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# Assessing the Impact of New Technology: Three Levels of Analysis

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ABSTRACT. It is ironic that farming systems research and extension (FSRE), long accustomed to condemning conventional agricultural research for having limited impact on farmers, is becoming increasingly vulnerable to the same charge. FSRE practitioners can no longer ignore questions of adoption and impact. This paper discusses methods for assessing the impact of FSRE programs, with emphasis on three levels of analysis:

- Monitoring farmer adoption of new technology;
- Estimating economic returns to investment in agricultural research, including FSRE; and
- Using general equilibrium analysis to examine the effects of widespread farmer adoption on non-adopting populations.

Of these three levels, the first is fundamental. Yet even that one has been largely ignored by FSRE practitioners. The third level has never been used by FSRE practitioners, and is unlikely to be, unless FSRE can be shown to be responsible for major changes in productivity over large areas.

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The roots of farming systems research and extension (FSRE) may be traced partly to a "crisis of expectations" created by the Green Revolution. The Green Revolution developed new technology for millions of rice and wheat farmers, especially in Asia. Its success led observers to anticipate similar achievements for other crops. Expectations were high that scores of crops, covering an abundance of production environments, would benefit from their own Green Revolutions.

In general, these expectations were not met. It became commonplace to hear of areas (e.g., hilly regions) or even whole continents (e.g., Africa) as having been "by-passed" by the Green Revolution. Some researchers felt that suitable new technology could be developed – even for "by-passed" farmers. These scientists, aware of the complexity of small farming systems, felt that research using a systems perspective and featuring contributions from researchers, extension workers and farmers might greatly increase the probability of successfully generating suitable new technology. Procedures following these lines evolved rapidly and are now collectively known as FSRE.

The inability of conventional research to meet the lofty expectations raised by the Green Revolution helped foster the evolution of FSRE. Concerns about lack of adoption of new technology have continued to be a major engine behind refinement of FSRE techniques. FSRE aimed to overcome the problem of limited farmer adoption by developing new technology as compatible as possible with farmers' circumstances. Indeed, FSRE became known for promising "near-term" solutions (Collinson 1987). Several observers took this promise to its logical conclusion and noted that rapid farmer adoption was the proper evaluation criterion for new technology and, implicitly, for the procedures generating that technology (Chambers and Ghildyal 1985).

## Concerns about impact

Research managers and donors have begun to doubt that FSRE is fulfilling its promise. It is ironic that FSRE, long accustomed to condemning conventional agricultural research for having limited impact on farmers, is becoming increasingly vulnerable to the same charge. Some analysts feel that this lack of impact is not due to any shortcoming in the FSRE concept itself, but rather to failures of implementation (Byrnes 1989). However, it is somewhat difficult to tell what the impact of many FSRE programs has been, as they typically failed to monitor farmer adoption (or lack of adoption) of new technology.

When widespread farmer adoption of productive new technology can be demonstrated, several levels of impact assessment may become important. Linking adoption of new technology with improvements in the welfare of farm households and rural villages can be an issue (Ranaweera and Gonzaga 1988). Questions of research efficiency — the economic returns to public investment in research programs — may be raised. Moreover, assessment of the impacts of new technology need not end with the adopting farm households. Impacts on non-adopting populations (e.g., consumers) mediated through product prices and wage rates may be equally important when adoption is widespread and affects major food cereals.

However, farmer adoption often *cannot* be demonstrated. Often, there is very little tangible to show for past investments in FSRE. Under these conditions, impact studies of any kind have little meaning.

## Objectives and overview

This paper discusses methods for assessing farmer adoption of new technology and the impact of FSRE programs, with emphasis on different levels of analysis. Three levels of inquiry are featured: monitoring farmer adoption behavior; estimating economic returns to investment in agricultural research, including FSRE; and using general equilibrium analysis to assess the effects of extensive farmer adoption on non-adopting populations.

Each level of analysis is briefly discussed and examples from Indonesia, Mexico and Pakistan are given.

## MONITORING FARMERS AND MEASURING ADOPTION BEHAVIOR

Whether or not FSR teams conduct formal studies of adoption and diffusion, they ought to monitor changes in farmers' circumstances and practices, including use of technology. New technology is rarely introduced into a static setting; rather, farmers' circumstances evolve and change over time. Roads may be completed; off-farm employment opportunities may open up; product and input prices may change; new pests and diseases may become important, etc. As has been noted, FSR teams typically aim at a moving target (Maxwell 1984).

