MEASURING PLOT SIZE EFFECTS ON COMMERCIALIZATION OF SMALL-SCALE AGRICULTURE IN KWAZULU: A DISCRIMINANT ANALYSIS APPROACH

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ABSTRACT

The aim of this study was to identify plot size effects on a broadly defined commercialization concept in three regions of rural KwaZulu using discriminant analysis. The division into small and large plot households was based on the mean plot size in each of the regions. A further division was made according to whether or not a household sold agricultural crops. Generally results indicated that the intensity of purchased requisites use was negatively related to plot size, crop sales tended to come from larger plots and households with crop sales tended to make more use of improved technology such as tractor hire and fertilizers. These results compared favourably with those of studies making use of alternative methods.

INTRODUCTION

Attempts to isolate the influences of farm size on input use and output have been prevalent. Early work was stimulated to an extent by the Schultz-Hopper theory of a "small but efficient" agricultural peasantry (Schultz, 1964) and therefore depended on the identification of acceptable efficiency measures. Extensive use was made of production functions (see, for example, Yotopolous, 1967; Yotopolous *et al.*, 1970; Hopper, 1965; Timmer, 1970; Bagi, 1981) while research was carried out by Yotopolous and Lau (1971, 1973) on the closely related profit function. Both approaches had a number of shortcomings, which are discussed more fully in Latt (1987), but are chiefly concerned with the applicability of the production function approach to small-scale agriculture.

Most earlier work on farm sizes considered the identification of size related input and output trends. Although the methods and aims of these studies were often very different, the results were much the same. Yotopolous and Nugent (1976, p. 73) summarize these as follows:

(i) Output intensity is inversely related to farm size as measured by area.
(ii) Intensity of input use (in terms of a "cost" concept which includes, among other things, both hired and family labour) is inversely related to farm size.
(iii) Output intensity was directly related to non-labour input use intensity.
(iv) Intensity of labour use is inversely related to farm size.
(v) Output per labour unit is directly related to farm size.

These observations contributed to the use of the maxim "small is beautiful" in reference to peasant agriculture. The aim of this paper is to consider the applicability of this maxim to small-scale agriculture in KwaZulu.

With growing population pressures in rural KwaZulu, it is expected that, under tribal tenure systems, the size of average household land holdings will decrease. The timely identification of size-related issues could have practical value in assisting policy makers to assess the effects of such changes. These and other policy issues will be discussed more fully below.

DATA ISSUES

Data for this study were obtained from two previous studies undertaken by Lyne around Mfume in the Umbumbulu district (Natal South Coast) during 1980, and by Stewart and Lyne in the Mpumalanga district (Natal Midlands) during 1985/86. The latter data were collected in two separate strata from different bioclimatic zones (Swayimane - mist belt, and Mbhava - valley bushveld) and could therefore be considered as two distinct sets.

Both surveys were conducted using a multi-stage sampling technique, details of which are presented in Lyne (1981).

A few potentially important variables, such as crop yields and non-purchased inputs, were not included in the data set. Where possible, proxies were used to account for these variables. However, a major consequence was the necessity to employ a broadly defined commercialization concept. Commercialization was defined as any market-related activity directly related to the agricultural activity of the household. It was therefore concerned primarily with the use of purchased inputs and the sale of farm produce. A theoretical validation of the concept is based on the assumption that development cannot occur in a predominantly autarkic subsistence sector. This idea is supported by Hyden (1986) who suggests that -

> "because there has been little surplus product, small-holder agriculture has proved an inadequate base for elaborate development

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programs" (p. 18).

The production of sugar cane by a number of the households surveyed further complicated the results, since although the sugar cane crop cycle is longer than one year, data were collected only for a single year. This reduced the efficiency of the crop income variable which was therefore replaced by a dummy distinguishing between producers and non-producers of crop income.

As a result of a predominance of zero-values in the data, many variables had positively skewed distributions which could not be rectified by data transformations. This violation of the normality assumption resulted in potentially biased tests of significance and the downward bias of correlations between these variables and normally distributed variables.

METHOD

Dichotomous plot size variables were calculated for each survey region based on arbitrarily determined cut-off levels. An attempt to make use of Doran's (1985) logistic curve method of determining the cut-off levels and thus avoid an arbitrarily determined division was abandoned since the positive bias of the plot size variables and the large variances resulted in a high proportion of the households being classified as indeterminate in terms of the size classification. As a result, the division of observations into small and large plot household groups was based on the mean plot size in each region.

