APPROPRIATE FSR METHODOLOGY IN ASIAN COUNTRIES

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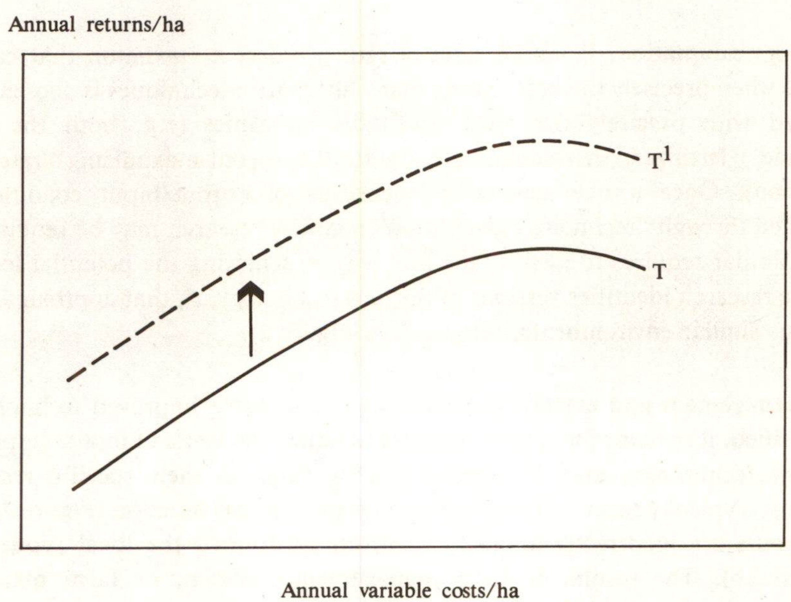
In farming systems research (FSR) we customarily consider that farmer's resources vary and that the production activities of farmers also vary. Farming systems research is like farming -- different research programs have different resources and often different goals. Therefore, the methods they use to "produce" technology should also vary. To choose appropriate research methods, a FSR program should be clear about its goals. At least three different goals appear to have been chosen by various FSR programs in Asia.

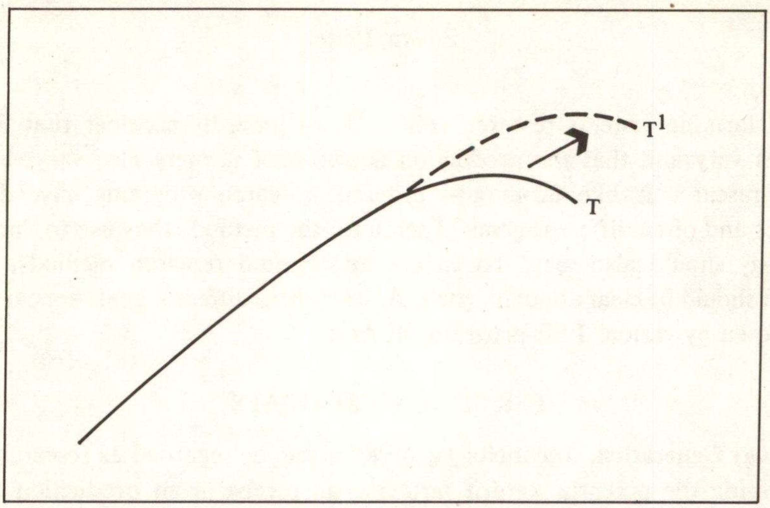
FSR RESEARCH GOALS

Technology Generation. Technology generation can be regarded as research aimed at increasing the potential return farmers can receive from production factors. Graphically this can be shown as a shift in a generalized production function reflecting the value off goods that can be produced at various cost levels in a given environment. While often we visualize this as shifting the production function upward (Figure 1a), it appears that more frequently in successful FSR the production function is extended, not raised (Figure 1b).
(IRRI, 1978).



a

Annual returns/ha



Annual variable costs/ha
b

Figure 1. Technology generation.

