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Social Science Contributions to Developing Appropriate Technology for Smallholders

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Introduction

Appropriate technology is defined in this paper as technology which will improve productivity over present levels and, at the same time, be acceptable to farmers.

Social science, as opposed to the technical sciences, has only recently been regarded as having an important part to play in the business of technology development. One of the major reasons for the recent involvement of social science is the experience that innovations are not necessarily acceptable to resource poor farmers just because they work well technically. Socio-economic factors are seen to be as important as technical factors in determining whether an innovation will be used by farmers or not.

A second major reason for the increasing importance of social sciences in technology research is the growing scarcity of resources available for research activities. This means that, for developing countries in particular, allowing scientists to research on whatever they fancy is a luxury that can no longer be afforded.

In this paper I consider the roles that social scientists can and have played in the planning of research on the one hand (the ex-ante roles), and in the utilisation of research results on the other (the ex-post roles). I illustrate my remarks with specific examples from southern Africa.

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The Ex-ante Roles

Two major ex-ante roles for social science involve assisting researchers answer the question:

> **"What are the priority issues that we should be spending scarce research resources on?"**

This question can be asked at two levels:

a) at the level of the individual researcher or research team (the micro level).

b) at the level of the national or regional research programme (the macro level).

Social science considerations and techniques are somewhat different at these two levels.

Micro Level Considerations

At the level of the team or researcher attempting to design an efficient research agenda it becomes important to make decisions about:

a) who are the clients for the research

b) what priority production problems do they have

c) what are the causes of these problems

d) which of these causes can technology research provide a solution for and have the greatest impact on.

Social science, which is more integrative and holistic than the technical sciences can contribute significantly to these decisions.

The major technique that has been used to help to make the above decisions are surveys of one type or another, together with systematic analysis to order priorities and select options.

Initial surveys have been used to group farmers into homogeneous recommendation domains on the basis of characteristics: natural (climate, soil, topography, crop diseases); socio-economic (markets, resources, objectives) and management (practices followed, crops grown).

In Zambia the first adaptive research work in each Province consisted of conducting a survey of extension workers to obtain information on the aspects listed in the previous paragraph. This information was used to demarcate Traditional Recommendation Domains. Socio-economic factors were among the three most commonly used to demarcate domains:

- cropping patterns
- resource levels (e.g. cattle ownership)
- farmer objectives (commercial vs subsistence).

Surveys, formal and informal, have been used to develop ideas about where research should focus its attention for a particular recommendation domain. An example of the use of formal survey data to influence research agendas comes from Malawi. Station researchers had conducted all maize fertiliser agronomy work on hybrids, based on the assumption that responses to local maize were uneconomic. From this work, the credit packages made available to farmers combined hybrid maize with fertilisers such that farmers could only obtain credit for fertilisers if they also bought hybrid seed. No recommendations on fertiliser levels to use on local seed existed.

Survey work, led by social scientists, produced the type of results presented in Table 1.

Table 1 Application of Fertiliser to Local Maize

	Number of farmers	Percent Applying	Chi²	Sig. Level
Ntcheu (1984)[2]				
All farmers	58	57		
Credit users	22	77		
Non credit users	36	44	4.7	0.030
Thiwi-Lifidze (1984)[3]				
All farmers	53	43		
Hybrid maize growers	22	73		
Non hybrid maize growers	31	22	11.2	.001

These results revealed that around half of the farmers were applying fertiliser to local maize and that there was a relationship between credit use (or growing hybrid maize) and the use of fertiliser on local maize. A higher proportion of farmers getting credit were applying fertiliser to local maize. Further questioning revealed that indeed many farmers were applying on local maize some of the fertiliser they obtained in the credit package for use with hybrid maize. These findings led to a change of direction in research on maize fertilisation in Malawi. On-farm research agendas included examination of local maize responses to fertiliser and methods of reducing the cost of fertilising local maize through intercropping and mixing organic with inorganic fertilisers.

[2] *Bulla et.al. (1984)*

[3] *Ndengu et.al. (1984)*

Another example of how socio-economic data obtained from informal and formal surveys influenced the content of a maïze research agenda comes from Swaziland.

Delayed and inadequate weeding was identified as a major maize production constraint. Informal surveys indicated that numerous strategies were used by farmers with a labour constraint for hand weeding to get around the problem:

1) use off-farm wages to supply cash to purchase maize instead of growing it,
2) trade goods (salt), or use cash to hire labour to weed,
3) stagger plantings to spread out the weeding labour demand,
4) plant later so that the need for weeding coincides with the Christmas holiday period when school children and visiting relatives are available to help out,
5) utilize modern inputs to increase production per hectare, such that homestead needs can be met with less acreage and less weeding,
6) trade planter, plough cultivator and oxen use with neighbors in return for their help with weeding,
7) arrange for traditional "*lilima*" - serving beer and food to groups of people in return for weeding,
8) communal exchange of labour between extended family members living in close proximity, and
9) use of intercrops, particularly pumpkins, to suppress weeds.

