Netherlands Journal of Agricultural Science 32 (1984) 253-261

Issues in farming systems research

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Received 4 June 1984; accepted 6 September 1984

Key-words: farming systems research, yield gap, agricultural research methodology.

Summary

There is growing concern about the gap between maximum yields obtained in research stations and actual farmers' yields. Farming systems research (FSR) aims to study the production constraints of small-farmers in the Third World outside the research station with a view to developing technology that fits their needs. Stages in FSR are: definition of recommendation domains, diagnostic survey, design and on-farm testing of technology and dissemination. Major methodological and institutional issues in the FSR approach are discussed. It is concluded that a future role for FSR lies in broadening the scope of existing agricultural research programmes. Thus, FSR is not a separate discipline but provides a focus for the different disciplines involved in agricultural research.

Introduction

The purpose of this paper is to introduce farming systems research (FSR) as an approach to agricultural research which is relevant to both on-station and off-station research. Although there is considerable difference of opinion on the application of FSR, a number of common principles may be distinguished. After a brief discussion of some of FSR's historical roots, these common principles will be outlined. The main methodological problems will be briefly covered. Finally, the institutional issues related to the integration of FSR into agricultural research and development will be discussed.

The application of the concept of 'system' in the study of agriculture is not new, nor is the idea that agriculture cannot be studied by biological scientists alone, but requires the input of other disciplines such as economics or anthropology. In the past, isolated individuals in different parts of the world have developed methods of research that are very close to what is now called the farming systems approach.

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One of the earliest examples is the Vries' work on Java in the 1920s: although he set out to improve mango and citrus cultivation, he considered it necessary to obtain an overview of the entire farm since trees are a component of it. He collected detailed data on household composition, land tenure, labour allocation, livestock, irrigated and upland crops and estimated yields on farmers' fields. He also spent time on historical investigations to understand changes in production patterns and established maps to illustrate the correlations between physical characteristics and the repartition of population density, paddy yields, etc. (de Vries, 1931). De Schlippe's definition of field types as a combination of agro-ecological and socio-economic characteristics constitutes another well known example (de Schlippe, 1956). This type of research depended very much on the individual researcher who spent many years in the field trying to master all the features of the agriculture in a particular area. It was not the affair of a multidisciplinary research team, nor were trials ever conducted on farms — two prominent features of today's farming systems research (FSR).

Yield gaps

Since the early 1970s the need to focus explicitly on small farmers as a target group for agricultural development in the Third World has been widely acknowledged (see, for example, Röling et al., 1979). Although the 'green revolution' has been effective in raising yields of irrigated annual crops, a growing number of scientists have become concerned about the failure of agricultural research to improve the overall productivity of small farmers the majority of whom practice rain-fed farming (Norman, 1978). This failure stems mainly from the fact that technology devel-

