
farming systems

bulletin

Eastern and Southern Africa



No. 4

October - December 1989

<i>Dear Readers</i>	<i>iii</i>
<i>Sustainability Issues with Intercrops</i>	<i>1</i>
<i>Sustainability of Cereal-Legume Intercrops in Relation to Management of Soil Organic Matter and Nutrient Cycling</i>	<i>7</i>
<i>Targeting Recommendations for Small Farmers: The Role of Economic Factors in Zimbabwe and Swaziland</i>	<i>22</i>
<i>Findings on Institutionalisation of OFR From a Review of the Experiences of Selected NARSs</i>	<i>27</i>
<i>Courses and Workshops</i>	<i>30</i>

INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER (CIMMYT)

Targeting Recommendations for Small Farmers: The Role of Economic Factors in Zimbabwe and Swaziland

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Summary

Natural conditions and major resource differences such as farm size are commonly used in on-farm research to define homogeneous 'recommendation domains' within which new technologies are tested. Successful trial results within these domains may not necessarily imply uniform acceptance across farmers, because an array of socio-economic factors influences the extent of the benefits accruing to individual farmers.

Analysis of on-farm trial results from Zimbabwe and Swaziland is used to show that variations in the socio-economic circumstances of small farmers operating in similar natural environments substantially alter the benefits of new technologies across farmers in these domains. These findings have implications for how extension messages are developed and delivered.

Introduction

The shortcomings of blanket crop production recommendations for whole communities, districts, or regions have been recognised for some time. Adoption studies have shown that recommendations and new technologies are not adopted evenly and that this uneven adoption is often due to the different circumstances facing farmers (Byerlee and Hesse de Polanco 1986; Gerhart 1984). The concept of 'recommendation domains' or 'target groups' has been adopted, particularly in on-farm research, to better target new technology at homogeneous groups of farmers who are expected to respond uniformly (Byerlee and Collinson 1980; Tripp 1986). Most often natural circumstances have been the criteria distinguishing one target group from another. Rainfall, soil type, and slope are typical of these circumstances and it is not difficult to target and physically locate trials and test responses in one of these 'natural domains'. Sometimes, resource level is used as the distinguishing characteristic and, for example, only farmers with land below a certain maximum size will be chosen to host trials.

The point of locating trials in specific recommendation domains is to establish the technical response to treatments within that specific domain. However, it will often be the case that within a domain in which

treatment effects are uniform, farmers will have differences in objectives and economic circumstances that will lead them to assess the value of a technology differently even though it gives the same technical response on their fields as on those of their neighbours (6).

In this paper, examples from on-farm research results in Zimbabwe and Swaziland are used to show that while trials placed in specific recommendation domains may provide a uniform technical response, the implications of the responses obtained may vary widely among farmers within the domain. This variation can have important implications for extension strategy as well as the impact of the technology.

Two cases are discussed in this paper: one from Zimbabwe and one from Swaziland. Both cases relate to on-farm trials with maize, the major staple food in the region. The first case looks at fertiliser recommendations for small farmers in a recommendation domain characterised by rainfall and soil type. The second case considers the appropriateness of a new weed control technology for neighbouring farms on Swazi Nation Land with different household characteristics.

In both cases economic rather than locational or technical factors determine the appropriate level for an input and the most responsive target households for extension.

Case 1: Fertilizer Use on Maize in Zimbabwe
 During the 1984/85 and 1985/86 seasons, the Department of Research and Specialist Services conducted a series of fertiliser trials on maize at 27 sites on communal area farms in Natural Region III (Agronomy Institute 1986). The purpose of the trials was to test the appropriateness of the recommended levels of fertiliser on small farms in this medium rainfall agro-ecological region (650-750 mm/yr).

The experimental treatments varied from site to site depending on recommended applications based on soil analyses at each site. In 1984/85 the treatments were 0.25, 0.5, and 0.75 of the full recommended level of basal fertiliser and topdressing determined for each site. After the first year it was felt that a wider range of levels should be tested, and in 1985/86 the treatments were 0, 0.5, 1, and 1.5 times the recommendation based on soil analysis.