Technology adaptation. Potential rates of return reflect a maximum that can be achieved when precisely the best among many alternative techniques is chosen, and employed with precisely the most profitable intensities (e.g. both the right insecticide, fertilizer, herbicide, etc. and the profit-maximizing rates of application). Once a new generalized schedule of output/input condition is established through "technology generation" adaptive research may be required in various similar requires to identify the best way of achieving the potential locally. Adaptive research identifies versions of the new technology, t', that approximate T' in various similar environments, (e = 1,2, in Figure 2).

Farm management and extension. Once locally adaptable improved technologies are identified, it remains for specific farmers to adjust the levels of inputs employed with new technology, and enterprises combinations to their specific resource situations. Typically this is a movement a long production function (Figure 3a), or when inputs are incorrectly applied, a movement toward the local production function (3b). The results of farm management research, or farm planning, achieves the first adjustments (3a), while extension achieve the letter (3b).

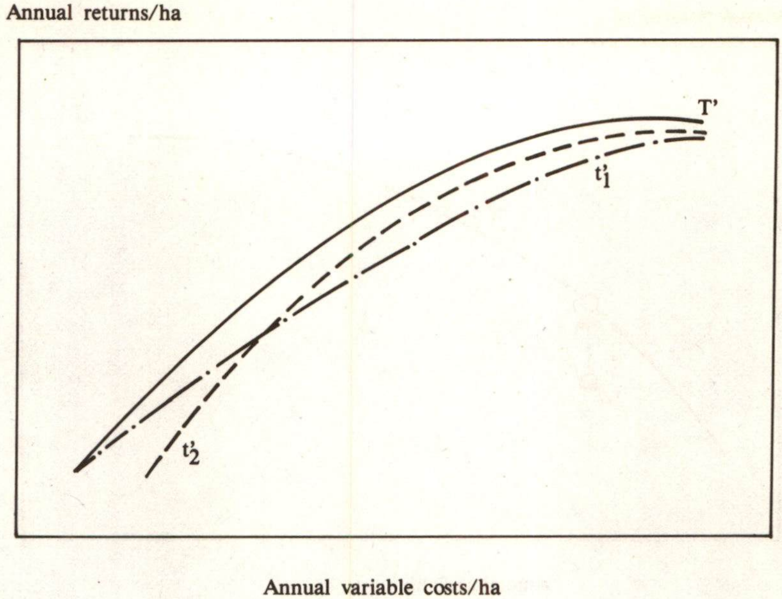
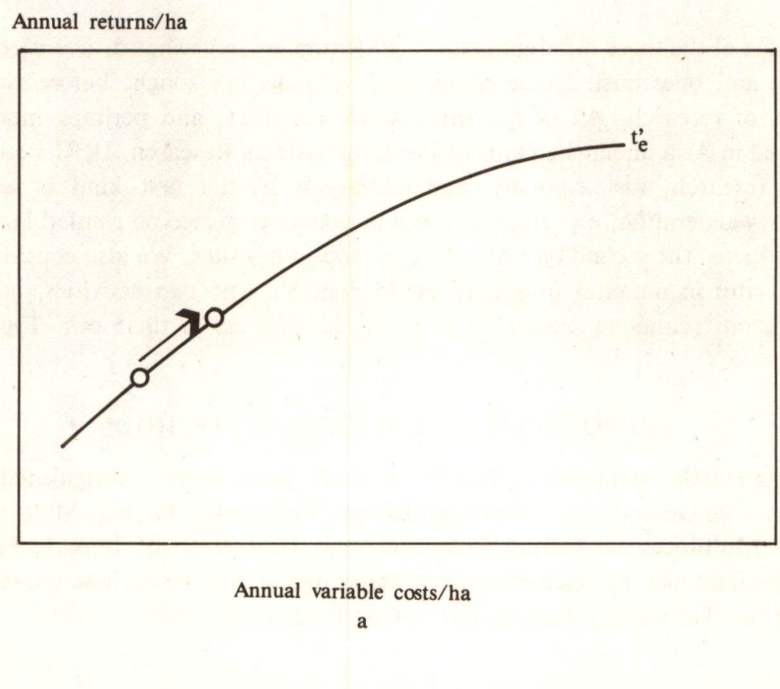


Figure 2. Adaptive research.