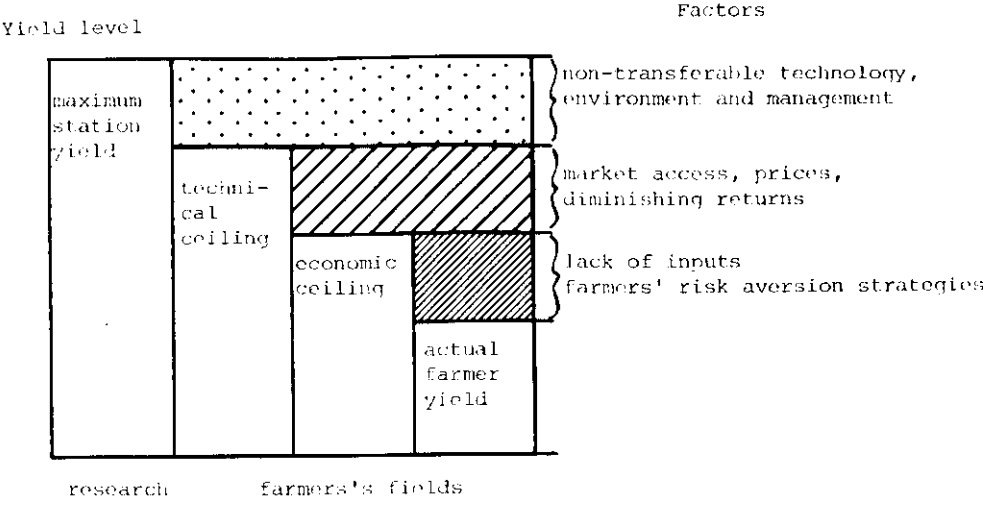

Fig. 1. The yield gaps between maximum and actual farmer yields. After: World Bank (1982) and Zandstra et al. (1981).

oped in research stations takes insufficient notice of the technical and socio-economic constraints faced by small farmers. In other words, there is a significant gap between research recommendations and farmers' reality. Some of the factors explaining the difference between yields in research stations and in farmers' fields are shown in Fig. 1.

The lower technical ceiling of farmers may be explained by the fact that they do not operate under optimal physical and technical conditions while research stations do. Because farmers' profits are highest at input levels lower than those necessary for maximum yields, the economic ceiling is lower than the technical ceiling. However, farmers' actual yields are usually even below economic ceilings as a result of risk avoidance strategies and the unavailability of inputs or unpredictable prices (World Bank, 1982:73). Moreover, researchers' criteria for evaluating new technology are different from those of farmers, because the latter do not necessarily maximize yields or profits, but seek optimality given their priorities and resources. FSR tries to provide an answer to the yield gap problem. It advocates the study of farming in all its complexities outside the research station and the testing of new technology under farmers' conditions. One of its major objectives is the definition of yield gaps that may be recoverable (Zandstra et al., 1981).

Farming systems research

Since approximately one decade farming and cropping systems research have become a prominent feature of the programmes undertaken by the international agricultural research centres and have generated great interest from donors such as IDRC, USAID and the World Bank. Terminology varies, but basically three complementary activities may be considered FSR (Simmonds, 1984):

- the description of existing farming systems in a holistic way with a view to obtaining an understanding of the interrelations of the components of the system (for examples of different types of systems, see Ruthenberg, 1980).
- on-farm research with a farming systems perspective complementary to ongoing station research. This type of FSR usually focuses on one crop or commodity, e.g. the introduction of early-maturing high-yielding varieties that may alleviate labour bottlenecks and perhaps allow an additional crop to be grown. This type of research assumes that production increase results from stepwise changes in components of the farming system.
- the development of new farming systems under the assumption that a radical restructuring of the entire system is required, e.g. from shifting to permanent cultivation in the humid tropics, or the introduction of farming systems based on animal traction and fertilizer in the Sine Saloum in Senegal (Billaz & Dufumier, 1980).

Shaner et al. (1982:16) have defined farming system as 'a unique and reasonably stable arrangement of farming enterprises that the household manages according to well-defined practices in response to the physical, biological and socio-economic environments and in accordance with the household's goals, preferences and resources. These factors combine to influence output and production methods. More communality is found within the system than between the systems. The farming sys-

tem is part of larger systems — e.g. the local community — and can be divided into subsystems — e.g. cropping systems.' Some FSR emphasizes that farm households have multiple objective functions, i.e. farmers do not necessarily seek technical optima or even optimal economic returns from a single crop enterprise, and that farm-level production constraints may well be cultural rather than technical.