Monitoring is needed to periodically refocus research toward higher priority problems. Problem rankings may change over time as farmers adopt solutions to some problems and as new and important problems appear. Monitoring is, in theory, a standard FSR procedure contained in the concept of "diagnosis as a continuous process" (e.g., Byerlee and Collinsion 1980). However, theory often differs from practice.

### Conceptual issues: adoption and adopters

What is meant by "adoption"? Who is an "adopter"? We define adoption as "the degree of use of a particular technology or practice by farmers at a given point in time" (Jim Longmire, pers. comm.). This definition allows for a number of distinctions:

- Adoption may be interpreted as a binary variable (yes vs. no) or as a quantitative variable (e.g., fertilizer dose);
- Adoption may be interpreted in terms of a particular point in time (e.g., today) or a time range (e.g., over the last five years);
- Adoption can be reversible, i.e., farmer use of new technology may only be temporary.

It follows from the above that the stratification of farmer populations into two categories, *adopters* and *non-adopters*, may often be inadequate. Using information theory, Harrington (1980) developed this more exhaustive set of farmer categories:

- *Users*. Farmers fully using a recommended technology at the current time;
- *Partial users*. Farmers using only part of a recommended technology, e.g., a recommended cropping pattern, but non-recommended planting dates;
- *Ex-users*. Farmers who, having tried a recommended technology, have decided that it is not suitable;
- *Non-users*. Farmers who have consciously decided not to use a recommended technology, and farmers who do not yet have enough information to make up their minds one way or the other.

## Conceptual issues: the question of control groups

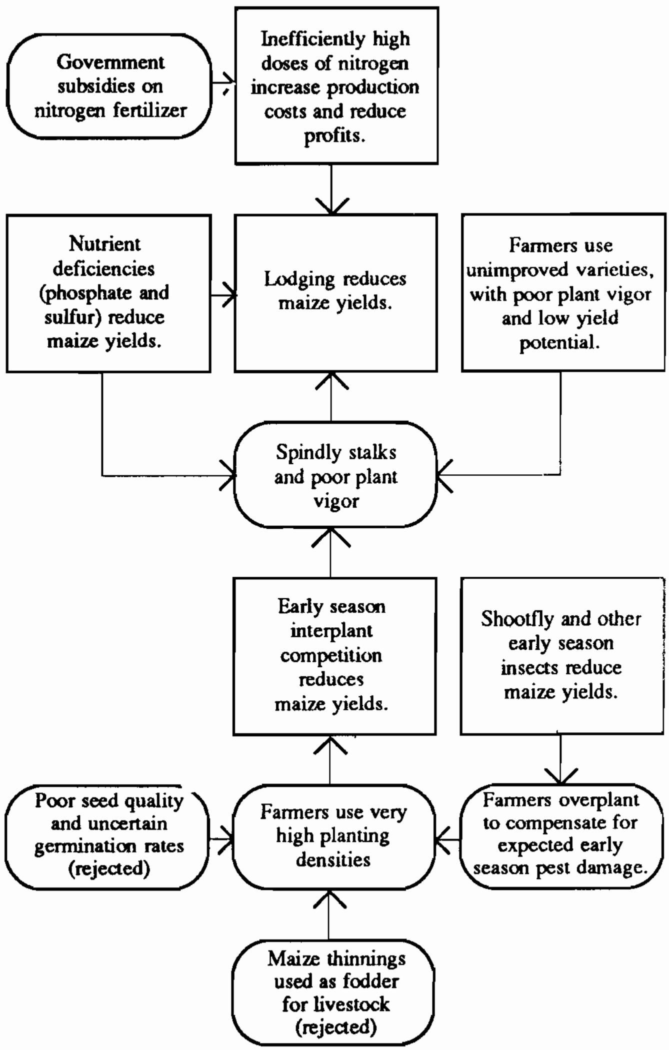
Farmer adoption of new technology may conceivably have little to do with research and extension activities. Changes in farmers' use of fertilizer may have more to do with changes in fertilizer or prices than with research recommendations. Establishing a causal link between research activities on the one hand and farmer use of technology on the other can be challenging. The literature on "quasi-experimental designs" is particularly pertinent here (Campbell and Campbell 1963; Trochim 1986). This topic will be discussed at length later.

