# Accenting the farmer's role: Purdue Farming Systems Unit

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We shall describe, analyze, and evaluate our experience with farming-systems research; we believe the information is valuable because modifications in our approach have substantially increased the role of the farmer in the process.

Principal considerations in the design of research are the objectives and the allocation of resources to meet the objectives. The emphasis in the objectives ranges from one extreme in which the principal concern is to institutionalize farming-systems research in the national program to another extreme in which the concern is with the rigour and sophistication of the research. Proponents of the latter extreme may view institutionalization as a secondary objective or one that is attainable only in the distant future.

Whatever the goal, credible, multidisciplinary investigation is essential to its achievement. At Purdue University's Farming Systems Unit, a primary concern is to design a research method that can be adapted as part of a national program. This goal forces us to forego complex data management and analysis in favour of simple and useful research that is readily adaptable to settings where skills in data management and analysis are limited.

Between the 1982 and 1983 cropping seasons, we made significant changes in our approach. Although, during 1982, we achieved the goal of conducting multidisciplinary research involving farmers to design new technology, we concluded that our method needed to be modified if it were to be adopted by national programs.

Given our concern with the design of an adaptable method, we believe we have moved much closer to an optimal allocation of scarce research resources. Specifically, we have:

- Increased the role of the farmer in the research;
- Increased the contribution of our Voltaic field staff;
- Increased flexibility for multidisciplinary and Voltaic participation in the design and conduct of farming-systems research;
- Increased the number of villages studied; and
- Increased the number of farmer-managed field trials.

These increases have been achieved with the same resources used during the 1982 cropping season. The major casualty in the reallocation of research dollars was the collection of labour data throughout the cropping season.

## *Initial approach*

Four types of socioeconomic data were collected during 1982:

- A census was taken in three study villages. Random samples of 60 farms were drawn from two villages, and a sample of 90 farms from the third. Detailed household and agricultural resource data (active workers, draft animals, and equipment) were collected from each household in the samples.
- Labour times and nonlabour inputs were recorded on a biweekly basis for all agricultural activities on each farm. For 150 of the farms, data were collected for all activities on all cereal fields and on at least one field of each other crop. For the other 60 farms, data were recorded for five farmer-managed field trials.
- Decision-making interviews were conducted by the economist with at least 30 farmers in each of the three villages. These explored the farmers' goals and objectives, factors affecting their resource-use decisions, and their assessment of binding constraints to increased production.
- Field sizes and yields were measured for all fields for which complete labour data were taken. Yield was weighed, and grain production was estimated from the percentage of grain remaining after a 10-kg sample was threshed.

By far, the most demanding of the four activities was the collection of labour data. This required 90 of the hours worked by 12 interviewers throughout the growing season.

The other major activity was agronomic research employing two types of on-farm field trials. At the direction of four agronomic assistants, a farmer-managed millet trial with five treatments was conducted by each of 30 farmers in each village. The themes of these trials were low-dose applications of rock phosphate (100–200 kg) and urea (50 kg) and water conservation using tied ridges. In addition, eight researcher-managed trials were conducted in all three villages. These trials included varietal, fertilizer, and water conservation themes for corn, sorghum, and legumes.

## *Principal findings*

Highlights of the findings were that:

- In two villages on the central plateau, and in half of the sample village on the edge of the plateau, the farmers are clearly oriented toward subsistence. They claim to ignore price in cropping and in deciding when to sell their crops. Their sales are strictly residual, prompted only by "urgent need" regardless of the market price. If, as harvest approaches, their stocks are adequate, they sell grain to purchase small ruminants, which are kept for sale during lean years. The data documented the farmers' reliance on livestock sales as a principal source of revenue to purchase grain Thus, the farmers are not, by plan, part of the cash economy.
- Although the principal grain crop in all three villages is millet, farmers would like to plant more sorghum because sorghum stores twice as

long (3 - 4 years) as millet (1 - 2 years) and, during good years, yields more than millet. They plant less than desired quantities because the variability in yield of sorghum and, therefore, production risk are much higher than those associated with millet.

- Labour, as has frequently been observed in other studies, is often a binding constraint during the first weeding but is slightly more available during the second weeding.
- Millet plantings are highly and consistently correlated with the number of active labourers/household. Sorghum plantings are confined to land that is more fertile or has better water retention.
- Use of draft animals is profitable in the land-abundant zone because of intensification effects and on the central plateau where extensification is possible. On the plateau, no intensification effects were detected.
- In two villages, the farmer-managed millet trials showed statistically significant ($P < 0.05$) yield responses to phosphate in the seed pocket and to tied ridges. The most promising treatment was a combination of the two techniques. For one village, average yield increases easily covered cash costs and provided returns to labour of about 28 CFA/work hour.

