PN-AAS-263

THE LOCATION SPECIFICITY PROBLEM IN FARMING SYSTEMS RESEARCH

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SUMMARY

Farming systems are usually location specific. That is, they cannot be implemented satisfactorily over large geographical areas without modification to local needs and conditions. Given a limited resource availability, farming systems research must find cost-effective methods for coping with this problem. One method is to identify parameters of environments and of existing systems which are relevant for guiding the formulation of new systems but which do not result in the definition of so many 'locations' as to obscure research priorities. The second method emphasises the development of 'preliminary' technologies, or systems, leaving the fine tuning of such systems to institutions or individuals in the specific locations. Important interrelationships exist between the two methods.

AN OVERVIEW OF THE PROBLEM

The objective of farming systems research is the improvement of existing farming systems. A standard approach to farming systems research has evolved in recent years: first the farming system is described and the 'constraints' involved in meeting objectives are identified. Following this, attempts are made to develop farming methods/technologies/systems for overcoming these problems (Kellog, 1977; Flinn, 1978; Norman, 1978; TAC, 1978).

Technology can be broadly defined as a way of doing things (Anderson & Hardaker, 1979). Since any movement towards a 'better' farming system involves a different way of doing things on the farm, the design of technology is what farming systems research is all about! A 'better' farming system is one which comes closer to meeting the farmers' goals, given the associated socio-economic and ecological environment. The environment is determined by a large set of parameters, such as

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Agricultural Systems 0308-521X/81/0007-0095/$02·50 ©Applied Science Publishers Ltd, England, 1981
Printed in Great Britain

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those listed by Okigbo (1976), Flinn (1978) and Norman (1978). The farming systems researcher is interested in these parameters insofar as they determine the nature of better systems.

'Location specificity' exists when a new technology (farming system) is 'better' than the existing system over a limited area. (A narrower definition could be obtained by substituting 'best' for 'better'.) When such areas are small relative to the total mandate area of the farming systems research team, the allocation of research resources between systems becomes a problem (FAO, 1974; Ruttan, 1977; IITA, 1979), especially in developing countries where research resources are few (Evenson & Kislev, 1975, p. 17) relative to the number of farming systems (for example, see Ruthenberg, 1976). The *complexity* of farming systems in developing countries (for example, see De Schlippe, 1956; Bradfield, 1978; Anderson & Hardaker, 1979) aggravates the problem of location specificity by making improvement—and measurement of improvement—more difficult.

The aim of this paper is to suggest some guidelines for coping with the problem of location specificity in farming systems design. New systems which result from marginal or total shifts from old systems are both within the scope of the paper.

LOCATION SPECIFICITY AND FARMING SYSTEMS CLASSIFICATION

In practice, all farmers are different in terms of environment, goals and, perhaps, technologies. However, research resources are insufficient to make the individual farm the basis for study and improvement. The objective of farming systems classification within a given mandate region is to identify parameters which allow the aggregation of farms into a relatively small number of farming systems on which to focus research resources. Decisions must be made both about the *type* and the *number* of parameters to be included in the classification scheme.

What type of parameters should be included? Some elements of farmers' goals are relevant, as are environmental parameters. Considerable weight should also be given to characteristics of the existing (old) farming systems, since:

(a) With primitive agriculture, which lacks a strong capacity to manipulate the environment, the existing system represents the result of the complex interaction between environment, goals and technology. As such, it represents a good starting point for designing improved systems.

(b) In order to gauge whether a new system is better than an existing one, some measure of the performance of the old system must be made.

In practice, classification usually incorporates climatic parameters and/or parameters which describe, in some way, present farmer practices. The difficulty of measuring farmer goals usually prohibits the direct inclusion of these.

Evenson *et al.* (1970) outlined a classification scheme which they felt would be useful in guiding agricultural research priorities. Their scheme involved a code which allowed shorthand descriptions of farming systems to be made. If these descriptions could be quantified, pattern analysis computer programs (e.g., Williams, 1976) provide a practical method for grouping farming systems having similar attributes. Bielecka *et al.* (1975) have used this method, but not with the objective of providing guidance for agricultural research.