### Empirical example: new maize technology in East Java

Farmer adoption of new technology was recently studied by the Malang Research Institute for Food Crops (MARIF) in Indonesia. Since 1984, MARIF staff have conducted an on-farm adaptive research program, focusing on *palawija* (non-rice food crops) in several study areas. The 1990 adoption survey, however, was restricted to maize technology in one study area in Malang District. The selected area embraces maize harvested areas of about 60,000 ha in Malang District and up to 150,000 ha in East Java.

Diagnostic activities included an exploratory survey, a formal survey and several kinds of special purpose surveys, diagnostic trials and laboratory tests. Major problems facing maize production in this study area were lodging, early season interplant competition, early season insect damage, use of germplasm with low yield potential, nutrient deficiencies and inefficient nitrogen fertilizer management. These problems and their corresponding causes are diagrammed in Fig. 1.

Fig. 1. Hypotheses on problems and causes (after two cycles of diagnostic surveys and trials).



On-farm research (OFR) activities aimed to find solutions that would be acceptable to farmers. A number of researcher-managed and farmer-managed designs were employed to test and assess technical alternatives. Recommendations were released for shootfly control, plant stand management and use of improved germplasm. Research-extension links were fragile at first, but grew stronger over time, with extension subsequently making major efforts to disseminate the recommendations.

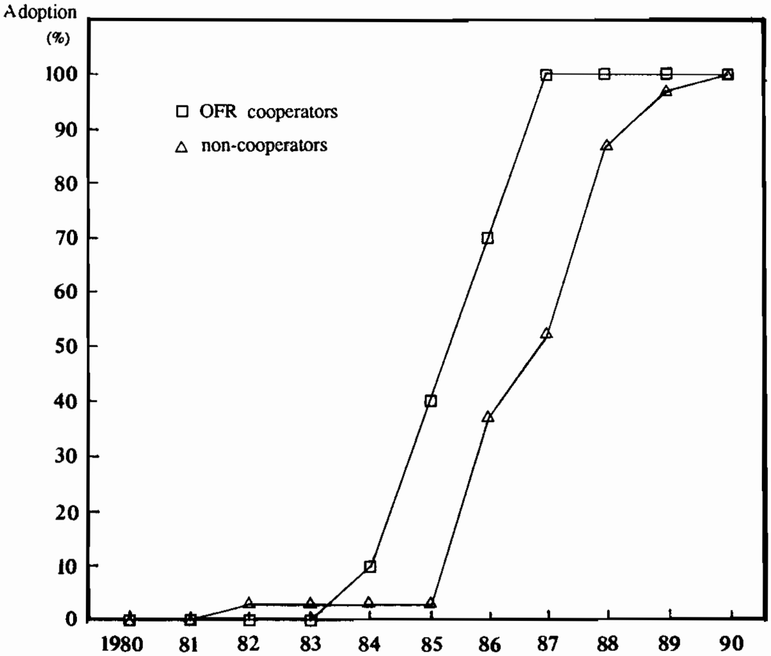
Preliminary results from the adoption survey reveal that farmers participating in the OFR program promptly picked up recommended practices (Table 1). Shootfly control has expanded and the farmers' earlier practice of overplanting and thinning to compensate for expected shootfly damage is being dropped. Similarly, improved germplasm, especially the improved variety *Arjuna*, has become widespread. Farmer adoption of recommended practices came during and after, not before, implementation of the OFR program, and trial cooperators tended to adopt improved practices earlier than did non-cooperators (Fig. 2). This suggests a link between research and farmer adoption.

Table 1. Changes in farmer practices, 1984-90 *

| Practice | 1984 | 1990 |
|---|---|---|
| Planted improved varieties (%) | 52 | 70 |
| Planted hybrids (%) | 0 | 15 |
| Seeds per hill at planting | 3-5 | 2-3 |
| Used pesticides for shootfly control (%) | 13 | 78 |
| Thinning (%) | 83 | 45 |
| Applied nitrogen this season (%) | 100 | 100 |
| Applied phosphate this season (%) | 30 | 38 |

* Sources include MARIF (1985), which reports on the 1984 baseline survey and preliminary analysis of the 1990 adoption survey. Both surveys used two-stage random sampling, with sample sizes of about 60 farmers. The adoption survey covered only villages where the MARIF OFR team had been active at one time or another.