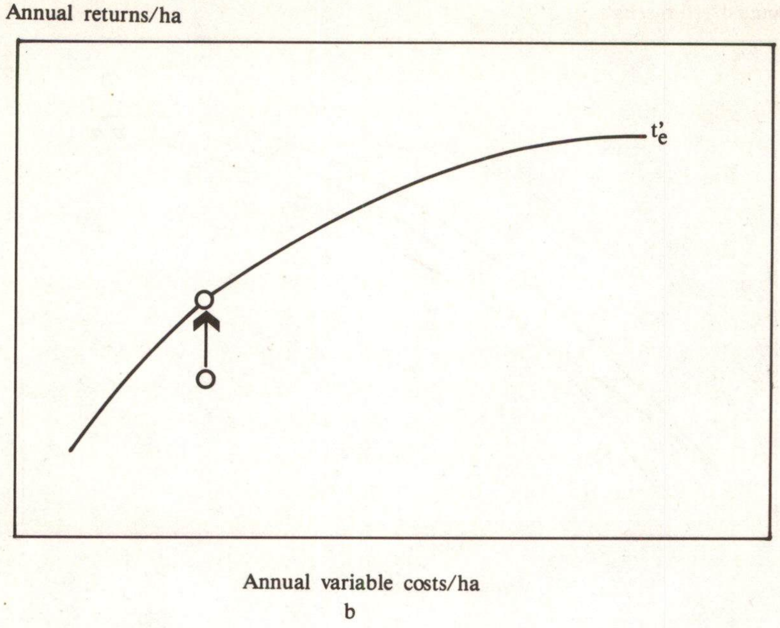


Figure 3. Farm management and extension.

Each of the three different goals of FSR implies somewhat different research methods and one must decide which goal or goals are sought before choosing methods of research. All of the three above activities, and perhaps more, are conducted in Asia under the name of Farming Systems Research. IRRI's cropping systems research was originally planned largely as the first kind of activity, technology generation, e.g. finding a way to double crop rice on rainfed land. We also conducted the second type of activity at subsidiary sites. We also consider that network sites in national programs would conduct type two activities, adaptive research, on technology generated at IRRI, as well as on their own Type One research.

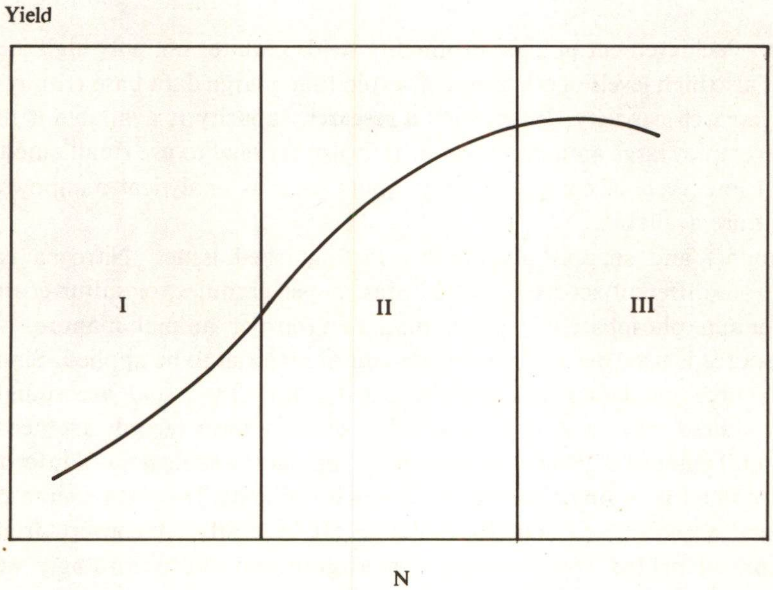
APPROPRIATE FSR RESEARCH METHODS

From IRRI experience, phases of FSR have been distinguished: Site Selection, Site Description, Technology Design, Technology Testing, Multilocation Testing, Multilocation Testing/Extension, and Evaluation of Impact. For this paper, I will discuss the research method associated with three of these phases: Site Description, Technology Testing and Impact Evaluation.