Analysis of formal surveys of Central, Northern and Mahlangatsha RDA's confirmed much of the informal survey findings and gave researchers confidence about the research direction they should take. Some of this analysis is shown in the following tables.

Table 2 shows the relation between the number of adult workers on the homestead and the number of weedings the household residents performed on their fields. Homesteads with the highest number of residents performed the most hand weedings, while those with the least number of residents did the least amount of hand weeding. This is evidence that supports the observations made in the informal survey and elsewhere that homesteads short of labour do less weeding.

Table 2. Relation Between Size of Farms Work Force and Number of Weedings in Central, Northern and Mahlangatsha RDA's.

Number Hand of Weedings	Number of Full-time Farm Workers
Single Weeding (n=115)	3.1
Two Weedings (n=123)	3.8
Three Weedings (n=31)	4.2
	F=4.2 p=.02

Source: Freund and Maphalala, 1983

The formal survey also showed that farmers who plant later do fewer weedings (table 3). Forty nine percent of the households that delayed weeding until weed height was 30 cm or more weeded only once; whereas, seventy five percent of households that weeded when weeds were 15 cm tall or less usually weeded more than once. This data shows that farmers delay their weeding (evident from height of weeds at time of weeding) so that they have to perform only one weeding.

Table 3. Relation Between Number and Timeliness of Weedings in Central, Northern and Mahlangatsha RDA's.

Households Who Weed	Weeding When Weeding Height is 5cm	15cm	+30cm
		%	
One Time Only (n=114)	16	35	49
More Than Once (n=155)	35	43	22

$Chi^2=27.3$ $p=0.001$

Source: Freund and Maphalala, 1983

The formal survey also showed that farmers who plant later do fewer weedings. Table 4 shows that 37% of households that plant before the end of October weed only once, while 51% who plant after that date do weeding only once. The conclusion is that delayed planting results in fewer hand weedings for maize.

Table 4. Relation Between Number of Weedings and Time of Planting in Central, Northern and Mahlangatsha RDA's.

When Planting Begins	Percent Weeding Only Once
Before end of October (n=178)	37
After Beginning of November (n=88)	51

$Chi^2=4.2$ $p=0.04$

Source: Freund and Maphalala, 1983

The results of both the formal and informal surveys clearly show the labour constraint that exists in the Swazi Nation Land farming system. There are many ways for farmers to resolve this constraint to improve maize production and profitability, but not all of them are appropriate for small farmers. Numerous authors have noted the labour constraint and related it to the problem of timely weeding (Jones, 1979; Saunders, 1982); but, they failed to recommend viable solutions. Extension workers have recommended clean weeding of maize for many years, and this view has been repeated recently (FAO, 1984). However, in view of the labour constraints, off-farm employment opportunities and farming strategies being pursued by small farmers on Swazi Nation Land, it is not reasonable to expect them to respond to new technologies or extension messages that require more labour or more management time to be spent in maize production.

The result of this analysis was that a large part of the on-farm agronomy trial work was devoted to the investigation of the technical feasibility and economic viability of herbicides on Swazi farms.

Developing appropriate research agendas is the first step to developing appropriate technologies. For no matter how marvelous the subsequent research turns out to be, if the wrong things are researched, the impact will be very limited, as was the case in Malawi, where only 3-5% of the maize area was planted to hybrids on smallholdings.

Macro-level Co siderations

Fewer examples exist of the use of social science to make decisions about:

- what proportion of national research resources should be devoted to each of the major crops

- what proportion of research scientists should exist in each discipline

- what proportion of research time should be spent on-farm or on-station.

These decisions have an economic element because they have to do with the allocation of scarce resources among competing ends (one definition of economics).

Techniques for developing relevant and useful information to assist research managers with the first of the decisions have been applied in the region.

One of these is the calculation of domestic resource cost ratios. These can be calculated for any crop and provide a measure of whether the crop in question uses domestic resources efficiently or inefficiently. A crop is considered an efficient user of domestic resources if for each unit value of domestic resources it uses a greater value of net tradeable output is produced.

Presumably research managers would want to devote more resources to crops which are efficient users of domestic resources compared to those that are inefficient or less efficient.

Examples of these types of studies in the region have focused on the comparative advantage of wheat compared to maize and other major crops. In Zimbabwe (Morris, 1988) large scale irrigated wheat was found to be an efficient user of domestic resources compared to alternative crops under normal rainfall, but not under low rainfall situations.