For Mfume a cut-off level of 1 ha was used. This resulted in exactly half the sample being classified as "large" (> 1 ha) and half classified as "small" (< 1 ha).

Plot sizes in the Mpumalanga district were generally smaller than those in Mfume. In Swayimane this could have been due to a higher population pressure, but in Mbhava this was undoubtedly due to the poorer agricultural potential of the area. A cut-off level of 0,67 ha was used in both regions. In Swayimane this resulted in 48% of the sample being classified as large and 52% classified as small. In Mbhava 36% of the sample was classified as large and 64% as small.

Discriminant analysis is a technique whereby linear combinations of predictor variables are used to predict the most likely group memberships of observations which have been divided into a number of discrete groups. Potentially, the number of discriminant functions extracted may be equal to one less than the number of groups or equal to the number predictor variables, whichever is the smallest.

When attempting to gauge the importance of predictor variables in discriminant analysis a number of methods may be employed. The most commonly used measure is the size of the standardized discriminant function coefficients. The significance of a coefficient is determined by its univariate F-value. As indicated by Tabachnick and Fidell (p. 298):

> "... univariate F's represent the ability of each predictor variable by itself to predict group membership. By themselves, univariate F's can be misleading, too, because they neither take into account correlations among predictor variables nor compensate for increased Type 1 errors with multiple testing."

A consequence of this method of determining significance is that even when there are more than two groups of observations, and hence more than one discriminant function, significance is still measured in terms of the overall significance of each variable in discriminating between groups across all functions and not in terms of that variable's individual significance in each function. In order to gauge the importance of individual variables in each function the loading matrix is also considered.

In this second method use is made of the loading matrix of within group correlations between the canonical discriminant functions scores and the discriminating variables. As Tabachnick and Fidell (p. 320) point out:

> "... caution should be taken, however, in interpreting these loadings. They do not necessarily indicate which variables contribute most heavily to discrimination among groups, after adjustment for remaining cases."

The emphasis of this study is on interpreting the discriminant space in terms of the variables contributing most heavily to group separation in space, rather than the construction of a decision rule of classifying new cases.

Since there were no *a priori* criteria for the selection of variables, a stepwise procedure which minimized Wilk's Lambda was used to select, from a set of potential variables, those variables which explained most of the between-group differences. Wilk's Lambda is an inverse likelihood measure of the discriminating power of the variables. Thus, the smaller the value of Wilk's Lambda, the better is the discriminating power of the variables.

RESULTS

Exploratory analysis using zero-order correlations and cross-tabulations indicated a strong positive relationship between plot size and the propensity to sell crops in two of the regions under consideration (Mfume and Swayimane). In the remaining region (Mbhava) there was little propensity to produce a saleable surplus, which may be explained in terms of the low agricultural potential of the region. In an attempt to reduce the effects of the strong correlations between discriminating variables, it was decided to differentiate the data according to both the plot size dummy and a crop income production dummy. This resulted in the following four group classification:

Group 1 : Small plots; no crop income
Group 2 : Small plots; crop income
Group 3 : Large plots; no crop income
Group 4 : Large plots; crop income

On *a priori* grounds, it was considered that groups 2 and 3 were deviations from the norm.

Mfume results

Three linear discriminant functions were extracted, with a combined Wilk's Lambda of 0,381 (X^2 (33) = 125,02, p<.001). After removal of the first discriminant function, there was still significant discriminating power within the explanatory variables (Wilk's Lambda = 0,783, X^2 (20) = 31,6, p<.05). After removal of the second function no significant discriminating power remained (Wilk's Lambda = 0,984, X^2 (9) = 2,06, p>.99) and the third function was therefore ignored in further analysis.

Group centroids are the mean discriminant scores for each group as calculated from the discriminant functions. The centroids for the first two discriminant functions are given in Table 1.

TABLE 1 - Group centroids of discriminant functions for plot size and crop income differentiation in Mfume

Group	Function 1	Function 2
Group 1	-1,383	0,083
Group 2	0,295	0,659
Group 3	0,025	-1,668
Group 4	1,280	0,045

As is clear from these centroids, the first discriminant function separates mainly along size related criteria with maximum separation between groups 2 and 4. The second discriminant function separates mainly along crop income related criteria with maximum separation between groups 1 and 2.