For the latter purpose, parameters of existing systems and/or environment must be chosen which: (a) are relevant to the agricultural research and (b) do not vary widely in value over the mandate region. If condition (b) is violated, the number of systems defined by the classification scheme can become so great that any value for guiding agricultural research is lost. Condition (a) is even more troublesome. How can the nature of relevant system parameters be known without knowledge of what the nature of research will be? Once it is known that research will focus on maize, for example, then certain parameters—such as the length and reliability of the maize growing season—become relevant. Where a research programme involves genuine multidisciplinary farming systems research, the nature of research is less well defined and therefore the choice of relevant classification parameters is more difficult. In that case, a low weight should be given to 'location specific' parameters ((b) above) in the grouping procedure. For example, what parameters would be most useful for guiding agricultural research resources into peasant farming systems in Africa? One cultivation method (slash and burn) is widespread. Its use as a classification parameter splits off compound farming and a clear dichotomy exists between the type of research project to be aimed at the slash and burn versus the compound farming target groups. An alternative classification parameter would be length of fallow, but this is quite variable across the region, providing a costly measurement exercise as well as a location specificity problem. If cropping systems were to be used as a classification parameter, these two problems would be exacerbated enormously.

Consider now the appropriate *number* of parameters to be included in a classification scheme for guiding farming systems research. As the number of parameters increases, each location (geographical point) is described more realistically (soil type + rainfall provide more adequate descriptions than soil type alone). However, this realism is at the expense of an increase in the total number of systems (combinations of soil type and rainfall classes) in the mandate region. Whilst it is not possible to say how many is the optimal number of systems into which a research mandate region should be divided, it seems clear that, beyond a certain number, further subdivision, resulting from the inclusion of additional parameters into the classification scheme, becomes self-defeating. The situation can be conceptualised as in Fig. 1. The maximum gap between total benefits and costs (AB) indicates the appropriate number of parameters to be included. 'Total benefits' are the gains to agricultural research from the sharper focus which results because of the classification process. Costs are mainly due to measuring parameters.

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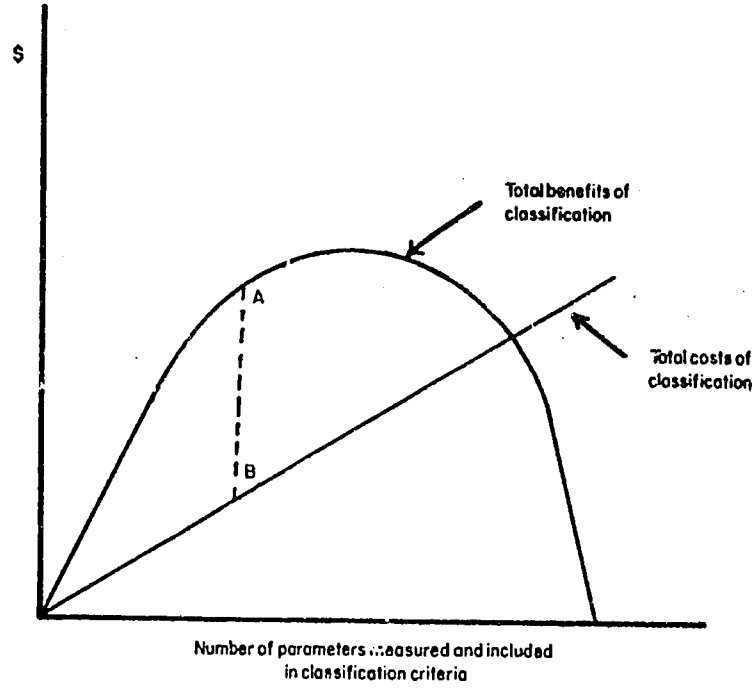

Fig. 1. Benefits/costs of classification of farming systems.

It is unlikely that the scheme in Fig. 1 could, or should, be carefully quantified—its value is in providing a framework for thinking about the problem and in explicitly recognising the influence of decisions regarding *number* and *type* of parameters to be included in the classification on the value of any classification scheme for guiding agricultural research resources.