The main stages of most FSR programmes are:

1. the definition of 'recommendation domains': homogeneous categories of farmers with comparable access to resources and markets and a comparable farming system. Each recommendation domain requires the development of specific technological innovations. FSR is therefore considered 'location-specific'. The more complex the system, the more location-specific FSR is likely to be.
2. the diagnostic survey: a combination of informal and formal data collection by a multidisciplinary team with a view to determining the production constraints of small farmers. A simple and effective procedure developed in Central America is the 'sondeo' or rapid rural appraisal (Hildebrand, 1981).
3. the design of a strategy to overcome the constraints through the introduction of technological innovations, involving on-station and on-farm experimentation.
4. the testing of innovations on farmers' fields with more or less supervision from researchers.
5. the dissemination of successful innovations to other farmers in the same recommendation domain and in similar recommendation domains.
6. the referral of unaddressed problems to relevant component and commodity research and the evaluation of reasons for adoption or rejection of the technology.

These stages may be sequentially cyclical or simultaneous, depending on the nature of the research programme. Strategies involve either the adaptation of existing technology or the development of new technology.

Because the FSR approach is location- or site-specific, FSR programmes may vary considerably. In general the FSR perspective may apply at two levels:

- at macro-level by providing an orientation for agricultural research and agricultural sector policy. This is sometimes called FSIP, farming systems infrastructure and policy, or FSP, farming systems perspective (Norman, 1982).
- at micro-level in diagnostic, experimental and pre-extension on-farm research programmes. This usually includes on-station research as well.

Methodological issues

Given the wide range of potential problems that may be addressed and the holistic nature of FSR, a limitation of its activities through the setting of clear priorities is essential. It must be decided which are the dependent variables that can be manipulated, e.g. varieties and cultivation techniques, but not labour input and food prices. In this context, one may ask to what extent institutional constraints should be seen as given, i.e. as a framework within which FSR should operate to develop adaptive agricultural technology. Or should FSR also look at the development of strategies to overcome these constraints and even aim at creating conditions that promote farm production outside the realm of agricultural research? This question

is of particular relevance to constraints in delivery systems, e.g. the supply of inputs or credit, or the extension service. For example, if no credit is available to small farmers, should the development of farm technology that does not require an external capital input be the priority, or should FSR (also) focus on the creation of a credit delivery service for small farmers?

In other words, are FSR priorities farmers' felt needs, or priorities selected by researchers on the basis of 'objective' criteria (e.g. watershed management and erosion control), or priorities imposed by national governments (such as food supply to urban areas or input substitution)? In practice, FSR priorities have been heavily influenced by the mandate of the international research institutes who have thus far focused on particular crops (rice, maize, sorghum and potato and some minor crops such as cow pea).

The setting of priorities also influences the definition of recommendation domains. There is a risk that the criteria for the definition of the recommendation domains remain rather superficial as they are often mainly economic. They do not include farm household composition although it is likely that this will influence adoption rates and production potential. Up till now, most work on the definition of recommendation domains has been undertaken in Africa and Central America. Little is known about methods to define recommendation domains in areas with very great local variation in farming and cropping patterns and strong social stratification such as southeast Asia. The danger of too broad a definition of recommendation domains is that sources of variability between farmers are inadequately assessed.

In the phase of the identification of the strategy and the technology to be developed and tested, FSR is again confronted with the issue of priorities. How are choices for a given technology made? The holistic and complex picture of the farming system obtained during the diagnostic phase is often reduced to one or a few technological constraints, for which technological solutions are to be found. Thus, technology usually involves crop improvement and sometimes the restoration of soil fertility. It is not excluded that in this process more emphasis will be placed on the maximalization of the gross returns or the yields of one farm component or crop than on the farm household's objectives which may range from optimal returns from the total range of farm components, risk avoidance or even minimalization of inputs, including labour. Moreover, most FSR assumes implicitly that (male) farmers are more or less free to take decisions regarding the adoption of technology, and usually ignores the decision-making structure within the farm households and the influence of other household members. In most FSR strategies little attention is being paid to non-agricultural components such as livestock, food processing, or off-farm employment.