Discriminant functions are extracted orthogonally and in decreasing order of importance, in terms of total variance contributed by each function. The first function explains 79,5% of the variance contributed by the discriminant functions and 51,4% of the total variance between the groups (The square of the canonical R value). The second function explains 19,3% of the variance and 20,4% of the variance remaining after the extraction of the first function. Group difference relationships based on the first function are therefore stronger than those based on the second.

The results of this discriminant analysis are presented in Table 2. The most important variables in the first discriminant function, based on the standardized coefficients, are: intensity of purchased seed use, proportion of land under sugar cane, number of implements owned and the presence of a permanent male household head.

The intensity of seed purchases may be expected to have a negative association with plot size since smaller farmers tended to grow proportionally more maize and mixed crops which constitute the major seed purchases. Negative signs of the standardized coefficient and the correlation coefficient for seed per ha in function 1, Table 2 confirm this.

Since sugar cane is a long-term crop which requires a quota to produce and has no direct subsistence value, it is expected to be grown proportionally more on larger plots.

The positive relationship between plot size and the number of assets, such as implements and cattle, is expected. According to function 2, ownership of implements was also positively associated with crop income production.

The negative relationship between plot sizes and the presence of a permanent male household head is puzzling, but not significant in terms of the loading matrix.

Household size was measured using an adult equivalence whereby one adult is equal to eight school children. This measure was based on that used by Mukhebi (1981). The purpose was to identify the family labour potential of the household. The positive relationship between household size and plot size was expected, since the larger households had more potential labour and greater subsistence requirements and tended to be allocated more land

TABLE 2 - Standardized canonical discriminant function coefficients and correlations between discriminant scores and discriminating variables for Mfume

Variable name[a]	Function 1 (Size separation)		Function 2 (Income separation)	
	Standardized coefficient	Correlation coefficient	Standardized coefficient	Correlation coefficient
Seed/ha***	-0,619	-0,383	0,088	0,330
% sugar area***	0,551	0,478	0,055	0,273
Implements***	0,432	0,536	0,128	0,377
Perm. male head**	-0,362	-0,017	0,683	0,484
Household size***	0,309	0,292	0,078	0,379
Cattle owned***	0,308	0,381	-0,068	0,104
% fallow area	0,303	0,158	0,026	-0,114
Migrants**	-0,263	0,159	0,440	-0,372
Fertilizer/ha*	0,216	-0,068	0,423	0,410
Draught hire/ha***	-0,216	-0,276	0,437	0,236
Land rent/ha	-0,051	-0,058	-0,501	-0,234
% maize area**	--b	-0,189	--	-0,058
Labour hire/ha*	--	0,014	--	-0,402
Eigen value	**1,057**		**0,256**	
% variance	**79,50**		**19,27**	
Canonical R	**0,717**		**0,452**	

Note:
a. Relevant variables are explained in text
b. Coefficients of variables not selected by stepwise discriminant procedure are denoted "--"
c. Significance calculated in terms of univariate F values
***Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

by chiefs.

Larger plot holders rested a greater portion of their land as borne out by the fallow proportion coefficient. This variable was not significant when considered across all functions, but may still be significant in the first function alone.

Smaller plot households tended to send more migrant workers out of the region, which could be related to reduced family subsistence requirement or limited work opportunities within the household.

After all other variables were accounted for, intensity of fertilizer use was positively related to plot size. This is a partial effect and therefore not directly comparable to the negative zero-order correlation between plot size and intensity of fertilizer use among users. It may also reflect the transmission of the positive relationship between fertilizer intensity and crop income production through the positive relationship between plot sizes and crop income production.

With larger plot holders owning more productive assets, such as ploughs and oxen, it may be expected that the intensity of draught hire is lower for these households, as indicated by the negative coefficient in the first discriminant function.

The second discriminant function (Table 2) is important in terms of the commercialization concept mentioned above. Important variables in this function are: the presence of a permanent male household head, number of migrants, intensity of draught hire, intensity of purchased fertilizer use and cost of land rented per ha. With the exception of the latter variable, each mentioned was positively related to crop income production.