The implications for the design of appropriate technologies are that:

- Noncommercial farmers resist the use of purchased inputs;
- In the absence of increased fertilizer applications, continuous cropping with cereals leads to poor-quality soil. Increased plantings of millet relative to sorghum are probable because labour, the only variable input, can be used to produce millet on marginal land.
- If the farmer were to use cash inputs, they would probably be for a preferred crop like sorghum.
- A shift to increased sorghum production would require that its yield variability be reduced or that expected yields be increased sufficiently to compensate for cash risk associated with purchased inputs.
- The use of nonpurchased inputs should be maximized so that cash risks associated with low-dose applications of fertilizer are minimized.

Taking this information into account, the agronomist chose to add sorghum and corn experiments to the farmer-managed trials for 1983. Because of the soil quality, the agronomist found that small doses of purchased fertilizer would be essential in sorghum trials. As a nonpurchased input, labour would be used during the second weeding to build tied ridges for water retention, the aim being to offset the cash risks associated with the use of chemical fertilizers.

The tied ridges would also be used in corn trials. Because the yield variability (risk) associated with corn is high and because corn is already planted in relatively fertile soil, no fertilizer would be used in the trial.

Whether these trials prove successful remains to be seen. What we find important is the research approach that permitted us to combine agronomic and socioeconomic findings in choosing these trials.

The agronomist and economist worked with the farmers to arrive at a

choice of farmer-managed trials for 1983. The steps in the process are noteworthy:

- The agronomist gave the economist an initial assessment of the agroclimatic environment: rainfall is as high as that in other regions of the world where much higher millet and sorghum yields are achieved. The problem is erratic distribution of rainfall over the season. Soil fertility and water retention are low. The soil has little organic matter, and some chemical fertilizer is needed for improved yields. Phosphate is relatively inexpensive and locally available but urea, which is essential, is more expensive.
- The economist suggested trials on millet because it is the dominant staple crop. He conducted simple breakeven analyses on various fertilizer-application rates.
- The agronomist concluded that expectations for yield increases can justify only low rates of fertilizer application. To get response from low-application rates, he suggested putting phosphate in the seed pocket and discussed this with farmers to find an acceptable method of doing so.
- In lengthy interviews, 94 farmers described to the economist their goals and objectives, factors affecting their cropping decisions, and their production constraints.
- The agronomist assembled results of field trials.
- The economist estimated hours required to apply each technology.
- The agronomist analyzed results of farmer-managed field trials on millet. The trial using both tied ridges and phosphate in the seed pocket was the most promising. A repetition of the trial was planned so that the residual effects of phosphate and the effects of water conservation from tied ridges in the early season could be measured.
- The economist concluded that, for the average participating farmer, the yield increase from use of tied ridges and rock phosphate would easily cover cash costs. He observed that risk is the critical factor in evaluating the trial. In spite of gains in the arithmetic mean yield, the distribution was skewed, and 50% of farmers would have lost cash. Residual effects of fertilizer and tied ridges would be critical to the adoptability of this technology.
- Farmers discussed farmer-managed trials with the agronomist. One trial (tied ridges and phosphate in seed pocket) was of interest. Some claimed they would do it again. At the beginning of the 1983 season, the farmers told the agronomist they see the effects on soil and water conservation of tied ridges and do not have to draw lines for planting because they can use the ridges that were built the previous year.
- The agronomist evaluated researcher-managed trials.
- Based on interviews with farmers and tests of hypotheses generated by these interviews, the economist told the agronomist that the farmers are subsistence oriented; that they would prefer to plant more sorghum but, to reduce the risks of poor yields, would have to improve the quality of the land; that they would consider cash inputs for sorghum but that cash inputs would have to be minimized and noncash inputs — mainly labour — maximized.
- The agronomist decided that fertilizer could make "millet land" into "sorghum land" and that building tied ridges, which draws on

nonpurchased inputs, would reduce the adverse affects of drought and would offset the cash risk associated with fertilizer use. Researcher-managed trials on sorghum showed strong interaction effect of tied ridges and low doses of NPK fertilizer.