Appropriate methods of description.

We may take the analogy of farming and FSR a step further in examining the appropriateness of methods for site description. Similarly, as agronomists study the relationships of nitrogen to yield, we may examine the relationship of data to knowledge. Farmers with low levels of cash resources often face a high opportunity cost for fertilizer investment. In such cases relatively low levels of nitrogen application maximize profit.

At early stages of technology adoption and low cash liquidity, nitrogen levels applied may fall into stage I of production (Figure 4a). Further, the level of the nitrogen response curve is often found to depend upon the levels of other inputs, water, solar radiation, phosphorous weed control, tillage, etc. We also observe that the knowledge used to create and/or fit new technology to farmers is similarly responsive to data. How much data to obtain cannot be decided in absolute terms such as "the minimum amount" needed, but rather in terms of the opportunity costs for its collection, the expected return, and the other inputs that go along with data to generate knowledge -- e.g. the capacity to analyze and interpret data.



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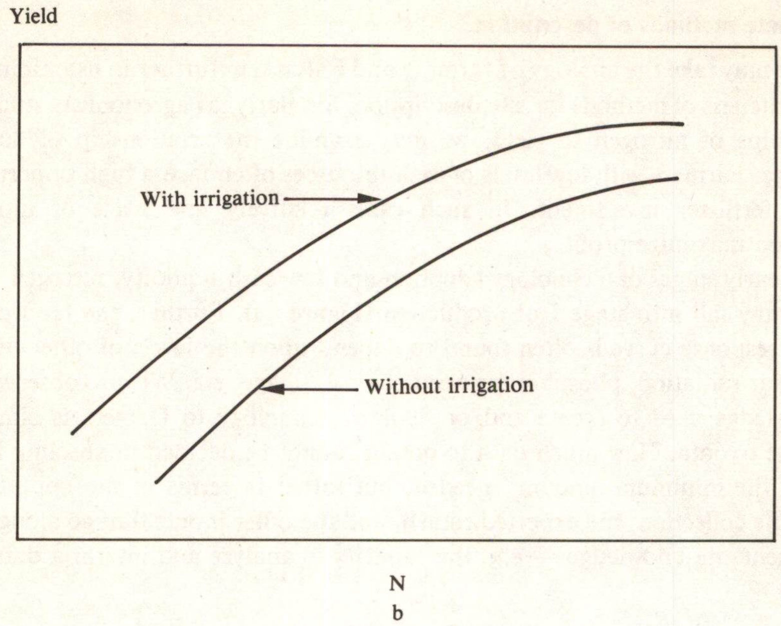

Figure 4. Yield response to nitrogen

Just as achievement of high commodity yields requires not only high nitrogen levels, but also high levels of other inputs, exploiting a large data base requires high levels of research capasity. When such a research capacity is available it may be rational to employ large amounts of data. It is also rational to use small amounts of data when low levels of complementary inputs such as analytical manpower and equipment are available.

Amounts and sources of data are distinguished issues. Nitrogen can be supplied from different sources - prilled urea, super granules, or sulfur coated, or from amonium phosphate, or green manure crops or animal manure. Which nitrogen source is used determines the amount of material to be applied. Similarly, different sources of data can substitute one for the other, and accordingly the quantity required may vary. A large number of daily farm records are needed to learn the total amount of labor used to grow a crop - or the same item of information may be obtained in a single answer by a key informant. The data source chosen should vary according to sources available. It is costly to convert from the manufacture of prilled urea to sulfur coated granules, and accordingly we may choose to gather data in a customary way rather than retool.