In Kenya (Longmire & Lugogo, 1989) wheat was found to be a more efficient user of domestic resources than maize under large scale mechanised production but not under small scale labour intensive farming.

These types of economic analyses can provide research managers with information for basing research resource allocation decisions. And these decisions will greatly influence the output of new technology in the years to come.

Ex-Post Roles

Social science can also contribute by improving the effective utilisation of research results. Involvement in the analysis of trials is perhaps the most commonly conceived role of an economist in a research department. But there are two other areas where social science skills can help to improve the utilisation of research results. The first is in adoption studies to see just how farmers use a new technology, the second is in relation to the provision of necessary services to support a new technology.

Trial Evaluation

Social science considerations become all important when the interest focuses on whether a technology will be acceptable to a particular group of farmers.

Whether the technology works (e.g. increases yields) or not will be only one of a number of factors that will determine whether farmers will change from what they are doing and adopt the technology. Other factors that need to be assessed are:

a) are the technical benefits (e.g. yield increases) representative of what farmers will achieve under the conditions in which they will use the technology.

b) does the value of the yield benefit outweigh the costs incurred to obtain the increased yield.

c) does using the technology involve other changes in the system and if so what costs or benefits are implied.

d) does changing to the new technology increase risks.

e) how will changing to the new technology affect other farmers in the community or other members of the farm household.

Social science input can assist in all these assessments. The economic analysis part is clear and obvious. But before that, a clear definition of the target group, the target group's circumstances, present practices and output levels achieved are needed to assess how representative the measured technical benefit is for the target farmers.

One way of ensuring representative technical response is to conduct trials on representative farmers' fields. Selection of representative farmers is not a straightforward affair, is seldom well done by technical scientists and is usually better done by sociologists than by economists (Sutherland, 1987).

Simple partial budget analysis is a powerful tool for assessing how the economic costs and benefit balance works out. The concept of opportunity costs are often used in these analyses to assess effects on the system of using more resources (cash, labour) in the new technology. A good understanding of the system as a whole and how it fits together is important for deciding on opportunity cost changes.

Extension of the simple budget analyses into assessment of risk and farmers' likely response to increasing levels of risk involves the application of behavioural analysis techniques. Further extension into community responses and acceptability introduces sociological considerations.

It is often assumed that these non-technical assessments only become important when a technology or trial programme has got to the stage of developing recommendations. They are vital at this point, it is true. But they also have a role to play at the earlier stages of experimentation to guide subsequent trial work in the right direction.

Example of Maize Nitrogen by Phosphorus Trial in Zimbabwe

Two seasons of NxP trials were conducted at 12 sites in three agroecological zones in Zimbabwe (Mataruka et.al. (1988) (II, III & IV). The sites were separated into two groups of 6 on the basis of total seasonal rainfall and rainfall received 1 week before and 2 weeks after topdressing (see Figures 1 and 2). The high rainfall group was taken to represent the moisture circumstances likely to be faced in a high proportion of years by farmers in the two better agroecological zones (II and III). The low rainfall group of sites represented agroecological zone IV in the same sense.

Significant responses were obtained from N only. However, the economic analysis revealed that these responses were only economic if the basal N was costed assuming AN as the source. On this assumption basal N was economic in both high and low rainfall groups, while topdress (at 30N) was economic in the high rainfall group, but not in the low rainfall one.

Economic analysis in this case does not lead directly to recommendations, but economic analysis does influence the interpretation of the results and hence the direction of future research on the issue. Further research questions arising from this analysis are:

a) Given farmer practice of applying the compound after germination, how often will a response to P be obtained?

b) What is the place of compounds versus straights in terms of economics of fertiliser use for small farmers?

c) What are the implications of reducing the cost of N in terms of the numbers of farmers obtaining access to credit packages and the hectares of maize receiving adequate N?

d) What are the conditions under which farmers in region IV can be expected to obtain an economic response to topdress N?

e) Can cheaper ways of applying maintenance dressings of P be developed?

Adoption Studies

Evaluating how farmers respond to new technology is an important, but often neglected part of technology development. A new technology will never be perfect for all farmers, the possibility of making it more useful to more farmers always exists. Feedback from farmers using the technology or reasons for them not using it can provide an important input into refining a technology or adjusting the circumstances under which farmers operate, to make the technology more useable by farmers.

Adoption studies usually involve surveys of target groups of farmers and information is collected on the use of specific technologies as well as other factors thought to influence the use of those technologies. In this way use or non-use of a technology can be related to factors such as farmer resource levels, education, market orientation, location, soil type etc. From analysis of these data some ideas about the factors that are restraining adoption or that encourage adoption can be obtained.