## *Implications for research*

The sources of socioeconomic information most helpful in the design of trials were "one-shot" interviews that drew directly on the farmers' knowledge and on empirical data (household surveys, field and yield statistics). We were able to ask the farmers questions, generate hypotheses, and then empirically test the farmers' claims. For example:

- Our understanding of the farmers' orientation toward subsistence was developed through "one-shot" interviews. While subjective, these interviews were thorough, and the responses were internally consistent among farmers. (Empirical verification and objective measurement of the meaning of subsistence is a major objective of a repeated monthly survey being used during 1983.)
- Interviews also spelled out the risk-averse behaviour of the farmers — the decision to plant millet instead of sorghum in spite of the higher expected return and better storability of sorghum. (Empirical tests using 1982 yield data confirmed higher yields but statistically greater yield variance for sorghum than for millet.) The farmers' behaviour is consistent with subsistence farming. If farmers could afford to assume more risk, they would plant more of a preferred, higher yielding grain even if its yield were variable. Higher yields in good years would compensate the losses in bad years.
- The rules that farmers followed in making decisions about crops were derived from personal interviews and then tested using land-area and household-resource data collected on a one-time basis.
- During interviews, farmers said that the constraint on labour was binding at the first weeding and that labour was somewhat less constrained during the second weeding. (Analysis of our labour data showed results consistent with this claim. The peak labour week during second weeding is nearly as busy as the peak week during the first weeding, but the second weeding takes less time. Farmers do not hire labour for the first weeding primarily because it is unavailable.)

These findings have shaped our research program for 1983, with respect to both socioeconomic and agronomic research. Socioeconomic research is devoted to defining subsistence production and to estimating risk and the risk preference of the farmer. The agronomic trials incorporate considerations of subsistence, risk aversion, and the preference for more sorghum.

During 1982, the bulk of our research resources was devoted to the collection of labour data, the principal use for which is the modeling of representative farms. But the socioeconomic information found most useful in shaping the design of future trials was that secured through "one-shot" interviews or objective data-collection efforts.

We are pleased with the quality of our labour data and believe that continued analysis of those data will also provide valuable insights for the

design of farm trials. Given the goal of developing a workable national program, however, continued investment in the collection of such data appears to be a misallocation of scarce research resources for several reasons:

- The sheer volume of data collected represented a massive task in data management: 6 months of skilled professional time was needed to "clean," enter, and verify data.
- Analysis using the data cannot begin until well after a cropping season is completed.
- Manipulation and analysis of large volumes of data are, in our experience, frequently delayed by power failures and breakdowns in computer hardware.
- Designing models is time-consuming and can only be done by experienced professional economists.
- The opportunity cost of such activity is high. Opportunities to conduct useful research on farmer behaviour are foregone each month that labour data are collected.

Meanwhile, the farmers are willing to answer a wide array of questions about how and why they farm the way they do. Their claims can be empirically tested, and the basic information about their resources and the way they allocate them is essential to the design of appropriate techniques. Farmer-managed trials also provide most valuable information not only with respect to the technical relationships between inputs and outputs but also with respect to the farmers' explanation of how the trial fits or does not fit into their cropping pattern.

Our experience in 1982 indicated that a broad range of information could be obtained from the farmers and tested by empirical data. It also indicated that crop risk and ownership of livestock were factors in the farmers' decision-making and should be a focus of research. The conditions that permit subsistence farmers to become active participants in the cash market are not well understood; the farmers' market behaviour and its relationship to food security, land, labour, and capital resources should be examined. An understanding of these relationships would permit one to determine the conditions under which purchased inputs may more readily become part of the farmers' cropping practices. Finally, our experience suggested that there is much to be gained from expanding farmer-managed field trials in the program.

## *Alternative approach*

During 1983, labour times are being measured only on the farmer-managed field trials. Socioeconomic research consists of two monthly interviews. In the first, which is repeated every month, interviewers deal with 150 farmers (30 in each of 5 villages) recording complete monthly data on grain in storage, consumption, purchases and sales, trades, gifts given and gifts received. Farm-level prices and motives for transactions are also secured. Data are assembled by crop and by family member initiating the transaction. The same data are taken for livestock and poultry. The second interview has a variable theme. It may be different each month, or one theme may be pursued for 2 or more months. The questionnaire can be coded or open-ended. To November 1983, the themes have included varieties of seed

Table 1. Resource base for two approaches to farming-systems research.

| | 1982 | 1983 |
|---|---|---|
| Agronomic assistants | 4 | 9 |
| Socioeconomic interviewers | 12 | 5 |
| Controllers | 3 | 2 |
| Professional and staff visits to villages/month | 6 | 10 |
| Field staff visits to head office/month | 0 | 1 |
| Questionnaires designed and analyzed | 4 | 12 |

employed, advantages, disadvantages, years used, and reasons for changes (May 1983); estimates of nonagricultural sources of revenue for year and case studies of hours, expenses, and revenue from one specitic activity by male and female members of the household (June 1983); marketing patterns, locations, motives, etc. of men and women (July 1983); farmers' goals and objectives (August 1983); noncereal food consumption by farm families (September 1983); and yield expectations of farmers (October–November 1983).