Finally, how to measure knowledge in order to conceptualize a response function to data. Unlike commodity yields, knowledge is not homogeneous. Two of the same fact are not more than one. Quantities of knowledge can be considered an accumulation of different facts. As one proceeds in the descriptive process in FSR it is usual to collect in turn the data required for Design, Testing and Evaluation of Impact. For design one needs information about on-farm resource (land, labor, capital and technical knowledge), their quality, and their current allocation to enterprises. Information about off-farm resources, or conditions, are also required - markets, transportation, credit, extension services, and other infrastructural aspects. Little can be achieved without this information, and hence it has a high pay off. It's probably an overuse of the metaphor, but there is some appeal to the notion that knowledge response to these early-assembled supportive data is higher than that produced in latter stages of description. There is a degree of concreteness to data on farm size, labor and cash availability, etc. and precision in the knowledge produced (Figure 5).

In a latter stage of description researchers assemble data to estimate the benefits that farmers receive from their present technology. This information is compared to the results of experiments on new technology to assess the likely acceptability of new technology. In this Testing phase of research, profitability is assumed to reflect benefits. Error may occur if farmers seek benefits other than profit, but more problematic is the estimation of the values of inputs and products used to calculate profits.

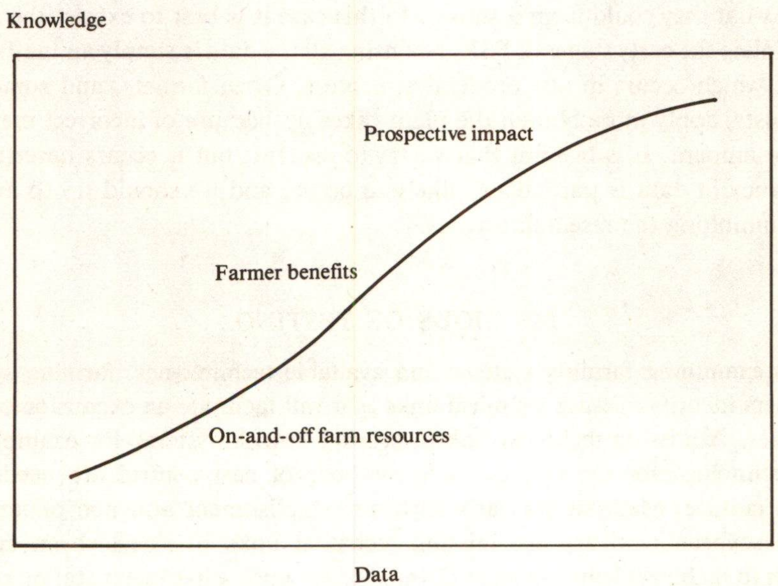

Figure 5. National relationship of knowledge and data in farming systems research.

Farm gate prices are better than control market prices, but harder to estimate, and still better, but harder to estimate, are opportunity costs. Valuation of family labor particularly is a problem. We can conclude the knowledge far Testing new technology is less responsive to data than knowledge used in Design.

Producing information for assessing impact, particularly for predicting impact, is most difficult of all. Prospective effects on distribution, labor employment, price effects, environmental impact are notoriously hard to project from current data. But procuring a data base before the introduction of technology sufficient to latter assess impact is also a formidable task. The often unexpected ramifications of technological change make it difficult to collect appropriate data and generate needed information before the change.

When little research resources is available, it is likely that shortcuts will be taken in calculating benefits (e.g. using central market prices) and producing information for Impact Evaluation may be neglected altogether. The point of all this is to say that knowledge for FSR is a continuous function of data. Small data bases offer a high knowledge return, but in the end, the knowledge is likely to be incomplete for the full range of useful analyses. But it's probably where most FSR programs should be. Large data bases can be useful for obtaining more complete information, on impact for example, but that knowledge comes at a high per unit cost.

Finally, it is useful to distinguish Stage III production function problems from Stage I and II inefficiencies in data use. Stage III is when too much data degrades the production of knowledge. This is when a large data set prevents researchers from learning what they could from a subset. In this case it is best to extract the subset and complete the early stages of FSR. Not using all the data is simply an inefficiency like that which occurs in any production process. Often farmers, and sometimes agronomists, apply more N than the plant takes up because of incorrect methods, timing or amount. It is N event that we try to prevent, but it occurs nevertheless. Redundancy in data is particularly likely to occur, and we should try to avoid it without inhibiting the research process.