Fig. 2. Timing of adoption of shootfly control by adopters only, by farmer category.




## CALCULATING ECONOMIC RETURNS TO ADAPTIVE RESEARCH

Farmer monitoring is crucial in keeping an adaptive research or FSRE program focused on farmers' needs and provides information on the effect of research on farmers. In many cases, however, a more comprehensive evaluation of a research program may be desirable. Research administrators faced with the problem of allocating scarce resources may wish to compare returns on investment in adaptive research with returns earned by other kinds of research. Is adaptive research an efficient use of public research funds?

Previous studies of returns to agricultural research have focused on estimating the returns to aggregate research investments (Griliches 1964; Evenson 1967; Bredahl and Peterson 1976; Kahlon et al. 1977) or to varietal development (Ardito Barletta 1971; Ayer and Schuh 1972; Akino and Hayami 1975; Scobie and Posada 1978). However, those studies provide little insight on how to appraise the returns to adaptive research. This section presents an analytical framework that can be used for evaluating such returns.

A program of adaptive research has the potential to produce multiple and varied products such as improved soil fertility management or pest control recommendations, suggestions for improved cropping patterns, guidelines for erosion control using alley cropping techniques, or improved planting and harvest practices. With few exceptions these research products are *information*. To estimate returns to research, a comprehensive list of these research products must be identified and the impact of each must be quantified.

## The empirical framework

An empirical analysis of the returns to adaptive research can be organized by reducing enterprise production to specific management practices that determine the final production outcome. For wheat, for example, these practices would include planting method, planting date, land preparation, nitrogen use, phosphorus use, irrigation management, weed control, insect control and harvest practice. Each practice can then be examined in four steps.

The first three steps describe conditions necessary for a given research activity to be logically linked to an increase in productivity, production and, eventually, producers' surplus. Since these are asserted to be necessary conditions, they can be considered sequentially. The failure of any one of the conditions results in an economic value of zero being assigned to the corresponding research investment.

The conditions are that:

1. Research must have led to the discovery of an improved management practice embodied in a new recommendation issued to farmers;
2. Producers must have modified their management practice in a manner consistent with the change in recommendation; and
3. There must have been evidence of causality between the change in practice and the change in recommendation.

The first condition recognizes that during the period covered by the analysis, not all research will bear fruit. We use the convention that if research does not lead to the release of any new information to farmers, it cannot have an immediate impact on production, even though potentially valuable scientific knowledge may have been generated. The second condition eliminates recommendations that are, for whatever reason, rejected by farmers.

The third step evaluates the evidence of causality. This represents a problem that is not easily made to conform to formal statistical testing. It is a problem more amenable to the accumulation of evidence and the use of less formal criteria. The simple heuristic criteria which we used were as follows:

the recommended practice and producer practice should have changed in the same manner during the study period;

- dissemination of the recommendation must have preceded the change in farmers' practice;
- it was "unlikely" that producers could develop the change in practice without the benefit of formal research.

The fourth and final step is to calculate the increase in economic surplus generated by each recommendation that successfully meets all prior conditions. The size and distribution of the surplus is determined by the magnitude of the induced shift in the supply curve and by the elasticities of supply and demand. If the area being studied produces a small share of the commodity consumed in the country, changes in consumers' surplus need not be considered and changes in returns above variable cost (RAVC) are an exact measure of producer surplus (Just et al. 1982).

The annual total value of an improved practice then is the product of the impact per hectare multiplied by the area over which the information or innovation is employed (equation 1).

$$QR_{it} = p_i k_{it} A_t \qquad \ldots 1)$$

Where $QR_{it}$ is the total quasi-rent generated by innovation $i$ in the year $t$, $p_i$ is the per hectare change in RAVC due to innovation $i$, $k_{it}$ is the percent of enterprise harvested area employing innovation $i$ in year $t$ and $A_t$ is the total harvested area in year $t$. Quasi-rent is defined as "the payment to any input in temporarily fixed supply" (Mansfield 1970). In this context it is the total increment in profits to producers, as measured by the RAVC criterion. The total quasi-rent generated by the research program is the discounted sum of the quasi-rent streams generated by each innovation (equation 2).

