Research

FARMING SYSTEMS RESEARCH TO IMPROVE THE LIVELIHOOD OF SMALL FARMERS

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We in the high-income countries have exhibited strong biases, sometimes unknowingly, in our dealings with the less-developed countries (LDCs). That has certainly been true with respect to agriculture. Over the last two or three decades our thinking has evolved through four successive stages: (a) the extractive philosophy of colonial times; (b) knowing what was best for the LDCs, resulting in transfer of technology from the high-income countries; (c) developing technology within the LDCs, using as building blocks elements that had made technological change successful in the high-income countries; and recently (d) supplementing this "top-down" approach by, but not replacing it by, a "bottom-up" approach, which provides a foundation for the so-called farming-systems approach.

Among reasons for changes in thinking, the first was the repeated failure of strategies, particularly of the first two, to improve the livelihood of small farmers. Policies and technologies incompatible from both a technical and a human point of view (Hardin) were advocated. As a result, they were either not adopted or were adopted under direct or indirect compulsion, sometimes to the long-term detriment of the small farmer, as happened, for example, with export-cash-crop emphasis in Africa (Lele). The second reason is that where improvements in the well-being of small farmers have taken place, it has sometimes not been as great as expected, while there has been inequity in terms of the distribution of benefits. In the case of rice, determining reasons for the former has been a focal point of the constraints study at IRRI. Although the success of the Green Revolution should not be underestimated, the "top-down" approach together with the primary emphasis on production, tended to ignore the potential distributional

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problems (Saint and Coward). Despite claims that technologies implicit in the Green Revolution were intrinsically neutral to scale, the quality of resources required, together with differential access to the requisite infrastructural support systems, resulted in inequalities in benefits to farmers (Poleman and Freebairn). That is at odds with the renewed interest in rural development, for which a basic prerequisite is the presence of an income-generating force for the majority of farmers (Holdcraft). In most areas that force will have to come from agriculture and is consistent with generating employment, so significant in the new economics of growth (Mellor). A third reason for the evolution of thinking about agriculture in LDCs has been the rising costs of fossil energy, firmly embedded in so much of the technology developed in the LDCs (e.g., Green Revolution technology), together with an increasing realization, supported by empirical evidence, of the value of many traditional practices undertaken by small farmers for generations (Jodha; Navarro; Norman). It has been argued that the major breakthroughs in technology exemplified in the Green Revolution now may have been achieved. The gains from such technology were often regarded as sufficient to more than compensate for the potential social costs involved in its adoption (Remeniyi). With the increasing likelihood that further quantum jumps might not occur, the equity issues will become more vocal and pressing. Other factors also have contributed to the emergence of a "bottom-up" approach to the development of technology. Popularized as the farming-systems approach, it is not easy to define and is applied rather loosely.

In this paper, I shall attempt to define a farming system; to review briefly the common denominators in farming-systems research as currently practiced; to give three examples illustrating the potential value of farming-systems research; and finally to point out some problems in executing such research at the present time.

The Farming System

A farming system is the result of a complex interaction among a number of interdependent components. To achieve it, an individual farmer allocates certain quantities and qualities of the four factors of production--land, labor, capital, and management--to which he has access to three processes--crop, livestock, and off-farm enterprises--in a manner which, within the knowledge he possesses, will maximize the attainment of the goal(s) he is striving for.

The types of, and physical potential of, livestock and crop enterprises will be determined by the technical element (Figure 1), that reflects what the potential farming system can be and therefore provides the necessary condition for its presence. Constituents of the technical element include physical and biological factors that have been modified to some extent by man, often through technology development.