METHODS OF TESTING

By examining farming systems and available technologies, farming systems researchers identify missing technical links that will facilitate an expansion of farm enterprises. A missing technical link in crops/livestock systems for example is a silage technology for the tropics. Safe methods of pest control are needed for rice/fish culture. Methods for early soybean establishment and non-photoperiod sensitive soybean cultivars are missing technical links in rice-soybean culture. Solutions to such problems are often claimed based upon experiment station results, only to find the available techniques are not suited to the conditions faced by farmers.

Farmers' fields are an appropriate laboratory for technology generation and adaptation in FSR. FSR must be approached with the same rigor as any scientific endeavor. Care must be taken in the formulation of hypotheses and the design, conduct and interpretation of experiments. The choice of farmers fields for experiments is not an effort toward demonstration of technology to farmers, but rather a procedure of setting the conditions under which phenomena will be studied. Qualitatively, it is no different from setting the thermostat for experiments in a green house.

Figure 6 illustrates the relationship of on-farm FSR to other agricultural research.

Highly discrete phenomena, meiosis for example, is best observed in a highly controlled environment. As phenomena involve more complex organisms, the environment is shifted to increasingly natural surroundings - to a phytotron, to a greenhouse, to a screen house, and eventually to an experimental farm. Agricultural systems are highly complex and are most efficiently examined in mostly natural surroundings. The appropriate medium for an experiment is not unique to the phenomena examined, but rather a choice based upon cost efficiency. It would be possible, but highly costly, to construct a farm and its environment in which to

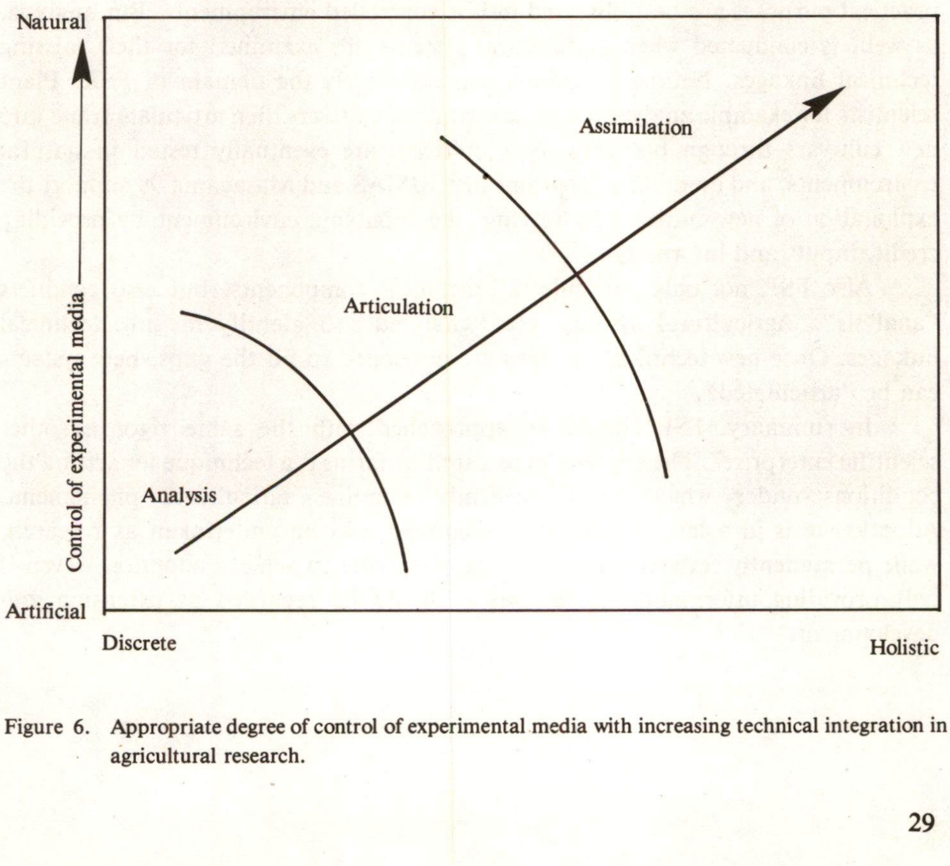

Figure 6. Appropriate degree of control of experimental media with increasing technical integration in agricultural research.

