AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

281.8
Ag835
c3

Vol. 23 No. 2
OCTOBER 1984

Price 50c
(+ GST)

Agrekon

BIANNUAL JOURNAL ON AGRICULTURAL ECONOMICS

Issued by the Department of Agricultural Economics and Marketing

FACTORS WHICH ADVERSELY AFFECT THE ACCEPTANCE OF TECHNOLOGY IN THE AMACI AREA OF KWAZULU: GUIDELINES IN FORMULATING A POLICY

by T.E. KLEYNHANS and M.C. LYNE *

INTRODUCTION

Agriculture's contribution to increasing prosperity in Black rural areas has been disappointing until now and agriculture in these areas is still characterised, for the most part, by its traditional subsistence nature. The starting point of this investigation was that the low level of acceptance of modern technology can be ascribed to logically explicable characteristics of the sosio-economic milieu of the Black subsistence farmer. The aim of the investigation, therefore, was to identify these socio-economic factors which prejudice the acceptance of technology. Of importance here is the way in which analytical techniques for the processing of accurate data can be used in formulating a policy concerning agricultural development.

METHOD

The data used in the investigation were obtained from 100 rural households in the Amaci area in Southern KwaZulu. Data were gathered on the use of certain technological inputs. These technology variables were united to obtain comprehensive innovation criteria by analysing principal components. They were used for identifying those who accept and those who do not accept modern technology. A distinction was made between labour-saving, land-saving and general innovations (a combination of the first two).

Data concerning socio-economic conditions with a theoretically expected influence on the acceptance of technology were also gathered. Only those socio-economic conditions already existing during the decision-making period concerning the use of technology can be regarded as reasons for low levels of acceptance. Selected socio-economic variables were subjected to discriminant analysis to distinguish between accepters and non-accepters. The discriminant function which can distinguish most accurately between these groups can be used as guide-line in formulating a policy and for classifying the unknown cases.

*T.E. Kleynhans is a Masters student and M.C. Lyne a lecturer at the University of Natal

Selection of technology variables for principal component analysis

Technology variables were selected by reason of zero-order correlation. The PEARSON CORR SPSS subprogram (Nie *et al.*, 1975, pp. 280-286) was used for this purpose. Preference was given to variables with high mutual correlations because the first principal component formed from these makes a greater contribution to the total variance.

Principal component analysis

Principal component analysis is a *transformation technique* with which a complex set of relations can be reduced to a simple canonical form. The purpose of principal component analysis can also be described as an effort to economize on the number of variables (Kendall, 1975, p. 10). Such a comprehensive criterion is obtained by transforming the observed variables as follows:

$$HK_1 = a_{i_1} X_1 + a_{i_2} X_2 + \ldots + a_{ip} X_p$$

where $X_1, X_2 \ldots X_p$ are the technology variables; $a_{i1}, a_{i2}, \ldots a_{ip}$ the coefficients calculated so that HK_1, the first principal component, makes the greatest contribution to the variance (or correlation) as contained in the p-number of original variables (Nieuwoudt, 1977, p.77).

Frequency distribution of the first principal component values

A frequency distribution was used to arrange the 100 farmers' values for the innovation criteria (first principal component values). This was obtained by using the FREQUENCIES SPSS subprogram (Nie *et al.*, pp. 194-202). Farmers with high first principal component values were regarded as accepters and those with low values as non-accepters. Farmers were grouped as accepters and non-accepters by using suitable cut-off points within the spectrum of first principal component values. Cut-off points were determined arbitrarily, although great differences (jumps) between successive values did serve as guide-lines. The grouping of cases by reason of their values for a continuous variable is significant only if natural breaks occur within the