The farming system that actually evolves, however, is a subset of what is potentially possible as defined by the technical element. The determinant that provides the sufficient condition for the presence of a particular system is the human element, characterized by two types of factors: exogenous and endogenous. Exogenous factors (i.e., the social environment), largely outside the control of the individual farmer, will influence what he will and or is able to do. They can be divided into three broad groups: community structures, norms, and beliefs; external institutions or those that are usually supported directly or indirectly by developmental agencies such as extension, credit, input-distribution, and product-marketing programs; and miscellaneous influences, such as population density and location. The endogenous factors, on the other hand, are controlled by the individual farmer, who ultimately decides on the farming system that will emerge, influenced and sometimes constrained by the technical element and exogenous factors.

Because of the complexity of the farming system, often technology thought to be relevant has not been adopted, or where it has been, it exhibits variations in degrees and levels of adoption. For example, much technological development has had a "top-down" approach of modifying the technical element to fit the crop or animal. In doing so it has assumed the presence of a strong support system such as a plentiful supply of inorganic fertilizer (i.e., an exogenous factor); and simultaneously has ignored the demands of the rest of the farming system (i.e., endogenous factors), with the likelihood that the support system will be neither well developed nor accessible to the small farmer. The farming-systems approach, seemingly supported in the World Food and Nutrition Study (French), potentially imparts greater reality to technology development by making it a variable (Saint and Coward) instead of a parameter in the "top-down" approach. As such it increases the potential for fitting the animal or crop to the environment rather than vice-versa (Van Schilfgaarde).

Farming-Systems Research

Research on farming systems in the LDCs has developed mainly within the last decade and is now represented in Africa, Asia, and Latin America. Work is being undertaken at national (e.g., CNRA in Senegal, ICTA in Guatamala, etc.), regional (e.g., CATIE in Costa Rica, GERDAT located in France but providing an umbrella for work in Francophone countries in Africa, etc.), and international (e.g., IRRI, ICRISAT, ICARDA, IITA, CIMMIT, ARVDC, etc.) institutes. Despite differences in degrees of emphasis at the various

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institutions, a conventional wisdom is slowly emerging regarding the execution of farming-systems research, so that common denominators concerning such work can be identified. The schematic framework in Figure 1 (IER) provides a simplistic approximation of the approach being used in some institutions. The common denominators can be summarized briefly as follows:

(a) To develop truly relevant improved technology, it is necessary to recognize the interaction of the technical and human elements. That can best be ensured by this "bottom-up" approach characteristic of farming-systems research. This requires a multidisciplinary group working in an interdisciplinary manner, with the social scientist playing an <u>ex ante</u> rather than simply the traditional <u>ex post</u> role characteristic of the "top-down" approach.

(b) There is recognition of the locational specificity or heterogenity in terms of the technical, exogenous, and endogenous factors. Recognized in the farming-systems research approach is the necessity of disaggregating such heterogenity into homogeneous subgroups and developing improved technologies appropriate to each. The disaggregation into homogeneous subgroups is first done in terms of ecological systems or according to differences in the technical element; then, if further disaggregation is necessary, in terms of differences in the human element. The constraint or constraints most limiting in the farming system as revealed by analyzing the results, then become a focal point for developing strategies that will overcome them or that at least will not exacerbate them further. Often that means developing technology that will, for example, overcome a particular disease problem or will result in a greater productivity of labor or in avoiding the use of labor when it is particularly limiting. At the same time the technologies envisaged need to be compatible with the exogenous factors. Developing strategies to overcome the most limiting factor (Binswanger and Ryan)--which, incidentally, may not always involve the development of technology, but rather group action, for example, in irrigation--is directly compatible with the induced development model advocated by Hayami and Ruttan.

(c) Because the farmer is a central figure in the research process, it has been suggested that the process might be more aptly called farmer's system research (Gotsch). Explicitly recognized is the value that a farmer's knowledge, based on his experience (Swift) and traditional experimentation (Johnson; Jodha, et.al.), can play in improving the farming system he is following. At the same time, his involvement increases the possibility of developing improved systems that will address the constraints he faces and, in building on the good parts of the system he already follows, will result in a new response surface which is a combination of the new and old (Harwood and Price). Thus, many changes envisioned in farming-systems research involve small adjustments in the system rather than complete changes. The role of the farmer is maximized and reality in the research process ensured by minimizing work on experiment station fields and maximizing it on farmers' fields; initially, the managerial input is provided by the research worker--trials at the farmer's level (Figure 1); and then, often later, by the farmer himself--farmer's testing.