The fact that rent costs per ha were negatively related to plot size could indicate that the occupational value of land exceeds the agricultural value. This supports the idea that under high population pressures the value of land is determined by human fertility (i.e. population pressure) rather than soil fertility (i.e. productive potential) (Warriner (1964), p. 284).

The positive association between a permanent male household head and propensity to produce a crop income may be attributed to the traditional relegation of females to subsistence production roles. Cobbett's (1984) observation that sugar cane quotas in the areas he studied were predominantly male controlled supports this notion. Furthermore, other operations, such as ploughing, which are necessary for commercialized agriculture, are traditionally carried out by males. These prejudices could also become apparent in extension workers' dealings with female headed households.

The positive relationship between crop income production and number of migrants could be due to a decreased subsistence requirement within the household resulting in increased agricultural surpluses, or due to the use of migrant remittances to purchase agricultural requisites and supplement subsistence food requirements.

The intensity of seed purchases did not feature prominently in the standardized function, which could reflect their relative importance in subsistence production rather than commercial production (e.g. maize seed).

The intensity of fertilizer purchases in differentiating between low and high crop income producers was important in both the standardized function and the loading matrix. This could be seen as an indication of the importance of fertilizers in commercialized agriculture and the potential gain in surplus production to be achieved through the stimulation of fertilizer use.

Draught hire including the hiring of tractors and other specialized equipment, was significantly related to crop income production. This could account for its importance in the second discriminant function even though it was more intensively used by smaller plot holders who tend to produce a smaller saleable surplus. The adequate provision of these services (draught hire) is essential, given the small farm sizes.

Swayimane results

Three linear discriminant functions were extracted, with a combined Wilk's Lambda of 0,328 (X^2 (30) = 123,78, $p < .001$). After removal of the first discriminant function, there was still significant discriminating power (Wilk's Lambda = 0,694, X^2 (18) = 40,57, $p < .01$). After removal of the second function, the predictor variables still retained significant discriminating power (Wilk's Lambda = 0,884, X^2 (8) = 13,63, $p < .10$). All three discriminant functions are considered below.

Centroids for these discriminant functions are given in Table 3.

TABLE 3 - Group centroids of discriminant functions for plot size and crop income differentiation in Swayimane

Group	Function 1	Function 2	Function 3
Group 1	-1,196	-0,130	0,158
Group 2	0,385	-0,721	-0,740
Group 3	-0,371	1,495	-0,545
Group 4	1,119	-0,054	0,213

The first function discriminated between groups 1 and 4, while the second function discriminated between groups 2 and 3. Thus, unlike the Mfume data, no clear-cut division could be made with respect to plot size criteria and crop income criteria. However, it appears that with the strong link between plot sizes and crop income production, the *a priori* expectation that groups 2 and 3 were deviations from the norm (i.e. that large plot households rather than small plot households tend to produce saleable surpluses) is justified. If this is the case, then the first function may be considered as explaining plot size and crop income differences between the most likely groupings, and the second function as explaining these differences between the deviant groups. The third function explains the difference between the two expected groups and the two deviant groups.

The first function explains 73,4% of the variance accounted for by the discriminant functions and 52,7% of the total variance between the groups (canonical R squared). The second function explains 18,1% of the variance accounted for and 21,5% of the variance remaining after the extraction of the first function. The third function explains 8,6% of the variance accounted for and 11,6% of the variance remaining after the removal of the first two functions.

Results of this discriminant analysis are presented in Tables 4a and 4b.

TABLE 4a - Standardized canonical discriminant function coefficients for size and income differentiation in Swayimane

Variable name[a]	Function 1 (Expected groups)	Function 2 (Deviant groups)	Function 3 (Mixed groups)
% sugar area***	0,602	-0,530	-0,043
Cattle owned*	0,527	0,348	0,207
% maize area***	-0,434	0,043	0,047
% fallow area***	-0,362	-0,139	0,067
Fertilizer/ha***	-0,272	-0,156	0,615
Household size	-0,218	0,112	0,309
Ox implements	0,136	-0,425	-0,270
Remittances***	0,098	0,798	-0,602
% bean area***	-0,071	-0,537	-0,729
Seed/ha***	-0,042	-0,347	-0,573
Eigen value	**1,116**	**0,275**	**0,131**
% variance	**73,38**	**18,05**	**8,59**
Canonical R	**0,726**	**0,464**	**0,340**