Since treatment levels varied from site to site according to soil analysis results and from year to year, standard ANOVA analysis across locations and years was not possible. Thus regression analysis was used to conduct a pooled analysis across sites and years. Quadratic, square root, and log-log functions were tried. The log-log function gave the best fit and most consistent coefficients. The following equation was obtained:

$$\text{Log Yield} = .605 + 0.094\text{FERT} + 0.593\text{PHOS} + 0.131\text{TEXT} - 0.115\text{SPAC} \quad (1)$$

(5.33) (19.82) (16.61) (2.49) (2.82)

$$R^2 = .66 \quad F = 184.6 \quad N = 421$$

where:

Figures in parenthesis represent t values

FERT = log fertiliser cost valued at list price

PHOS = log initial phosphorus in the soil

TEXT = soil texture dummy: 1 = light, 0 = heavy

SPAC = plant spacing dummy: 1 = 24.5 thousand plants/ha, 0 = 40.5 thousand plants/ha

The two dummy variables, soil texture and plant spacing, were included to test the sensitivity of the response to these technical factors. Although most fields were on light soils, some had heavy soils and it was thought that fertiliser recommendations should differ for heavy soils. Many farmers achieve plant populations below the recommended 44,000 plants/ha and again it was thought that fertiliser recommendations should be different for wide versus close spacings. The effect of these dummy variables on the economic optimum rate of fertiliser in terms of Zimbabwe dollars invested is given in Table 1.

Table 1. Estimated economic optimum level of investment (Z\$/ha) in fertiliser for varying soil texture and plant populations

	Light soils	Heavy soils
Low plant density	53	46
High plant density	60	52

The lowest response was obtained on heavy soils at low plant densities and the highest response at high plant densities on the light soils. The better response to higher densities was as expected, given the reasonable rainfall in both seasons. The higher response on lighter soils was surprising. However, the differences were not great. Moving from light to heavy soils or from high to low plant densities only reduces the optimal rates by 13-15%.

However, technical factors will not be the only source of variation between farmers. Economic circumstances will also be different from one farmer to another in Region III. One source of economic variation will be related to the cost of obtaining fertiliser. Some farmers will be members of farmers' groups and be able to obtain credit and arrange group transport from urban centres. Others will not be group members, will have no access to credit, and will have to purchase their fertiliser individually at rural co-operative stores.

Since credit can be used only for the purchase of the fertiliser package, the opportunity cost of this money for the group members will be the 14% interest payable on the loan. For the individual using his or her own cash, the opportunity cost will be much higher, probably in excess of 50%. Transport costs will also be considerably less for group members.

All the coefficients were significant at the 1% level.

Transport arranged on a group basis is about one-half of the transport markup made by the co-operatives. Average co-operative transport markups are 12%, and an additional markup of 18% to cover handling charges is added to the Harare list price of fertiliser (Mackenzie 1987). Assuming a local pickup to the farm transport markup of 5% for both types of farmer, the total procurement costs for group members and non-group members is presented in Table 2 in multiples of the list price of fertiliser.

Table 2. Differences in procurement costs

	Group member	Individual farmer
Invoice price paid at store/co-op	1.00	1.18
Transport, store to farm	.11	.17
Interest on credit at 14%	.15	
Opportunity cost of capital at 50%	—	.67
Total cost of fertiliser to the farmer as multiple of the list price	1.26	2.02

Given the estimated production function coefficients, using the procurement costs above and assuming a price for maize of 170 Z\$/t delivered to the Grain Marketing Board, we obtain the economic optimum rates for light soils in Region III for group members and individual farmers given in Table 3.

Table 3. Estimated economic optimum level of investment (Z\$/ha) in fertiliser for variations in procurement costs of fertiliser

	Group member	Individual farmer
Low plant density	53	29
High plant density	60	33

The increase in procurement costs for non-group members results almost in a halving of the economic optimum rate. This is considerably more than for variations in technical factors of soil texture and plant density. It is clearly easier to tie fertiliser recommendations to technical factors such as soil texture than to farmers' procurement costs and opportunity costs of cash. However, there should be a recognition that for either soil type within Natural Region III the most appropriate fertilisation rate is likely to vary over quite a wide range, depending on the farmers' economic circumstances. This implies the need for a flexible approach to setting fertiliser recommendations.

It would appear that farmers themselves vary their fertiliser rates according to economic circumstance, and access to credit in particular (see Table 4).

Table 4. Fertiliser application rates (number of 50-kg bags/ha), Mangwende, 1981

	1st planting		2nd planting	
	Basal	Top	Basal	Top
Credit users (n = 55)	2.9	1.9	2.8	1.9
Non-users of credit (n = 21)	1.9	1.3	1.3	1.3
Significance (p level)	(.0001)	(.156)	(.0001)	(.0001)

Source: Assessment Survey (Shumba 1984 unpublished)

Case 2: Weed Control Technology in Swaziland

Initial diagnostic studies in an on-farm research programme in Swaziland (SCSRETP 1985) identified the shortage of family labour as the major cause of poor weed control in maize. Farmers adopted various strategies in light of this labour shortage, including delaying the first weeding and conducting only one weeding. Farmers who managed on-farm herbicide trials across agro-ecological regions over three years obtained small or no yield differences between chemical and hand weeding. Nevertheless an assessment survey indicated that farmers were enthusiastic about the technology, citing labour saving as its major advantage. In the absence of any yield differences, the appropriateness of chemical versus hand weeding depends on the cost of saving labour compared with the opportunity cost of household members who would be doing the hand weeding.