(d) Explicit in the recognition of a farming system is an appreciation of the multi-utilization of resources, and the involvement of the farmer ensures the use of evaluation criteria relevant to the farmer, rather than simply the traditional net return per unit of land so often used in experimentation.

(e) The research process is recognized as being dynamic and iterative, with backward linkages between farmer and research worker, rather than simply the presence of forward linkages characteristic of the "top-down" approach.

(f) The farming-systems research approach is not intended to replace other basic and applied research (i.e., body of knowledge, as noted in Figure 1) but uses results from it whenever possible, by providing an integrative function and sometimes assists in giving priorities for research.

Value of Farming-Systems Research

Collinson cites work reported by Kiray and Hendricks in Turkey concerning the introduction of high-yielding deltapine varieties of cotton which were incompatible with the endogenous factors of some farmers. Substituting deltapine seed for local varieties affected the structure of the agricultural community adversely. Many of the small farmers could not earn sufficient income from the new varieties; as a result, they were forced to work part time for the larger farmers and in fact later some became landless as the larger farmers bought up the land. Raising deltapine was incompatible with the economic circumstances of the small farmers because, unlike the local varieties, it matured in so short a time that small farmers having to rely on family labor could not complete the harvesting operation. Large farmers, on the other hand, could cope because they could affort to hire labor. Under farming-systems approach, the farming structure might not have been so altered.

Another example pertains to cotton growing in northern Nigeria (Norman et.al.), where traditionally cotton, often grown in crop mixtures is planted late after priority has been given to food crops and the peak labor demand is partially past. Growing cotton according to recommended practices involved planting earlier, in sole stands, required the application of fertilizer and spraying six times with a knapsack sprayer that used 20 gallons of water per spray per acre. Although in per acre terms the net return was demonstrated to be 110 percent more than that from growing cotton in sole stands by using traditional practices, no farmers accepted the recommendations. The reasons were obvious when articulated in terms of the farming system and demonstrated once again incompatibility with the endogenous factors. The change in the labor distribution involving an increasing conflict with food crops meant that the improved cotton technology was no longer being compared with the traditional cotton technology but instead with the alternative of using the labor on food crops. That plus the problem of transporting large amounts of water for spraying precluded adoption. Using a farming-systems approach led to supporting the development of a technology under which cotton could be planted later and, although yields would be potentially lower, would fit in better with the farming system practiced in the area. Also recommended was replacing a water-based insecticide with an oil-based insecticide that could be applied with an ultra low-volume sprayer (Beeden et.al.).

An example in eastern Guatamala (Hildebrand) illustrates a genuine farming-systems approach from the outset. A survey indicated that the two controllable factors most important in limiting production of the traditional farmers on the steep hillsides were the limited planting season and the amount of bean seed the farmer had left to plant. Traditionally corn, beans, and sorghum are planted together at the same time in a number of similar arrays. Research indicated that by using twin or double rows of corn and sorghum, combined with reducing the population of beans (which require the most time to plant), it would be possible to raise the productivity of planting labor and of bean seed; that would be so because it would allow each farmer to plant more land than he could under the traditional cropping system, and land was not a limiting factor for most farmers in the area. Results of tests with farmers indicated that each farmer on average could, with the same amount of labor for planting and somewhat less bean seed, plant 40 percent more land; produce 75 percent more corn, 40 percent more sorghum, the same quantity of beans; and receive 33 percent more income. At the same time labor could be more fully employed on the farm at other times of the year.

The examples should indicate the perils of not using a farming-systems approach to assess the value of a proposed technology; the potential advantages in using such an approach to increase the efficiency of the resources devoted to developing improved technology; and the potential gains in terms of improving the livelihood of small farmers.