observe an agricultural system for study. Similarly, it would be possible to observe meiosis on farmers' fields, but it would take many attempts and the awkward installation of tools. Economics of research determines the method by which scientists fix the conditions under which to conduct experiments. Sit selection is the method used in FSR to control the environment for an experiment.

Three approaches to the examination of phenomena may be distinguished: analysis, articulation and assimilation. Analysis is used to discover the nature of separate components of a phenomena. A high degree of environmental control often is employed in order to identify the effects of technical components. Technical components may be linked or "articulated" when more complex phenomena are studied. Complex phenomena include many technical components, responding to various environmental conditions. It becomes practical to allow more of the experimental conditions to be set naturally. At late stages of research, phenomena are observed in largely natural environments and when no factors are controlled a test implies "assimilation" of the event into the environment. Observing the assimilation or non-assimilation of a technology into the environment comprises a test for adoption. Extension and development involves the permanent alteration of the environment, farmer knowledge, credit facilities, etc. - to accommodate technical events.

FSR articulates technical components into complex phenomena that for practical purposes are best observed in less controlled environments. But analysis, as well, is conducted when agricultural systems are examined for their missing technical linkages. Neither is articulation exclusively the domain of FSR. Plant scientists for example analyze the genetic traits of cultivars then articulate traits into new cultivars through breeding. New cultivars are eventually tested in natural environments, and eventually programs like BIMAS and Masagama 99 support the exploitation of new cultivars by revising the economic environment by providing credit, inputs and information.

Also FSR not only "articulates" technical components, but also conducts "analysis". Agricultural systems are "analyzed" to identify missing technical linkages. Once new technical linkages are developed to fill the gaps, new systems can be "articulated".

In summary, FSR should be approached with the same rigor as other scientific enterprises. The conduct of research on farms is a technique for setting the conditions under which to scientifically examine agricultural phenomena. Adoption tests in a largely natural environment may be undertaken as research, while permanently revising the environment in order to achieve adoption - even if only providing information to farmers - should be regarded as extension and development.

EVALUATION OF IMPACT

The final stage of FSR to be discussed is treated only briefly here. There are now strong suggestions that prospective impact should be evaluated at the design stage of research. At IRRI, we're now being encouraged particularly to examine technical objectives in relation to national development policies. It's also suggested that we pay greater attention to possible effects on the environment. The suggestions imply that it may not be appropriate to seek technological advances that can be achieved under current market conditions, but rather to envision desirable future market conditions that new technology may help to create. That is, for example, to try to develop technology that employs more labor from landless households perhaps in spite of an inclination of farmers to mechanize, or a technology that employs fewer petroleum-dependent inputs in the face of the current economic expedient if using them, or a technology that substitutes domestically grown plant protein for imports. Clearly, such research must be undertaken in close cooperation with policy-makers. The viability of such technologies are dependent upon changes that policy-makers can bring about. An infant industry for soybean production may require import restrictions or other policy measures over a period long enough for researchers and farmers to establish a competitive industry. The challenge to policy makers to bring about conditions that will support labor-intensive, environmentally benign and import-substituting technologies is likely as great as the challenge to researchers of developing such technologies.

Finally, it was suggested the ex-ante impact evaluation of technologies is the most inexact of knowledge producing exercises. Screening of technology for prospective impact is, therefore, also an inexact process. Type II errors are the likely hood rejecting technologies that are actually good. Society must weight the cost of forgone development resulting from erroneously rejecting good technologies against the cost of remedies to problems caused by introducing currently economically viable technologies eventually found to have bad effects.