On Swazi Nation Land at least three types of household can be found farming side by side:

1. **Labour scarce/cash rich households (HH A).** These are young households with small family labour forces and good opportunities in the wage labour market. They do only one late weeding because of the high opportunity cost of family labour in the market and/or in the maintenance of young pre-school family households.
2. **Labour rich/cash rich households (HH B).** These are mature households with relatively large labour forces boosted by older school/ adult children and having better on-farm as well as off-farm incomes. These households do two weedings and have a good chance of obtaining access to credit.
3. **Labour rich/cash poor households (HH C).** These would be older households or women-headed households which may not have plenty of labour as such, but have few off-farm earning opportunities and therefore low opportunity cost of labour in market production as well as low opportunity labour cost in non-market production. These households can only do one weeding and are the least likely to have easy access to credit facilities.

Using labour data obtained from the on-farm trials (Seubert, Low, and Currey 1985), we can set up the analysis in Table 5 to calculate the cost of saving an hour of weeding labour with herbicides.

Because of differences in minimum acceptable returns to cash and in the amount of weeding time saved, each type of household faces a different cost per unit of time saved. Each type of household will also likely have a different opportunity cost of family labour and it is the comparison of the cost of saving labour with the opportunity (earnings) of that labour saved that will determine whether the technology is appropriate for a particular type of household.

In Swaziland (where hired labour for weeding is hard to find) the market opportunity cost of family labour ranges from 20 Z¢/hr for school children or older members to Z¢ 50 for unskilled rural wage labourers to Z¢ 100 for more skilled or experienced urban workers.

Many of the Type A households will have an opportunity labour cost on the high side of this range (100), not only because of market wage opportunities but also because of non-market household maintenance activities and the absence of members at the lower range. Type B household are likely to have an opportunity labour cost in the middle of the range (50), with Type C households having an opportunity labour cost at the lower end of the range (20). On the comparison of expected costs of saving labour (H) with opportunity labour costs (I) for the three types of household, we would expect herbicides to be adopted readily by Type A households, to a lesser extent by Type B households, and very little by Type C households. For type A households, the cost of saving labour by using herbicides is clearly less than the amount that labour could earn, whereas for type C households the higher cost of using herbicides is clearly much more than the lower earnings they could expect.

Table 5. Costs of saving labour with herbicides for different household types

	HH A	HH B	HH C
a) Minimum acceptable return on cash invested	0.4	0.4	1.0
b) Number of weedings	1	2	1
c) Cost of chemical (Z\$/ha)	45	45	45
d) Cost of capital (Z\$/ha) (a x c)	18	18	45
e) Hand weeding time (hr/ha)	150	200	150
f) Weeding time with herbicide application (hr/ha)	75	75	75
g) Time saved (hr/ha) (e - f)	75	125	75
h) Cost per hour of labour saved (Z¢/hr)((c + d) x g x 100)	84	50	120
i) Opportunity labour cost (Z¢/hr)	100	50	20

Note: HH A = labour scarce, cash rich households; HH B = labour rich, cash rich households; and HH C = labour rich, cash poor households.

Of course few households will fit nicely into any one of these categories. What the analysis does is to indicate that acceptance of the technology will depend on a whole range of household factors:

- Cash scarcity
- Market labour opportunities
- Non-market labour demands
- Type of members available for weeding
- Hand weeding management practices

It may not be possible to tie these factors down very precisely. However, they provide extension workers with an idea of the types of factors that will influence the propensity to adopt herbicides. With that knowledge extension workers will be in a better position to judge where they might best concentrate their initial extension and training efforts.

Conclusion

Initial target grouping according to natural circumstance and the resource base of farmers is an essential research tool for defining the boundaries within which the technical response to new technology is relatively uniform. But within these boundaries farmer acceptability may differ according to less definable socio-economic factors. Understanding and analysis of the effect of these socio-economic factors can help shape extension strategy and predict adoption and impact.

Byerlee (1987) has argued that recommendations should be considered as guidelines, which farmers must adapt to their own individual needs. He suggests that farmers should be given the necessary information about the performance of the technology under different conditions to enable them to do so. This assumes a degree of literacy and analytical skills on the part of the farmers. An interim step in the southern African setting might be to make extension officers more aware of the shortcomings of 'prescriptive' recommendations and to encourage them to adapt extension messages and strategies according to their knowledge of their clients' circumstances and objectives. This implies a greater role for extension in developing and tailoring messages rather than merely communicating recipes on the best way to grow crops in a given recommendation domain.

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