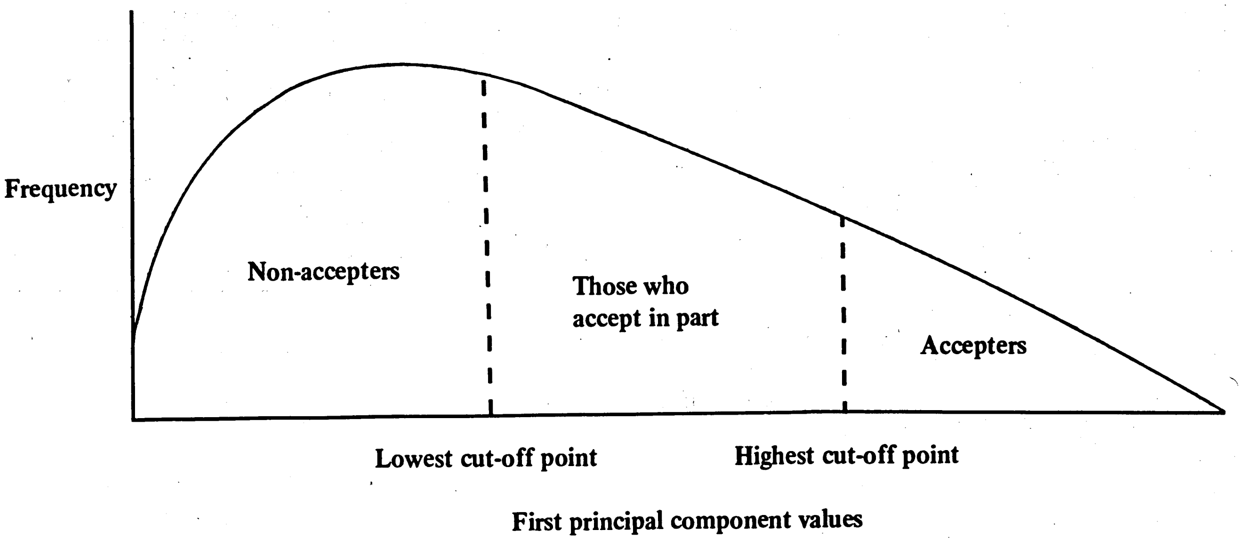

FIG. 1 - Grouping of farmers by reason of their first principal component values

spectrum of values (Eisenbeis, 1977, p. 888). The grouping of farmers is represented in Figure 1.

Using only the two extreme groups as reference framework, the results of the discriminant functions could be evaluated more efficiently.

Selection of the socio-economic variables

The socio-economic variables differentiating or discriminating most clearly between accepters and non-accepters were selected on the basis of three criteria. The first two criteria based on a single variable served as basis for the final selection on a multivariable basis.

(i) Correlation test

A correlation test was carried out in which the correlation of socio-economic variables with the comprehensive innovation criteria was calculated. Preference was given to those variables which indicated high correlations with the comprehensive innovation criteria.

(ii) Single variable F test

A single variable F test was carried out to determine the significance of differences between the group averages of accepters and non-accepters for the socio-economic variables. Preference was given to variables which showed significant differences between the group averages of the two groups.

(iii) Discriminant analysis

Discriminant analysis was used to identify those socio-economic variables which differentiated most accurately on a multivariable basis between accepters and non-accepters. The accuracy of classification could be calculated on the basis of the identification of accepters and non-accepters with the aid of comprehensive innovation criteria. The socio-economic variables were expressed as discriminant variables in a linear discriminant function. The absolute magnitude of the coefficients of the variables represents their relative contribution in the process of differentiating between accepters and non-accepters. The aim of the discriminant function is to separate the groups as much as possible statistically (Klecka, 1975, p. 435). With only two groups (accepters and non-accepters) only one function is obtained in the form -

$$DW_i = d_{i_1}Z_1 + d_{i_2}Z_2 + \ldots + d_{ik}Z_k$$

where DW_i is the discriminant value of the i-st farmer; $Z_1, Z_2, \ldots Z_k$ are the discriminant variables (socio-economic variables) in standardised form; $d_{i_1}d_{i_2} \ldots d_{ik}$ are the coefficients (in standardised form) so chosen that the group mid-points are maximally separated.

EMPIRICAL CONCLUTIONS

The selected technology variables with their mutual correlations are given in Table 1.

