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Farming Systems Research Group
Michigan State University

The Farming Systems Research Group at Michigan State University, supported by Title XII Strengthening Grant Funds from the U.S. Agency for International Development, and administered by the Institute of International Agriculture, has included Dr. Jay Artis, Department of Sociology; Dr. Robert J. Deans, Department of Animal Science; Dr. Merle Esmay (and Dr. Robert Wilkinson), Department of Agricultural Engineering; Dr. Eric Crawford, Department of Agricultural Economics; Dr. Russell Freed, Department of Crop and Soil Sciences (also representing Horticulture); Dr. Al Pearson, Department of Food Science and Human Nutrition; Dr. Tjaart Schillhorn van Veen, Department of Veterinary Medicine; with Dr. George Axinn, International Studies and Programs and Agricultural Economics, Chair; and Ms. Beverly Fleisher.

The Farming Systems Research Approach in the Agricultural Engineering Field

by Merle L. Esmay

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Farming Systems Research Group - WORKING PAPERS

The papers in this series were prepared during the 1980 - 1981 academic year by members of the Michigan State University Farming Systems Research Group. Papers one through nine were prepared by individual members of the group, after much discussion, and were reviewed by members of the group prior to final revision by the authors. However, each of the papers represents the author's personal perspectives on Farming Systems Research. Each paper is different from the others. All papers are an attempt to answer the following questions:

From the perspective of my discipline - what is Farming Systems Research?

What research has been done in my discipline which relates directly to Farming Systems Research?

What opportunities are there for further research from the perspective of my discipline?

What assistance would scholars from my discipline need from other disciplines in order to carry out Farming Systems Research?

Each individual responded to these questions in his own way. Paper number ten is an attempt to summarize the perspectives of the various disciplines represented, identifying commonalities and differences. Paper eleven sets forth the recommendations of the group for further work in this field at Michigan State University.

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June, 1981

The Farming Systems Research Approach in the Agricultural Engineering Field

by

Merle L. Esmay

Introduction

This paper attempts to define and discuss Farming Systems Research (FSR) in a somewhat narrow sense as to how the MSU Task Force may be able to progress in a meaningful and practical manner. Of particular concern is how professionals from the existing discipline may play a role in FSR. Regardless of what may develop in the future as to the interdisciplinary nature of FSR, or on the other hand the development and training of FSR specialists; the movement to FSR must start from where we are now in the various professional disciplines.

Definition

First, it should be recognized that FSR consists of an interdisciplinary approach to development. The term interdisciplinary is used rather than multidisciplinary to differentiate that specific disciplines are necessary in contrast to a broad generalized array of disciplines. In the arena of Agriculture and food production, in which Title XII is involved, there are basic requirements for professionals from four disciplines; (1) biology (2) physical technology, (3) economics and (4) sociology.

Second, the FSR approach is focused towards the farm family and the family farmer

I would like to narrow this to a focus on small farms in developing countries. Small farms are defined as average sized farms and smaller in whatever country, region or district one might be concerned. It is the author's belief that FSR evolved mainly because of the need to cope with the problems of small farms for which other educational, extension and developmental approaches and institutions have experienced various degrees of failure. The developing country constraint was placed on this FSR definition because of the international focus of the Title XII strengthening grant that is being used to support the MSU FSR task force. This is not to argue that FSR cannot be applied to large farms in any country, but rather to focus more specifically on how FSR might help solve the burdensome problems of the small farmers, particularly in developing countries.

Third, it should be recognized that FSR has a positive connotation of improvement and development. It thus, should not be interpreted as a program designed to maintain the status-quo of the small farmers in their lock-in subsistance existance. FSR has the general objective of improving the quality of life of small farm families, but specifically in the sense of improving food production and financial returns through the application of appropriate technologies.

My definition is then that FSR consists of an interdisciplinary approach to the development and introduction of improved technologies for increased food production appropriate to the needs and circumstances of small farmers. New technologies are necessary as farmers have pretty well maximized outputs from traditional inputs and methods. An increase in production is assumed as the principle way to increase income and thus enhance the quality of life for the farm families. Production is interpreted to include all production and post production operations and activities. Producing more has no

benefit if it doesn't reach the consumer as a high quality product. Also the production should be studied and evaluated with respect to equal benefit to all. This is the reason for the focus on the small farmers as they have traditionally received the short-end of returns from new technologies.