Land under cultivation and yield will also be measured because they provide empirical information needed to test hypotheses generated in discussions with farmers. Specifically, these data facilitate direct tests of land-use decision rules. Because we are no longer gathering labour data, the total interviews are fewer than in 1982, and we have been able to expand agronomic activity. Whereas 12 socioeconomic interviewers and 4 agronomic assistants worked in 3 villages during 1982, 5 socioeconomic interviewers and 9 agronomic assistants work in 5 villages in 1983.

A new feature in our approach is a monthly conference with our interviewers and agronomic assistants. Interviewers present to the entire staff a critical, qualitative assessment of the data they have gathered during the month. They also work with the data-processing personnel to explain "gaps" or inconsistencies in their data. Agronomic assistants present reports on crop progress and on particular problems faced by farmers in their zones during the month. Their reports add a qualitative dimension to the coded data and generate new and useful research ideas.

Using this approach, we believe we are accenting the activities that most helped us to achieve our objectives in 1982. Meanwhile, the 1982 labour data will be analyzed and we will be able to determine whether they tell us enough to justify collection. Given our resources, we could follow farmers' labour activities only during critical periods; otherwise, we would have to forego the opportunity to draw upon the farmers' knowledge.

The approach used in 1983 draws essentially upon the same resource base as that for 1982 (Table 1), but the research product is different (Table 2). In effect, the research outputs of the two approaches represent two points on a curve of research-production possibilities. If the goal is to institutionalize research that draws upon combined agronomic and socioeconomic inputs to shape future trials, researchers must choose among approaches that range from a nearly exclusive focus on the collection of cost-route data to a sole reliance on subjective interviews with farmers. The approach used during 1982 focused more on the collection of data needed to do modeling. The approach currently used draws heavily upon subjective information from farmers but retains a focus on the collection of objective, empirical data to test hypotheses generated through such interviews.

Table 2. Research product using alternative approaches.

| Dimension | 1982 | 1983 |
|---|---|---|
| Villages studied | 3 | 5 |
| Farmer-managed field trials | 1 | 3 |
| Researcher-managed trials | 8 | 7 |
| Interviews/farmer | 8/month | 2/month |
| Variable-theme interviews | 1/year | 10/year |
| Number of farms on which complete labour data were collected | 150 | 0 |
| Number of field trials on which labour data were taken | 90 | 340 |
| Use of outside expertise in research design | Rare | Frequent |
| Professional roles for Voltaic staff | 0 | 2 |
| Farmer's role in socioeconomic research | Passive | Active, diverse |
| Interview's role in: | | |
| Socioeconomic research | Repetitive | Variable theme |
| Interpretation | Nil, informal | Active, formal |
| Printed reports | Annual | Monthly |
| Multidisciplinary input opportunities | Close coordination in planning | Flexible |
| Feedback from agronomic assistants | Informal | Formal (status) |
| Feedback to technology design | Annual, indirect | Monthly, direct |
| Feedback to component research | Indirect | Direct |

There remains a need for permanent survey instruments. Responses to certain questions are difficult to test empirically. Such questions require that we use "permanent" questionnaires to check on the internal consistency of attitudinal or qualitative data. However, such questionnaires "lock" up scarce research resources for an entire year. Reasons for committing scarce resources to such an approach must be compelling. We are collecting monthly data on stocks, transactions, and disposition of grain. These will permit us to measure the farmers' risk preference, the objective meaning of subsistence, and the conditions under which farmers become more commercial in their orientation.

We are increasing our reliance on "one-shot" research methods because:

- They introduce flexibility, with the potential for researchers to address economic, agronomic, and sociological themes. The expertise of professionals not on the field staff can be drawn upon, and national researchers can gradually assume leadership roles.
- They allow for researchers to draw more upon farmers' knowledge to formulate hypotheses, which can be tested empirically with data collected simultaneously, subsequently, or, if justified, in repeated interviews during the succeeding year.
- These were the primary sources of information used to shape agronomic trials during the previous year.
- The data can be rapidly processed and analyzed, with basic computer skills, and the maintenance of computer hardware is not critical.