Note:
a. Relevant variables are explained in text
b. Significance calculated in terms of univariate F values
***Significant at the 1% level
* Significant at the 10% level

TABLE 4b - Correlations between discriminant scores and discriminating variables for size and income differentiation in Swayimane

Variable name[a]	Function 1 (Expected groups)	Function 2 (Deviant groups)	Function 3 (Mixed groups)
% sugar area***	0,715	-0,146	0,126
% maize area***	-0,421	0,259	0,059
Fertilizer/ha***	-0,407	-0,142	0,103
Tractor hire/ha***	-0,299	-0,037	0,038
% fallow area***	-0,299	-0,058	0,179
Seed/ha***	-0,283	-0,168	-0,348
% bean area***	-0,234	-0,331	-0,496
Cattle owned*	0,223	0,204	0,128
Household head	-0,163	0,167	0,045
Ox implements	0,097	-0,039	-0,125
Labour hire/ha	-0,054	0,031	-0,126
Remittances***	0,043	0,662	-0,483
Household size	-0,022	0,262	0,051
Eigen value	**1,116**	**0,275**	**0,131**
% variance	**73,36**	**18,05**	**8,59**
Canonical R	**0,726**	**0,464**	**0,340**

Note:
a. Relevant variables are explained in text
b. Significance calculated in terms of univariate F values
***Significant at the 1% level
*Significant at the 10% level

The most important variables in the first discriminant function, based on the standardized coefficients, are: proportion of land under sugar cane, number of cattle owned, proportion of land under maize and proportion of land left fallow.

In the first function (separating most likely groups) the larger plot households were the crop income producers. It is therefore not surprising to find that these households had proportionally more land under sugar cane and proportionally less under maize. It was also interesting that the larger plot households tended to have proportionally less land left fallow. This could have been a result of their greater sugar cane production, since sugar cane is a longer-term crop and is fallowed less often.

More cattle were owned by the larger plot households which could reflect their relatively greater wealth and higher standing within the community.

Interestingly, the smaller plot households without crop income production seemed to make more intensive use of fertilizers than the larger plot household with crop income. This could indicate that increased fertilizer use may be regarded as a substitute for scarce land. Furthermore, farming techniques may not necessarily be regarded as a significant factor preventing surplus production by these smaller plot households.

The most important variables in the second discriminant function are: total remitted income, proportion of land under beans, proportion of land under sugar cane, number of ox implements, number of cattle owned, and intensity of purchased seed use.

In the second discriminant function (deviant groups) the smaller plot households were the crop income producers and therefore had proportionally more land under sugar cane and beans, both of which are major cash crops in the region.

The larger plot households without crop income tended to receive more remitted income from outside sources. These remitted incomes included cash from migrants, pensions and disability payments. This seems to indicate that although these households had sufficient land for surplus production, they did not produce this surplus because they received cash from elsewhere. Since these households were not producing surpluses on their relatively larger plots, it seems likely that their methods of production were more extensive.

This latter observation is supported by the fact that these households used purchased seed and fertilizers less intensively and tended to own fewer ox implements.

If the number of cattle owned was taken as an indication of the relative well-being of the household, then lack of available funds could not reasonably be considered as a reason for the lack of surplus production in these large plot households, especially in the light of their higher average remittances.

The third function tended to separate the expected groups (1 and 4) from the deviant groups (2 and 3). Most important variables in this discriminant function include: proportion of land under beans, intensity of purchased fertilizer use, intensity of purchased seed use, total remitted income and household size.

Since this function did not separate on plot size or crop income criteria it was difficult to explain within the framework of this study. However, although significant, it explained only a minor part of the total variance explained by the discriminant functions. Further consideration of this function was therefore thought to be of limited value.

Mbhava results

With only three of the four potential groups represented in the Mbhava data set, only two possible linear discriminant functions existed. These were extracted with a combined Wilk's Lambda of 0,419 (X^2 (12) = 45,67, p< .001). After removal of the first discriminant function, the predictor variables retained significant discriminating power (Wilk's Lambda = 0,786, X^2 (5) = 12,65, p > .05). Both discriminant functions are therefore analysed below.

Group centroids for both discriminant functions are presented in Table 5.