Heady (1973) stated that a structure of research is needed that will facilitate a synthesizing, integrative, team-oriented outlook rather than one that is analytical, compartmentalizing and disciplinary. A successful FSR approach should do this. Dillon (1976) stated that before the advent of systems thinking, scientists tended to derive understanding of the functioning of the whole from the mechanical structure of the parts. He called this reductionism and mechanism; and suggests that expansionism,teleology, and synthesis are necessary modes of thought in understanding the world. The functioning of the whole must first be considered and understood before dissecting it into parts. A system is more than a sum of its parts. The teleological or means-ends approach is recognized as a valid scientific method for the study of social systems or systems with social effects. Goal seeking and goal-setting are intrinsic parts of such research.

The Green Revolution

Technologies may be either biological, physical or social in nature. Considerable emphasis has been given to biological breakthroughs of high yielding plant varieties (HYV) of the important food crops of rice, wheat, maize and others. During the early phases (1950's and 60's) of such development, referred to by some as the " green revolution", there was an associated need for new and different inputs to attain higher yields. Many of these inputs, even though prescribed by biologists, were physical in nature, such as; the application of fertilizers and pesticides (the manufacturing of them was also a physical process), water control (irrigation and/or drainage)

the development of a plant growth micro environment through soil manipulation processes of primary and secondary tillage. Weed control has generally been a physical process prior to the advent of chemical control and even then must be properly applied as to chemical fertilizers and pesticides. When some or all of these physical technolgies were not carried out according to prescription the early HYV's did not yield as much consistantly as the old indiginous varieites. This introduced a risk factor for the plante as well as an increased investment for inputs particularly if all of the prescribed practices were not followed. The more recent emphasis on HYV's has been for the crops to produce more under the traditional environment of the old indiginous varieties.

A biological characteristic that was apparently overlooked in the early development of higher yielding rice varieties was the resulting easy shattering nature (separation of the seed kernels from the plant panicles). This change of a biological factor compared to the old accustomed indiginous varieties necessitated numerous physical changes in harvesting methods and post harvest operations to minimize what would otherwise be excessive losses. Once the harvested rice plant (which includes some portion of the plant stems) is to be threshed, ease of separation (high shattering characteristic) of the seed from the rest of the plant is desirable (although mechanical threshing technology does overcome). The problem lies in the necessity of harvesting the HYV's early enough, while the seed moisture content was still at least 20 percent (wet basis) or above, to minimize pre-harvest in-field shattering. Then the harvested crop (stalk paddy) must be handle in such a way to minimize harvesting, drying and transporting (shattering) losses.

Possibly some early collaboration between the biological and physical scientists on the shattering problem would have made the introduction of t

new biological technology more successful. One can extrapolate the HYV example further to imply that if agricultural economists had been more involved early on, there would have been a better understanding (possibly before the introduction) of cost and returns as related to risk; particularly for the small subsistance farmer who traditionally has had neither input investment resources nor the capability of risk without suffering dire circumstances (possibly hunger) of a crop failure. Social-cultural scientists could have helped provide an early understanding of the small subsistance families as to constraints, capabilities, aspirations and traditions.

I use the example of the early HYV's and the "green revolution" not to emphasize its' negative characteristics, as I give it an overall rating of "successful". We, however, live in an imperfect world which means there is always room for improvement. The "criticism" should be used for constructive discussion in the search for improved introduction processes through the application of the Farming Systems Research approach. I do not enjoy researching projects after the fact (the introduction of them) in order to determine how unsuccessful they were in terms of income distribution, labor utilization, migration, etc. We must, however, learn from experience in order to improve future programs. The greatest challenge is to develop new programs that will stand the test of time and subsequent investigations. The Farming Systems Research approach can help identify problems before they occur.

Holistic Approach to FSR

Farming Systems Research (FSR) should be holistic in its' approach, but not necessarily designed to change the entire system. A FSR approach might be partitioned to study the development and adaptation of a particular type of technology, but with a holistic understanding of the farm system. (Rohrbach, 1980).