It is clear that the problem of location specificity in farming systems research can be circumvented, to some extent, by an appropriate choice of the number and type of parameters to be included in a classification. Whilst 'appropriate' has been defined here in fairly general terms, some practical guidelines are provided. Whilst farming system classification schemes abound, little effort appears to have gone into the efficient design of such schemes for guiding agricultural research.

LOCATION SPECIFICITY AND STAGES OF FARMING SYSTEMS DESIGN/EVALUATION

In this section, another strategy is examined for minimising the location specificity problem—the emphasis by farming systems research teams on less than fully developed technologies. Important complementarities exist between this section and the previous one, but, for clarity of exposition, discussion of these complementarities is deferred until later in the paper.

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The development of new technologies occurs in stages. Anderson & Hardaker (1979) conceptualise technology design as a three-stage process. (Others who consider technology design as a multistage process include Evenson & Kislev, 1975.) New technologies can be thought of as passing through a notional, a preliminary and a developed stage:

Notional → Preliminary → Developed

All technologies begin as notions and pass through a preliminary stage. Once a new technology is adapted for individual farmer use it can be regarded as 'developed' or 'final' technology. The decision to proceed with the development of a technology implies that some *evaluation* has been undertaken (Menz, 1980). Indeed, farming systems research can be regarded as a continuous process of technology design and evaluation.

There are numerous types of evaluation. The most frequently used and cheapest is intuition, often in association with informal discussions. These two methods are typically used with respect to technology in the notional stage. As technology development proceeds, more formalised (and costly) evaluation techniques are warranted—for example, controlled scientific experiments. Finally, the evaluation of *developed* technologies should include testing under real-world conditions—for example, on-farm experiments. The appropriate form of evaluation depends upon the stage of development of technology, as indicated in Table 1. *In general*, evaluation becomes more expensive as technology becomes more developed.

There are two reasons for this. First, in moving down the list in Table 1, the evaluation techniques *per se* tend to become more expensive. In developing countries, on-farm experiments in particular are costly, partly due to severe logistical problems (TAC, 1978). A second, irrefutable, reason why farming systems research becomes more expensive in moving down in Table 1 is that, as technology becomes more developed, the results of farming systems become more location specific. This raises the real cost of evaluating the technology by requiring the

TABLE 1

ARMING SYSTEMS EVALUATION METHODS AND THE STAGES OF TECHNOLOGY DESIGN

s of technology design		*Most cost-effective evaluation method*	
Preliminary ↑		Intuition	
		Informal discussions	
		Formalised discussions	
		Laboratory experiments	
		Research station field experiments	
		Budgetting	
	Developed ↑	Computer simulation experiments	Surveys
		Unit farms experiments	
		Researcher-managed on-farm experiments	
		Farmer-managed on-farm experiments	

evaluating to be done in many locations. If evaluation is restricted to a few locations, there is an *opportunity cost* of neglecting farmers at other locations. Farmers at the chosen locations gain (Zandstra, 1979), whilst other farmers are neglected. Thus, the cost of location-specific research consists of the direct cost of evaluation/design plus the opportunity cost of neglecting other locations. Both types of cost are increasing as the new technology moves through the stages.

The place of surveys in relation to technology design depends upon their purpose, scope and depth. Surveys can be relevant at each stage of the technology design process—for example, in generating notional technologies. Not only surveys, but *all* forms of evaluation *could* be relevant at each stage in the technology design process. Nevertheless, some generality is claimed for Table 1, when the relative costs of various forms of evaluation are taken into account.

What are the implications of these cost considerations for farming systems research programmes? At present researchers usually do attempt to prescribe fully developed systems (e.g., McInerny, 1978), emphasising the benefits which can accrue. But the approach runs head on into the problem of location specificity with its attendant high cost of evaluation (see previous paragraph). Is it desirable that a research institute even attempts to test and adapt a system to local farmer needs? It seems that the farmer himself should do this job since he is the only person who can evaluate and adapt a new technology to his own (local) specific situations (Anthony *et al.*, 1979). Furthermore, technology adaptation is not a 'once only' process. Climatic, disease, price and institutional instabilities cause farmers to *adjust constantly* their farming systems (Menz & Longworth, 1976). The conclusion is that too much fine tuning of farming systems by researchers is expensive, as well as inappropriate.

