solve* farmer's problems can be readily pinpointed in the small circles labelled "basic disciplinary research" located prior to the top circle labelled "Farmers' Problems." In other cases, research may have progressed to an on-farm testing stage and the results regretfully shelved in science archives. The model, by stressing the need to complete the circle to be successful, makes it clear to what degree research has progressed and what activities or research hurdles remain. Until the circle is closed back-to-the-farmer, scientific research can only be suggestive of practical payoffs.

Most importantly, however, we believe that the Farmer-Back-To-Farmer approach leads to a greater chance of success in the generation of appropriate agricultural technology. And by doing this, it can help save time and valuable research funds, both of which are desperately needed resources in the race against the population-food time bomb that haunts our hungry planet.

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