For discussion purposes I will describe a post rice production (includes harvesting as well as post harvest operations) technology and losses in a Southeast Asia program in which I have been involved for the past five years with a number of Doctoral students. One of the first procedural decisions made was that studies and measurements would be made strictly on farmer operations. Different methods and technology would be studied in so far as they were now being used by some farm operators.

Existing technology was identified and evaluated as to losses, labor utilization, possible harvesting delay constraints and other cost and return factors. A part of the evaluation phase was to formulate computer systems models to simulate in so far as possible the utilization of technology under farmer operation conditions. Simulation studies were then made to identify comparative advantages, constraints and undesirable features.

Systems Modeling

The systems modeling was flexible to the extent that other technology systems could be introduced for simulation studies if and when desirable. The study of new technology would depend mainly on the availability of representative operational data under farmer conditions. Although some survey data were obtained in each study to describe farmer conditions, they fall considerably short of a true FSR approach in which understanding of the farm families and all of their constraints and incentives would be given primary attention.

The Nature of Change

The doctoral dissertation research projects did not follow through with the verification and acceptability of new improved technology in the conventional sense of adoption. A central Java study by David Gaiser in 1979-80 provided some insight on a harvesting technology change that was taking place. The farmers (rice producers) were breaking the old traditional

ani-ani harvesting system in favor of a 79 percent more labor efficient sickle cutting system by selling their pre-harvested rice crop to traders. The out-of-village traders would then move in with sickle cutting crews and harvest the crop quickly and move it out for threshing, drying and milling (possible storage) someplace else.

In explanation, the ani-ani system included more than the physical technology of cutting the individual stems of rice with a small knife in one hand and gathering in the other. It also carried with it the social priviledge of all local disadvantaged family members (the landless) to come in and harvest all the land owners rice crops for a share (generally around 10%). The change to the HYV rice crops made the ani ani systems much less appropriate technically because of the higher yields (many more panicles), shorter stems and higher shattering nature (higher harvest shattering losses). From the farmers standpoint the traditional ani-ani system was completely outside of the farmers control. In some cases large numbers of people would move into a farmer's field, many of whom he might not know. Their incentive to harvest all of the rice with a minimum of loss was not particularly high. In contrast to too many harvesters Gaiser's central Java study indicated that rice farmers were experiencing delays of many days before ani-ani harvest crews were available.

Socially, within the village, farmers seemed constrained to not hire their own sickle cutting crews even though delays in harvesting were occuring. However, to break the system farmers began selling the standing crops to "outsiders" who apparently had no qualms about bringing in the sickle cutting crews. The unfortunate aspect of this type of a "forced" change rather than a more desirably planned one is that the traders brought in outsiders to cut the crop which entirely eliminated any local labor. Also

the traders moved the harvested stalk-paddy crop out of the area for threshing, drying and milling. All of these value adding operations were thus lost to the local labor. Individual farmer control, particularly through the cutting, threshing and drying stages, would benefit local laborers as well as the farmer, and in general keep the returns of these value increasing operations within the villages.

In summary of the post rice harvest changes taking place in Indonesia most social planners saw the substitution of the 78 percent, more-efficient, sickle cutting as an undesirable change. Unfortunately, when change was left to the farmers, who are not necessarily social conscious, the local labor was cut out of nearly all of the post harvest operations. Also the traders will tend to mechanize the cutting, threshing and drying as soon as feasible (cost return wise) regardless of village labor unemployment conditions. A thorough Farming Systems Research approach to this problem at an early stage might have been able to provide recommendations and planning guidance to direct change into a more overall favorable direction. Now changing the established trader system will be most difficult. An early FSR study would have developed an understanding of the farm families and also the disadvantaged family members in order to consider the aspirations and goals of all concerned.

Land Preparation Mechanization

Another example of where and how Farming Systems Research (FSR) might have been beneficially applied is with reference to the question of mechanizing rice paddy land preparation in Indonesia. Some mechanical power was introduced for the primary tillage operation during the past few years Indonesia, particularly the island of Java, has a dense population; therefore, the problem of providing meaningful employment for all of the people is critical. Mechanization that displaces people from labor

intensive operations is not necessarily desirable. The appropriateness of any agricultural mechanization is thus questionable.