Methodological problems are abundant during the on-farm testing of technology. On-farm testing aims to verify the assumption that the technology is suited to the specific farm environment and that the resource requirements (labour, capital, cash, animal traction, etc.) can be met. On-farm trials require a sound classification of farm types within each recommendation domain with a view to selecting representative farmers. Adequate performance criteria must be defined, which take into

account farmers' own priorities and relate the on-farm experimental results to the whole farming system. The degree of researcher supervision varies according to the type of trial (Matlon, 1983). A potential bias is introduced by the close contact between researchers and farmers who may change their management to please the visiting researcher — superimposed trials which do not require a modification of farmer operations and are simple to understand for farmers are very useful. It must be acknowledged that FSR's main focus thus far has been the testing of partial crop-technological solutions (varieties, cultivation techniques). The testing of new farming systems, involving livestock and perennials as well as variables at higher levels (e.g. economic variables such as prices which operate at a regional level), will require the development of long-term monitoring techniques.

Institutional issues

Once the on-farm testing is under way, the problem of institutional linkages becomes acute: while diagnostic and strategy design might have been possible in relative isolation, the FSR sequence needs to be institutionalized in order to guarantee replicability and continuity. FSR's impact will be very limited unless the approach is part of a larger series of rural development programmes. If FSR is considered as an autonomous process, there may be a tendency to overestimate its role and equate it with (research for) rural development. The definition of FSR activities in relation to other institutions is of extreme importance.

Linkages to government objectives
Billaz & Dufumier (1980) have pointed out that FSR's success depends very much on high-level political support, and the government resources provided to the small farm sector. FSR does not always seem to recognize the potential conflict between small farmers' production priorities and national agricultural policies: national goals are not necessarily most effectively met through small farmers, whose short-term production increase is limited in many cases.

Links with agricultural research
FSR constitutes an integral part of the national agricultural research structure (Gilbert et al., 1980). Room for a systems approach to agricultural research is limited by the component and/or commodity orientation of national research structures and by the lack of experienced generalist personnel with an interest in field work with farmers. Moreover, the incentive and salary structure rarely encourages staff to spend time on interdisciplinary work. Efforts to train researchers in FSR methodology have only recently been initiated by the international research centres. The cost of implementing FSR programmes within the existing research structure must not be underestimated: although rapid rural appraisal methods yield numerous data in short periods of time, usually FSR requires high manpower and resource investments for relatively small groups of farmers, in particular if a high degree of detailed information is required. In the near future it cannot be expected that national research programmes will be able to fund FSR activities independently. As a

matter of fact, the nature of the FSR process (iterative, with activities and resources being specified as the research objectives become clearer) is rather ill-adapted to the financial management requirements of most government departments and national agricultural research programmes. Also, adequate criteria for the evaluation of FSR's contribution to the overall agricultural research objectives have not yet been developed.

Links with delivery structures

Many FSR projects have not been able to develop close linkages with rural services such as credit, input delivery and agricultural extension. In cases where the FSR approach has not been clearly defined there has been a tendency to include extension as an FSR activity. Although direct links between researchers and farmers are certainly one of the assets of the approach, the role of extension cannot be substituted by FSR. On the whole, with some in-service training extension personnel could contribute fruitfully to a number of FSR activities such as the identification of recommendation domains, data collection, the implementation and evaluation of on-farm trials and the extension of results to similar farmers. Linkages with existing development and/or farmers' organizations are essential to improve the setting of realistic priorities, to assist in the diffusion of the technical innovations and to ensure the delivery of farm inputs. A detailed analysis of factors causing yield gaps must lead to policy recommendations.

It may be concluded that FSR tends to limit its definition of small farmers' production constraints in two ways: to technical rather than socio-economic problems, and to the farm level rather than to institutional level problems. Often crop technology improvement is focused upon with the exclusion of solutions for which the manipulative variables are located beyond farm level (e.g. input supply constraints). As a result, FSR may tend to focus on varietal testing and improved seed distribution: easy to multiply, to test and to deliver, easy for farmers to adopt without changing other farming practices, improved seed may make a considerable difference to yields and may constitute a first step toward intensification, and if they do not, at least, seeds tend to persist after the completion of the programme (USAID, 1982).