A potential method of minimising the problem of location specificity is for research institutions to place a greater emphasis on the testing of preliminary technologies rather than on fully developed packages. An expanded role is implied for farmers and extension services in evaluating and adapting (fine tuning) new systems, especially where a diverse mandate area is accompanied by a scarcity of research resources. Some research into developing methodologies to aid farmers in testing technologies within their own system would be justified. Pick and choose packages (Welsch, 1978) and the minikit trials of the Nigerian Accelerated Food Production Programme (NAFPP, 1978) provide examples. The general objective of institutional research would become one of maximising the probability of 'new discoveries' at the farm level.

FARMING SYSTEMS CLASSIFICATION AND STAGES OF TECHNOLOGY

In the previous two sections it was argued that the location specificity problem in farming system research can be dealt with in two basic ways. These are: (a) by classifying existing farming systems on the basis of a limited number of attributes

which are characteristic of, or significant for, the system and which are non-location specific; (b) by releasing 'unfinished' or preliminary technologies from research, supplemented by assistance to farmers in doing their own testing/development. In practice, these two strategies are interrelated.

In the notional stage of technology development, a rudimentary classification of farming systems is usually sufficient. For example, the choice of the locations and mandate areas of the regional International Agricultural Research Centres was based mainly on only two factors: (1) climate and (2) crop/agricultural output. Note that these choices imply some notional idea of what new technology will be relevant to a region.

As technology advances from the notional to the preliminary stage, its properties become more clearly defined. Awareness of these properties will, in turn, determine the attributes (of the environment and of existing farming systems) that will direct (evaluate the demand for) the continued development of such technology. In general, the number of attributes which enters an optimal classification scheme for evaluating a *preliminary* technology will exceed the number of attributes used for an optimal scheme in the *notional* stage. For example, if an early maturing crop variety is being developed, the critical range of the duration of growing season(s) clearly becomes an important attribute to be incorporated in the classification of farming systems.

When a technology approaches the adoption stage, even more characteristics become relevant for the potential user. Again, using the example of a new variety, attributes such as colour, taste and storability must be considered by the researcher, since all these will be factors influencing final demand for the technology. Thus, for assessing the direction of further technological developments in these areas, potential users (or farming systems) should be classified by these attributes in addition to the others.

CONCLUSION

The problem of location specificity is inherent in farming systems research. This paper has explained the nature of the problem and has provided suggestions as to what can be done to circumvent it. Two general strategies are proposed. First, in classifying the mandate region, emphasis should be on a *limited number* of parameters which are relevant to potentially producable technologies. In addition, the range of values taken by a parameter in the mandate region should not be so large as to result in an overabundance of defined systems. Secondly, the design/evaluation of less than fully developed systems is appropriate, leaving farmers and extension agents to adapt to their individual needs. This is particularly true in large and agriculturally diverse regions with few research resources, since the evaluation of new systems at the farm level by researchers is expensive.

The classification of existing agricultural systems is essentially done to gauge the demand for new technologies within those systems. There are thus strong interactions between the most appropriate form of classification and both the nature and the stage of technology development. Mathematical procedures exist which are amenable to computerisation and which (given the base data) would allow iterative classifications of farming systems to be carried out appropriate to the nature/stage of technology under consideration. The number and type of parameters to be used in the classification scheme will be determined in part by the nature of the technology and in part by its stage of development.

Historically, the 'top-down' approach to increasing agricultural production has failed because of a lack of accompanying adaptive research to fine tune the technology to specific locations. However, there may now be a danger of over-reaction into purely adaptive type research which is extremely location specific. A multi-stage process is required which integrates the two approaches. Hopefully, the present paper will assist in meeting this objective, by providing some practical guidelines, as well as a basis for further discussion and research.

ACKNOWLEDGEMENTS

The authors acknowledge the useful comments of Hans Ruthenberg, Jock Anderson, John L. Dillon, Martin Upton and Christine Okali on an earlier draft.

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