The question of appropriateness of mechanization for rice land preparation in Indonesia is presently polarized along professional lines into the "anti" group and the "pro" group. The "anti" group tend to be mainly the agricultural (Socio) Economists and the "pro" group the Agricultural technologists (Engineers). I doubt if many of the professionals of either group feel comfortable in being classified as absolutely "anti" or "pro". The lack of communications between the two professional groups has, however, allowed if not stimulated the extreme positions taken by each.

There is a great need for a true FSR approach to the evaluation and planning for appropriate agricultural mechanization in Indonesia. Unfortunately such a program has not been formulated. Instead an extensive survey has been undertaken, mainly by Agricultural Economists, to prove that mechanization is uneconomical to the tractor owners (buyers). A paper was presented at the Regional Seminar on Appropriate Mechanization for Rural Development with Special Reference to Small Farming in the ASEAN countries in Jakarta January 26-31, 1981. The evaluation project and the title were entitled "The Consequences of Land Preparation Mechanization in Indonesia: South Sulawesi and West Java". The paper was presented by Ir. Mamum and the project is headed by Dr. R.H. Bernsten of IRRI/CRIA Bogor, Indonesia.

The project and paper title is quite appropriate, but the approach presented in this first paper based on one years preliminary data was to prove financially that the mini-tractors in South Sulawesi and power tillers of West Java were uneconomical to the owners. The numerical analysis

made was based upon unsupportable assumptions or cost of operation, length of life, day length, and total time of operation of tractors per year. Such data could be obtained by studying the experiences of the tractor owners. But this was not done nor at least the data were not included in the paper presented. Such a study if and when undertaken would need to be carried out mainly by technologists thoroughly versed in the physical knowledge of tractor operations and performance.

On the financial side of the cost and returns analysis presented in the seminar paper; there was no mention made of the fact that the contract price for custom work was a "set" price by government, and that the tractors were purchased (obtained) by farmers through a government program without down payment and with two installments due per year which are not enforced. Apparently over half of the tractor buyers were defaulting on their payments. It seems to me that a true economic analysis should be made which would recognize all of the incentives and constraints for owning tractors.

I tend to believe that the imported, expensive, complex small four wheeled tractors are not economical nor appropriate for Indonesia but the survey approach and financial analysis is not proving it. A coordinated FSR approach to this problem with a number of disciplines involved could obtain and present supportable documentation for proving the inappropriateness of the tractor mechanization. Agricultural economists need to evaluate the overall economics of the tractors including the effects of the subsidized prices and set fees; while Agricultural Engineers need to study in detail the experience of the tractor owners and operators. Other socio cultural people need to be included in order to better understand the farmers, laborers and rural conditions.

Under the circumstances of the government program for introduction of the tractors, I believe that the tractor mechanized land preparation is probably economical for both farmers contracting for tractor tillage and for the tractor owners. The fee for tillage is set arbitrarily low to make it attractive for the farmers contracting for work done. The owners are not paying for the tractors under the "soft loan" arrangements so ownership is financially favorable for the owners under these fixed circumstances. Unfortunately these financial conditions are unrelated to the overall economics and broader effects of mechanization on unemployment and income distribution in the rural areas.

My bias is that some mechanization of land preparation is inevitable, particularly in the islands outside of Java. There is no way that the rural people can or should be "forced" to continue to grow rice by human labor in the mud when the city people are riding motor bikes and automobiles. I believe that local manufactured, simpler, less costly tractors and machinery are more appropriate in the long run. Farming Systems Research would, however, provide guidance so that direction does not depend on biases and opinions of individuals or professional groups.

Farming systems research plans should depend directly on qualified professionals from a minimum of the basic technology fields of biology, physical technology, economics and sociology. There are exceptions wher one person might qualifiy to cover two of these fields. Such a trend should, however, be discouraged or the interdisciplinary approach will be defeated. The excuse today for the single disciplne approach is often that one person feels that he or she can cover 2 or 3 or more fields adequately.

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