TABLE 5 - Group centroids of discriminant functions for plot size and crop income differentiation in Mbhava

Group	Function 1	Function 2
Group 1	-0,682	0,044
Group 2	-	-
Group 3	1,130	-0,420
Group 4	1,629	1,977

The first discriminant function again distinguishes between the groups along size-related criteria and the second function distinguishes along crop income production lines. With only 3 cases in group 4 (large plots; crop income production) the value of the second function should not be over-estimated.

The first function explains 76,3% of the variance accounted for by the discriminant functions and 46,7% of the total variance between the groups (canonical R squared). The second function explains 23,7% of the variance accounted for and 21,4% of the total variance remaining after the removal of the first function.

Results of this discriminant analysis are presented in Table 6. Important variables in the first discriminant function (size separation) include: number of cattle owned, intensity of purchased seed use, household size, proportion of land left fallow and intensity of tractor draught hire.

Mbhava had a lower population density than either of the other two regions considered and a predominantly subsistence orientation (few households sold any crops at all). It was therefore not surprising to find that size of household was an important predictor variable in the plot size separation, since larger households have both more potential family labour and greater subsistence needs.

With Mbhava more suited to livestock production than crop production, it was not surprising to find that larger households (which also happened to have larger plot sizes) had more cattle. The intensity of purchased seed use was negatively related to plot size even though there did not appear to be marked differences in cropping patterns according to plot size. The other purchased inputs were not really used by sufficient households to enter the analysis meaningfully. Even the tractor hire variable seemed to enter more as a result of the second function than the first.

The importance of the second discriminant function (crop income separation) should not be overestimated since only three of the households surveyed in Mbhava produced a crop income. The important relationships in this function were the positive relationships of intensity of tractor draught hire and remittances and the negative relationship of household size to crop income production. This latter relationship may be an indication of the greater subsistence requirements of the larger households.

DISCUSSION

Since the three regions were located in areas of different agricultural potential, it was possible to consider the effects of these differences on the

TABLE 6 - Standardized canonical discriminant function coefficients and correlations between discriminant scores and discriminating variables in Mbhava

Variable name[a]	Function 1 (Size separation)		Function 2 (Income separation)	
	Standardized coefficient	Correlation coefficient	Standardized coefficient	Correlation coefficient
Cattle owned***	0,712	0,751	-0,047	-0,165
Seed/ha**	-0,424	-0,374	-0,191	-0,012
Household size***	0,421	0,560	-0,619	-0,284
% fallow area	-0,314	-0,068	-0,272	-0,017
Tractor hire/ha**	0,287	0,033	0,864	0,662
Remittances**	0,112	0,365	0,722	0,329
Ox implements	--b	0,373	--	-0,169
Household head	--	0,296	--	0,008
Labour hire/ha	--	-0,196	--	0,288
% bean area	--	-0,071	--	-0,004
% maize area	--	0,062	--	0,193
Fertilizer/ha	--	-0,046	--	0,241
Eigen value	**0,876**		**0,272**	
% variance	**76,28**		**23,72**	
Canonical R	**0,683**		**0,463**	

Note:
a. Relevant variables are explained in text
b. Coefficients of variables not selected by stepwise discriminant procedure are denoted "--"
c. Significance calculated in terms of univariate F values
***Significant at the 1% level
** Significant at the 5% level

observed plot size relationships. Unfortunately since, in addition to the spatial differences, there were also temporal differences between the surveys, it was not possible to isolate these spatial differences with absolute certainty.

Of the three regions, Swayimane appeared to have the greatest agricultural potential, followed closely by Mfume, with Mbhava having extremely low potential.

The first consequence of this was found in the population densities of the areas. Swayimane had the highest population density and therefore smaller average plot sizes and little communal grazing land. Thus, even though agricultural potential was higher in this region than in Mfume, proportionally fewer households in Swayimane (54%) sold crops than in Mfume (63%). Mbhava had the lowest population pressure of the three regions, but the low agricultural potential of this area also resulted in its having the lowest average plot sizes and almost no households (5%) selling crops.

A second consequence was that purchased requisites were strongly size and crop income related in Mfume and Swayimane, but not in Mbhava. This could indicate that the former regions would respond to programmes aimed at stimulating surplus production through the stimulation of demand for requisites more than the latter region. In this regard, smaller plot holders were already making use of purchased inputs more intensively than larger plot holders which could indicate that the latter group would be more responsive to these programmes.