$$QR = E_i E_t \Phi^t QR_{it} \qquad \ldots 2)$$

Farm survey and on-farm trial data can be used to estimate the values of $p_i$ and $k_{it}$, while secondary data can be used to identify $A_t$. The estimate of the total change in producer surplus can then be compared with research costs $C_t$, to calculate the internal rate of return (IRR). The IRR is the discount rate $(i)$, which satisfies equation 3.

$$E_t (QR_t - C_t) / (1 + i)^t = 0 \qquad \ldots 3)$$

## Summary of results from an application of the framework

The above framework was used to evaluate an on-station program of crop management research in the Yaqui Valley of Mexico in 1977-87 (Traxler 1990). The valley is a mechanized, high-input, high-yielding wheat area and is served by a single research station that will be referred to here by its Spanish acronym CIANO. Nine management practices were considered: planting method, planting date, land preparation, nitrogen use, phosphorus use, irrigation management, weed control, insect control and harvest method.

*Step 1.* Significant changes were found in recommendations for three practices (planting method, phosphorus use and insect control) and minor changes for three other practices (land preparation, nitrogen use and planting date).

*Step 2.* Statistical analysis of farm survey information was used to examine changes in producers' practices over time. The six practices that were examined are of two types: practices that take on continuous values, e.g., nitrogen use; and practices that are dichotomous, e.g., use of subsoiling. Changes in continuous practices were examined using the Friedman rank test. Chi-square tests for changes over time in relative frequency of the outcome of interest were applied to practices that take on dichotomous values. This step of the analysis found significant changes in four practices: planting method, insect control and N and P rates (Table 2).

Table 2. Changes in crop management practices, 1981-89

| Practice | 1981 | 1982 | 1987 | 1989 |
|---|---|---|---|---|
| Soil preparation | | | | |
| % subsoiling clay soils | 32 | na | 36 | 23 [a] |
| Planting method | | | | |
| % using ridge method | 8 | 5 | 37 | 33 [b] |
| Seeding rate | | | | |
| ridge method (kg/ha) | 76 | 75 | 122 | 125 [c] |
| traditional method (kg/ha) | 163 | 156 | 175 | 175 |
| Planting date | | | | |
| median date | Dec. 5 | Dec. 9 | Dec 10 | Dec 6 [d] |
| Fertilizer use | | | | |
| Phosphorus (% applying) | 59 | 56 | 83 | 78 [b] |
| Nitrogen (kg/ha) | 176 | 194 | 218 | 230 [d] |
| Insect control | | | | |
| % applying insecticide | 82 | 64 | 27 | 56 [b] |

[a] Fail to reject equality of proportions across years based on chi-square test.

[b] Reject equality of proportions across years.

[c] Average seeding rate significantly different between planting methods in all years.

[d] Reject equal distribution of values in all years based on Friedman rank test.

*Step 3*. An examination of the causal link between changes in farmers' practices and CIANO research led to the conclusion that the adoption of the new planting method and the change in pest management strategies would not have occurred in the absence of CIANO's research efforts. The changes in nitrogen and phosphorus use, on the other hand, were easily explained as the result of farmers' response to relative price and risk considerations. The fact that only two practices, planting method and pest control, satisfied the three necessary conditions (Table 3) suggests that more careful monitoring of producer behavior could improve the efficiency of the research program.

Table 3. Conclusions concerning induced changes in crop management practices.

| Practice | Change in recommendation? | Change in practice? | Causality? |
|---|---|---|---|
| Weed control | No | — | — |
| Harvest | No | — | — |
| Irrigation | No | — | — |
| Land preparation | Minor | No | — |
| Planting date | Minor | Yes | No |
| Nitrogen | Minor | Yes | No |
| Phosphorus | Significant | Yes | No |
| Planting method | Significant | Yes | Yes |
| Insect control | Significant | Yes | Yes |

*Step 4*. The total change in quasi-rent attributable to each of these innovations was calculated using partial budgeting and yield function estimation. The aggregate diffusion of the new planting method through 1989 was taken from the farm survey information. A logistic diffusion curve was estimated to predict the future diffusion path.

Estimates of the IRR to the crop management research investment were derived under a range of assumptions about the benefit and cost streams. Under the most reasonable set of assumptions, the IRR was estimated to be 16-26%. The model was most sensitive to assumptions concerning cost reduction attributable to the new planting method and to the assignment of extension costs. The assignment of maintenance research costs and the impact of the change in pest control practice had only modest impacts on the model's estimated IRR.