Problems

So far in this paper I have strongly supported the concept of a farming-systems research approach. At the same time, however, it is necessary to recognize problems with its potential execution and widespread adoption. Some of these are as follows:

(a) The term farming-systems research is somewhat of a misnomer. To date most research has been confined to crop-production processes. Even here methodologies for undertaking such work need to be improved. Apart from pleas for its desirability (Boer and Welsch), the approach has not been applied to livestock processes, except when it impinges directly on crop processes (CNRA). Other areas generally omitted from consideration to date are more explicit consideration of off-farm enterprises and a more holistic systems approach, which goes beyond the farm gate and attempts to endogenize, for example, the marketing process.

(b) In the approach a possible conflict exists between short-run private gains and long-run social costs. Articulating constraints by farmers may tend to be biased toward the former, which could exacerbate the latter (e.g., perhaps by a lack of concern for maintaining or even improving soil fertility where individuals simply have usufructuary rights to land). The potential conflict needs to be recognized by those using the research process so that they can apply evaluation criteria that appeal to the farmer but do not lead to such a conflict. The onus lies on developing technology that does not encourage such a situation. Such a responsibility has, for example, been recognized in the work of CNRA (Elliott).

(c) There is inevitably a time lag in the recognition of a problem, the finding of a relevant solution, and its adoption by farmers. Farming systems research can be time consuming, particularly when potential solutions are not available as a result of other research (i.e., the body of knowledge noted in Figure 1). There is then a conflict between shortening the time period for deriving solutions in farming-systems research by drawing on the body of knowledge and recognizing that considerable inefficiency, in terms of time and research resources, may have been involved in creating that body of knowledge in the first place. A farming-systems approach is now, quite rightly in my opinion, being advocated in places where the body of knowledge is not well established. Funding agencies, however, need to recognize the implications of the time required to derive results. Also such results, when achieved, may not be visually spectacular although in aggregate may be large. With reference to the time between which solutions are derived and farmers adopt them--adoption being the best test of their relevancy (Hildebrand)--the link with extension and development agencies is often not as well established as it should be. That alone provides sufficient reason for involving representatives of such agencies in the research process (IER).

(d) Because of the locational specificity of farming-systems research, it is intrinsically expensive to execute. We need to explore ways to maximize the return from such research by making results more widely applicable. Technological development can aid this through the incorporation of greater flexibility in application even though that may mean some sacrifice of potential maximum return.

(e) Farming-systems research tends to be approached from the perspective of a high-income country and often is undertaken by individuals originating from, or at least trained in, such a country. As a result, it is difficult for those persons to appreciate and understand local wisdom and values, to handle the complexities of a family-farm system, to appreciate the role of noneconomic variables and the potentially significant role to be played by rural sociology or anthropology, and to be able to fit into an interdisciplinary farming-systems research team. Currently such an appreciation is being gained by individuals with longevity in the field, helped sometimes by short courses at regional and international institutions rather than through academic qualifications obtained in high-income countries. This deficiency needs to be rectified.

Conclusions

The farming-systems research approach is consistent with current notions of rural and economic development as articulated in equitability, local participation, and employment generation. As yet, however, perhaps mainly because it is largely in the developmental stage, the farming-systems research process has not been firmly established as an efficient way to improve the livelihood of the majority of small farmers.

I believe that the future in the LDCs is now more promising than previously, in that we in the high-income countries are at last shedding some of our cultural arrogance. To paraphrase the words of a wise Islamic scholar, Alhaji Junaidu, sound development must build upon rather than destroy the farmers' traditional techniques. I think now, toward the end of the fossil energy era, we in agriculture are at last beginning to appreciate the desirability and indeed the necessity of such an approach, which lies at the base of the farming-systems research process.