The observations by Bembridge (1984), Erskine (1982) and Fényes (1982), that a large proportion of the rural population merely reside there and have little or no desire to become agriculturally active may be explained in terms of logical responses to various factors, such as restrictions on freedom of movement for Blacks, the migrant labour system and cultural factors, many of which have become ingrained into the rural social structure. There is therefore little that may be done to change this situation through purely economic stimuli. Any agriculturally orientated programmes are bound to affect only a limited proportion of the rural sector directly, but certain programmes which, for example, stimulate surplus production and commercialization of agriculture, will have ramifications for the whole sector in the longer term. These complications must be considered with respect to policy suggestions since they are bound to affect the rates of response to and attractiveness of various programmes.

Given that the stimulation of agricultural surplus production would appear essential for the development of KwaZulu, the existence of positive relationships between purchased input use intensities and crop income production indicates that an increase in the former could result in an increase in the latter. Methods of stimulating input use include extension work and, during an interim period, subsidies.

Subsidies may be particularly important with respect to the fixed costs of acquiring new knowledge. These are substantially higher per unit area for small-scale agriculture than for large-scale agriculture. These subsidies may be regarded as one-off events and should therefore not be confused with continuous subsidization which may lead to perverted market responses.

The importance of fertilizers in the commercialization concept could suggest potential short-term benefits from direct subsidization of fertilizers.

Similarly, draught hire, particularly tractor hire for ploughing, appears important in commercialization. This could be due to reduced draught costs through hiring rather than maintaining oxen and implements throughout the year. Ensuring that sufficient tractor power is available in specific areas to meet seasonal needs may also result in increases in marketable surpluses.

There is a trend towards the privatization of tractor hire services, stimulated by perceived inefficiencies in the government service. One problem associated with this is that certain operations, such as ploughing, need to be carried out within a critical period which may require more tractors on a regional basis than are privately available. However, during the slack periods there is little call for hiring tractor draught power and then there would appear to be too many tractors in the area to support private operators efficiently. A potential solution may be to use these tractors and any other idle resources, such as labour, in rural improvement programmes (e.g. building roads, waterways, clean water supplies, etc.). The benefits of these programmes to the rural areas will be felt in two ways. First, directly through the improved services and secondly indirectly through increased rural employment and income which could stimulate further development. However, as with fertilizer subsidies, the potential benefits of these programmes must be weighed up against the social costs of supplying these services.

CONCLUSION

Various shortcomings of the production function approach, e.g. rigid assumptions, stimulated a search for alternative means of measuring size-related differences in small-scale agriculture. The robustness and less stringent assumptions of discriminant analysis and the interpretability of the results, tend to favour its use in this regard. On the whole, the consistency of the results with *a priori* expectations seems to indicate that the robustness of the discriminant technique was not severely detrimented in the above analysis.

As a result of increasing population pressures in the rural areas, average plot sizes may be expected to decrease. These reductions could have important consequences in the rural areas in terms of depletions of natural soil fertility (more intensive farming with less fertilizer applied on smaller plots) and reduction of potential marketed surplus (larger plot households have a higher propensity to produce surpluses). Unless some acceptable, non-draconian method of reducing population growth is discovered, there seems little hope of reducing these population pressures without positive urbanization.

Unfortunately, the urban areas are not prepared for a large influx of rural inhabitants and working within the small-holder framework would therefore seem more likely to produce results than trying to change this framework, even in the medium-term.

With regard to the maxim "small is beautiful", more clarification of aims is required. In so far as inputs appear more intensively used by smaller plot holders, it may be reasonable to assume that output intensities are higher for these plots. However, in terms of profitability, this may not be the case. Fewer small plot households produce saleable surpluses as measured by the crop income dummy. With respect to smaller plots, the reduced potential total earnings may actually act as a disincentive to agricultural production as an alternative to other non-agricultural income sources. Production on these plots will not cease completely since, in accordance with Low's household theory, there are almost invariably some members in the household whose opportunity cost of alternative income is low enough to warrant production. Thus, while smaller plots may sustain more people in a given area, this may be at the expense of profitability and marketed surplus.

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