## DIFFERENTIAL IMPACTS ANALYSIS

The preceding sections discussed the measurement of farmer adoption of new technology, and the returns to research investment resulting from this adoption. This section outlines a framework for incorporating the *indirect* effects of improved technologies on *non-adopting* populations (including both farmers and non-farmers), using general equilibrium modeling techniques. The discussion focuses on a particular kind of new technology, one that affects the aggregate level of food grain production and, in addition, is suited to only a subset of a country's farmers. To illustrate the kind of information that such models provide, the empirical results of a study on the diffusion of semidwarf wheat varieties (HYVs) in Pakistan are presented. The general equilibrium modeling techniques described are just as relevant for assessing the impact of new technology generated in FSRE programs, as long as these programs have had a significant impact on aggregate levels of food production.

### Background

A new technology may be expected to have direct productivity effects on adopting farmers, and indirect effects on both adopters and non-adopters. The most important of these indirect effects operate through output markets and labor markets, taking the form of changes in commodity prices and changes in wages.

To the extent that increased productivity leads to an outward shift in aggregate supply and markets clear without undue distortion (e.g., through government intervention), the price of the affected commodity will fall. This will tend to benefit various socioeconomic groups differently. Households that are *net consumers* of the commodity in question (including non-producers and farms unable to satisfy household demand out of their own production) will benefit unambiguously from the decline in product price. Moreover, poorer households will reap relatively greater benefits since the share of expenditure on staple foods is typically inversely related to household income. Among households that are *net producers* of the commodity in question (i.e., farms that produce more than they consume), non-adopters will unambiguously lose, since they now face lower output prices without a change in productivity. Whether adopters gain or lose depends on whether the positive impact of the new technology on their production outweighs the negative effect of falling output price. Empirical studies have generally found that such households usually gain on net (Akino and Hayami 1975; Scobie and Posada 1978; Lipton and Longhurst 1985).

Technological innovations generally involve changes in labor use. A yield-enhancing technology implies a greater demand for harvest labor. Other technologies entail new cultivation or weeding practices for current enterprises, or the introduction of new enterprises that can have large effects on the demand for labor. When per hectare changes in labor demand are not small and when adoption of the corresponding technology is widespread, changes in labor demand will be reflected in changes in wage rates in rural labor markets. This, in turn, affects the incomes of all households in adopting areas that rely on agricultural labor as a source of household income. This includes farm households that do *not* engage in off-farm employment, as the implicit return to their labor will have changed.

The impact of a new technology on labor markets may extend beyond the area in which technology adoption occurred – if laborers are sufficiently mobile. If real wages due to increased labor demand rise sufficiently to cover the cost of changing locations, laborers from non-adopting areas may migrate to take advantage of better employment opportunities. This rural-rural migration can transfer the benefits of technological change to households in non-adopting areas, as has been widely noted (Dhar 1980; Lipton and Longhurst 1985; Quizon and Binswanger 1986). Recent work in Asia confirms that such a transfer from irrigated to upland areas has indeed occurred (Otsuka et al. 1987; Sudaryanto 1989; Upadhyaya et al. 1989; Isvilanonda and Wattanutchariya 1989).

## A general equilibrium model of differential impacts

Up to this point, the indirect effects of new technology have been discussed market by market. While useful in understanding the process of technological change, such partial equilibrium analyses are inadequate for assessing the overall impact of a particular innovation on various socioeconomic groups within an economy. Typically, people cannot be classed as simply consumers or producers, laborers or landowners; rather, they are a combination of some or all of these. Consequently, a new technology can have multiple (perhaps conflicting) impacts on welfare.

One way of sorting out the net effect of new technology on different socioeconomic groups is through general equilibrium modeling. Such models have been used to analyze marketing and storage policies (Behrman and Murty 1985), food price policies (Braverman et al. 1987) and the impacts of technical change on urban and rural households (Quizon and Binswanger 1986). This methodology entails describing an economy mathematically – i.e., writing down a set of general functional relationships governing the markets of interest – and totally differentiating these to derive a system of linear log-differential equations. Solution of this system yields information on changes in prices, quantities and income, given a set of behavioral parameters and changes in a subset of exogenous variables.