Footnotes

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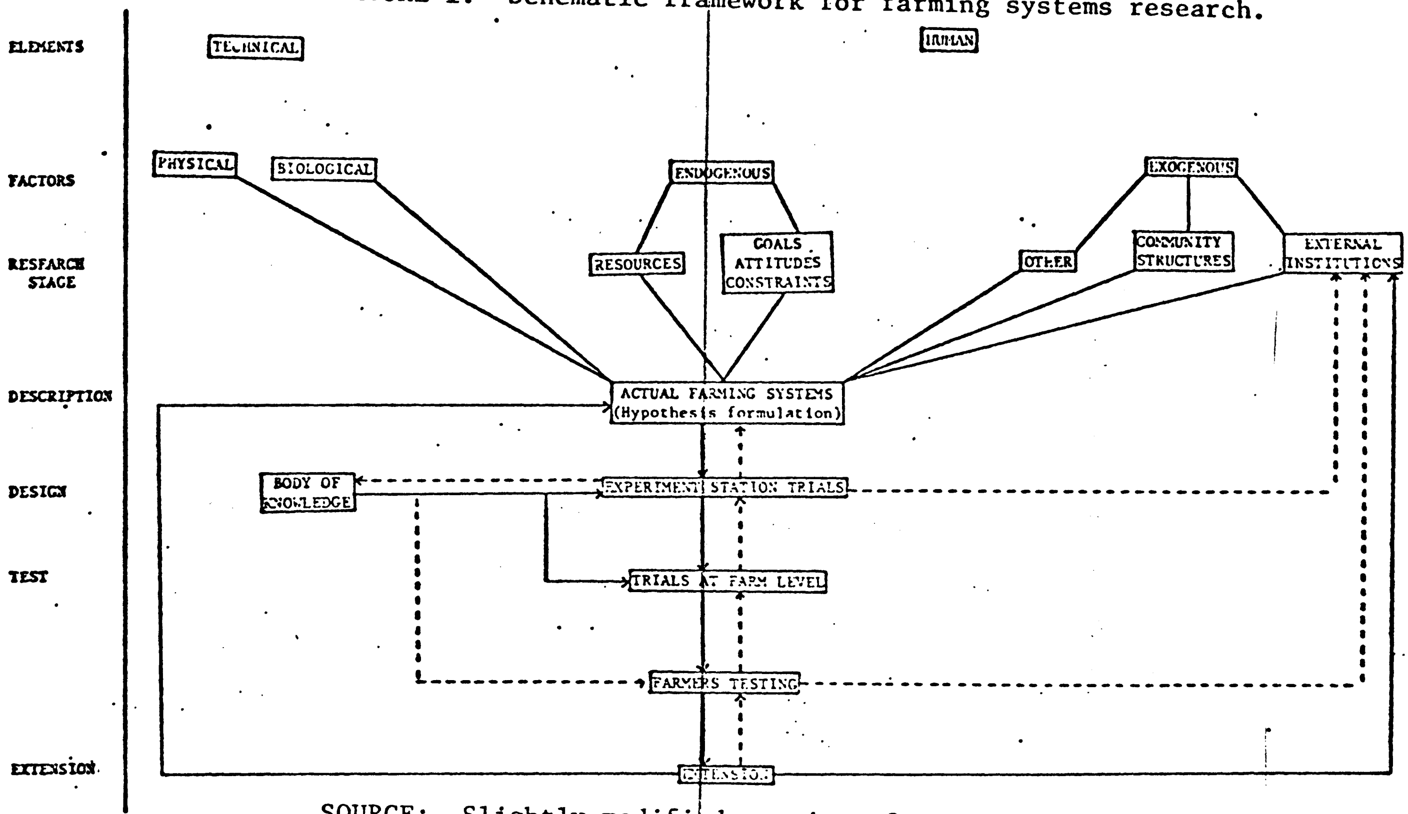
FIGURE 1. Schematic framework for farming systems research.



SOURCE: Slightly modified version of IER.