Perspectives for farming systems research

Since the late 1970s considerable funds have been devoted to FSR. Although results of varying quality have been obtained, it is difficult to draw any conclusions about the merits of the approach because programmes funded by foreign donors with expatriate staff are not really representative of the potential nor of the problems of FSR. Without underestimating the methodological and institutional problems outlined above, it seems that the contribution of FSR to agricultural development in the Third World lies in (1) broadening the scope of existing agricultural research, and (2) the formulation of strategies for the agricultural sector.

FSR's first role is to complement existing agricultural research, not as a new discipline but rather by providing a new focus. This complementarity may be methodical as well as technical. A number of FSR methods can also be utilized outside the

framework of an FSR programme. In all cases where little information is available and experienced researchers are few and far between, the sondeo constitutes a relatively cheap and rapid method of data collection. The yield gap and constraints analysis methods may be useful whenever one wants to identify factors explaining the differences between potential and actual yields, although they only apply to situations where adoption of a new technology has already taken place (Sarin & Binswanger, 1980). The importance of FSR and on-farm experimentation methods to plant breeding must not be underestimated. As Simmonds (1984:5) points out, roughly half of total funding in agricultural research goes to plant breeding. Since more is known about the interactions between genotype and environmental factors, it becomes clear that breeding and selection within research stations may not produce farm-adapted genotypes as breeding is rather site-specific. Breeding programmes must therefore include systematic on-farm experimentation to test for location specificity.

The technical complementarity between FSR and mainstream agricultural (station) research is mainly situated in FSR's integration of component and commodity research results into adapted technology at farm level and the referral of unaddressed problems to the appropriate research station programmes. Where mainstream agricultural research is weak, FSR's contribution will necessarily be limited, and vice versa.

Major technical issues still to be addressed are agro-forestry and perennial crops, erosion and fertility management, livestock, food processing and storage technology, while special attention must be paid to the need to reduce variations in total farm output and constraints to female labour productivity. These require a longer-term research involvement than has been in the case in most projects.

FSR's second role could be to provide elements for the formulation of agricultural sector policies. The complementarity between existing simulation (LP-linear programming) models for the agricultural sector (e.g. SOW, 1981) and FSR could be the following. On the one hand, a farming systems approach to data collection, especially the sondeo and yield gap surveys conducted in the different agro-ecological zones of a country, may lead to a refinement of farm categories and to a more precise definition of their production constraints, so that corrections could be introduced into the aggregated statistics now used in the LP model. A reliable assessment of the existing situation will become all the more important when in the near future the LP models are to be further developed. FSR should also be of use in the formulation of new farming and agricultural systems for policy purposes.

On the other hand, LP models integrating the farm and agricultural sector levels could potentially be of great assistance to FSR. Instead of a lengthy trial-and-error process to test possible innovations on farmers' fields, a wide range of proposed experimental patterns could be pre-screened for agronomic feasibility, level and dependability of profits, and comptability with the existing farm resources and the community's social and economic infrastructure (Flinn et al., 1982). On-farm experimentation could then be carried out to verify these proposals. Computer simulation can, of course, never substitute the direct contact between farmers and researchers, but it would permit the inclusion of factors at other levels than crop or

farm level, especially economic factors such as changing price relations. This requires that further work be undertaken to formulate adequate models for farming systems.

In final instance, FSR could be integrated into national level simulation models: factors that are considered exogenous at a farming system level, such as price policies, could then be treated as variables, contributing to the formulation of realistic scenarios for development.

Perhaps the most important contribution of farming systems research is that it provides a focus for all the disciplines involved in agricultural research and development, and that it attempts to classify farmers into relevant categories for agricultural research and policy, while involving them in an active way.

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