In Mangwende Communal Area in Zimbabwe a farmer assessment study in relation to a new minimum tillage technology (the ripper tine in place of the mouldboard plough), indicated farmers concerns about increased weed problems with the minimum tillage technique. As the Table 5 indicates, adoption of the tine technology is likely to be influenced by the use of a herbicide weed control technology. Few farmers have ever used herbicides, but those that have used herbicides seem more likely to be adopters than those that have not.

Table 5 Likely Adoption by Herbicide Users and non-users

	All (n=76)	had used herbicides (n=19)	never used (n=57)
	.... Percent		
Percent of Farmers Saying:			
Weeds are the major problem with the tine technology	45		
They would adopt the tine next season	30	46	25
		$Chi^2=2.5$	$p=0.113$

Adapted from Shumba (1989)

Herbicides were introduced as a complementary technology in anticipation of this problem. However as yet herbicides have not become widely used in the area because of supply, training and cost factors. Without the widespread adoption of herbicides, the minimum tillage tine technology is likely to remain unattractive to many farmers.

Influencing Supply Services

The last role that social science can play in influencing how technology is utilised is in extrapolating field level research findings to area or regional wide implications for input supply and production. Often research findings will require new or more input supplies or marketing facilities at the field level. If the supply and production implications of trial results and surveys are not transmitted to input suppliers and policy makers, it is unlikely that changes that might be required will be made.

For example the following points were made in a brief from the Adaptive Research Planning Team in Eastern Province Zambia to the cotton marketing agency (LINTCO), who supplied farmers with seeds and sprays in a credit package, but no fertiliser (Waterworth & Muwamba, 1989).

1. Research over several years has shown that, on the plateau, 4 bags of 'X' compound fertiliser per hectare will give a farmer an extra 500 kg or 50% more yield than unfertilised cotton.

   Trials are continuing this season at Masumba, but the results so far indicate that an extra 400 kg or 33% more yield than that from unfertilised cotton can be expected on the richer valley soils.

2. This means that, merely by providing fertiliser in their package LINTCO could have increased production in the province (in 1984/85 season) as follows:-

   3 980 hectares on the plateau produced 2 402 035 kg cotton. With fertiliser the same hectarage could have produced an additional 1 201 020 kg.

   1 760 hectares in the valley produced 1 245 175 kg cotton. With fertiliser the same hectarage could have produced an additional 415 025 kg.

   Total production with fertiliser would then have been 5 263 255 kg instead of 3 647 210 kg.

3. It should be relatively easy for LINTCO to provide fertiliser for cotton and so dramatically increase cotton production. To produce more by an increased hectarage is much more difficult because this crop competes severely for labour with local maize, hybrid maize and groundnuts.

4. For the individual farmer the extra yield of for example +500 kg above a yield with reasonable management of 1 000 kg/ha is worth K495 (Grade A) for an outlay of K192 (assuming fertiliser will cost K48 and cotton price is 99N).

Conclusion

Social science can make a substantial contribution to the development and effective utilisation of new technologies for small farmers.

In the first place, social science can assist with focusing research onto areas where the payoffs are likely to be greatest. The capacity to take a global, holistic view, to integrate information from many different sources and to evaluate trade-offs in the use of scarce resources place social scientists in a strong position to contribute significantly to "**ASKING THE RIGHT QUESTIONS**".

In the second place, social science has a role to play in the effective utilisation of new research information through ensuring that implied technologies are acceptable and can be adopted by farmers. Technologies must be evaluated from the point of view of the farmer, not the technical scientist. Household objectives, economics and risk behaviour are all non-technical factors that impinge on the acceptability of technology by farmers. Finally ensuring that necessary changes are made in the supporting services can be crucial to the adoption of new technology. Again the integrative skills of economists and their close disciplinary association with planners, gives them a role and responsibility to be instrumental in effecting institutional or policy changes necessary to enable technology adoption.

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The Ex-ante Roles

helping to decide priority research issues

a) at the level of the individual researcher or team (micro)

b) at the level of the national or regional research programme (macro)

Application of Fertiliser to local maize in Malawi

	% applying	Chi Sq	Sig level
Ntcheu			
credit users	77	4.7	0.030
non credit users	44		
Thiwi-Lifidze			
Hybrid growers	73	11.2	0.001
non hybrid growers	22		

Ex-Post Roles

Trial evaluation

Adoption Studies

Influencing Supply Services

Tine Adoption (%)

	intend to adopt	Chi Sq	Sig level
have used herbicides	46	2.5	0.113
never used herbicides	25		