## An example from Pakistan

Such a model has been developed for Pakistan to examine the impacts of differential diffusion of HYV wheat varieties on the incomes of various socioeconomic groups (Renkow 1989). The groups considered included

1. large farm households, small farm households and non-agricultural households in *adopting* rural areas;
2. large farm households, small farm households and non-agricultural households in *non-adopting* rural areas; and
3. "poor" and "rich" households in *urban* areas.

For each of the farm household groups, output supply and input demand functions were specified. Two outputs (wheat and other crops) and two inputs (labor and others) were considered, with output supply and input demand taken to depend on output prices, the price of labor and other inputs, and (for wheat) an exogenous technology shifter variable.

For each rural household group, agricultural labor supply was assumed to depend on the real agricultural wage. Demand for wheat and those for other commodities were specified as depending on commodity prices and real income. Nominal income was determined by summing net returns to all factors rented out by a particular group, including farm profits, family labor income and other (exogenous) income. Group-specific price indices (based on the prices of consumed commodities weighted by their respective budget shares) were then used as income deflators. Finally, the model was closed by equating supply and demand in the two markets assumed to clear endogenously (the wheat market and the agricultural labor market).

Implementing a general equilibrium model such as this one requires information on the underlying behavioral responses to price changes of the various socioeconomic groups modeled (i.e., elasticities), along with a set of parameters related to the shares of aggregate demand and supply of the outputs and inputs accounted for by each group. For the model discussed here, these parameters were drawn mainly from secondary sources.

*A brief summary of results.* In Pakistan two key relationships appear to drive the relative impacts of new technology on income. First, in non-adopting areas, small farmers are net consumers of wheat, while all other wheat-farming groups are net producers. Second, all groups of rural households are engaged in agricultural labor activities.

Two simulations were made using the model:

1. The first assumes an improved wheat variety yielding a 5% increase in productivity in one "favored" region with no accompanying change in productivity in a non-adopting "marginal" region.

2. **The second assumes that farmers in the marginal region are able to use the new variety as well, but its impact on yield is only half that in the favored region. Results are shown in Table 4.**

Table 4. Simulated percentage changes in real income, real wages and wheat prices for different socioeconomic groups.

| Region | Group | % change in real income<br>Scenario 1 [a] | <br>Scenario 2 [b] |
|---|---|---|---|
| Favored | Non-farming | +0.72 | +0.81 |
| | Small farms | +1.15 | +1.09 |
| | Large farms | +1.26 | +1.15 |
| Marginal | Non-farming | +0.78 | +0.88 |
| | Small farms | +0.51 | +0.74 |
| | Large farms | -0.79 | -0.26 |
| Urban Poor | +0.48 | +0.54 | |
| | Rich | +0.35 | +0.40 |
| % change in real agricultural wage | | +0.17 | +0.20 |
| % change in wheat price | | -4.48 | -5.05 |

[a] 5% productivity increase in favored region only.

[b] 5% productivity increase in favored region and 2.5% productivity increase in marginal region.

The results highlight the rather complicated set of interactions between new wheat technology, wheat prices, real wage rates and real household income. In both scenarios, the supply shift induced by the technical change leads to a decline in the price of wheat and an increase (slight) in real agricultural wages. For nearly all groups of households this means improved real incomes. The exception here is the large farms group in the marginal region. As net producers of wheat, these households are hurt more by the decline in wheat prices than they are helped by the lower price of food (in their role as consumers).

One useful aspect of this analysis is that it provides information on the relative impacts on different groups, thereby allowing an assessment of whether these impacts are equitable. In the favored rural area, where direct productivity impacts are stronger, distributional effects appear to be regressive, with large farms benefiting more than small farms and landless households. In the marginal rural and urban areas, where changes in the price of wheat to consumers is the dominant effect, the impact of new technology on income distribution appears beneficial.

## Implications for FSRE programs

The preceding example was *not* from an FSRE program. Rather, it was a Green Revolution example of varietal adoption. In this case, widespread adoption of new technology helped low-income consumers and small farmers. Only large farmers in non-adopting areas were losers.

To assess equity impacts in the manner shown above, FSRE programs will have to document adoption of new technology. Moreover, they will have to document adoption of new technology on a wide scale and in enterprises that are important in terms of farmers' incomes. Clearly, FSRE programs have a long way to go.

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