Although the *intensities of the use* of fertiliser, herbicide and insecticide were measured, these variables could not be used in a comprehensive criterion, since negative correlations with the other technology variables were obtained. Negative correlations between intensity and scale variables were expected by reason of many similar conclusions from investigations undertaken in other underdeveloped areas (Feder, Just & Silberman, 1981, p. 7).

Three comprehensive innovation criteria were derived by using GENSTAT (1977). These results are given in Table 2.

TABLE 1 - Matrix of zero-order correlations between technology variables in the Amaci area

Technology variable		X_1	X_2	X_3	X_4	X_5
Area tilled by tractor (hired) (m^2)	X_1	1				
Area planted by mechanical planter (m^2)	X_2	,68**	1			
Amount of fertiliser applied (kg)	X_3	,40**	,61**	1		
Value of herbicide and insecticide applied (R)	X_4	,49**	,42**	,03	1	
Area under intensive vegetable crops (m^2)	X_5	,21	,39**	,33**	,20	1

Remarks:

*Intensive vegetable crops include potatoes, beans, spinach, onions, cabbage, carrots, chillies, tomatoes and amadumbies (*Colocasia antiquorum*).
Areas under mixed crops were multiplied by a correction factor of 0,5 to give preference to single crop cultivation
**Implies significance on the one percent level

The percentage contributions to the total variance of the various first principal components compare favourably with the 25% of the "performance index" in Nieuwoudt (pp. 77-81).

using the three criteria. The power of variables to differentiate between accepters and non-accepters on a single variable basis is illustrated by the differences between the group averages in Table 4.

TABLE 2 - Characteristic vectors of the first principal components

Technology variables		Type of innovation		
		Labour-saving	Land-saving	General
Area tilled by tractor (hired)	X_1	0,66		0,51
Area planted by mechanical planter	X_2	0,75		0,56
Amount of fertiliser applied	X_3		0,60	0,42
Value of herbicide and insecticide applied	X_4		0,39	0,36
Area under intensive vegetable crops	X_5		0,69	0,34
Percentage contribution to the total variance by first principal component		84	47	52

The elements of the characteristic vectors of the first principal components form the coefficients of the three linear equations with which farmers' values ("scores") for the comprehensive innovation criteria were calculated.

The results of the grouping of farmers by using the frequency distribution of their first principal component values are summarised in Table 3.

TABLE 3 - Grouping of farmers using three comprehensive innovation criteria (Amaci area)

	Innovation type		
	Labour-saving	Land-saving	General
	No. of farmers	No. of farmers	No. of farmers
Accepters	18	18	18
Non-accepters	51	51	50
Those who accept in part	31	31	32
Total	**100**	**100**	**100**

The ratio between the three groups corresponds very closely to that between the three divisions of the innovation criteria.

Five socio-economic variables were selected

The discriminant functions were derived for labour-saving, land-saving and general innovations by using the step-by-step procedures of the DISCRIMINANT subprogram (Klecka, pp. 434-462). All the selected variables were also included in a function derived by using the direct procedure. The standardised coefficients of the selected variables expressed in the various functions are given in Table 5.

The relative magnitudes of the standardised coefficients reflect the relative importance of the influence of the socio-economic variables on technology acceptance. The selected socio-economic variables can, generally, be arranged as follows:

Z_1: Tillable land area per permanent member of family (m^2)
Z_3: Number of cattle in possession of the family
Z_2: Number of adult migrant labourers in the family
Z_4: Number of visits to an agricultural extension officer by the farmer
Z_5: Number of visits by an agricultural extension officer to the farmer

Differences in rank of the socio-economic variables as reflected by the different functions can be ascribed to the type of innovation described. In this way the number of cattle in possession of the family (Z_3) carries more weight in the acceptance of labour-saving technology.

TABLE 4 - Differences between group averages of accepters (A) and non-accepters (NA) for the socio-economic variables

Socio-economic variables		Innovation type											
		Labour-saving				Land-saving				General			
		Grand mean	Group Averages		Significance of F value	Grand mean	Group Averages		Significance of F value	Grand mean	Group averages		Significance of F values
			A	NA			A	NA			A	NA	
Area/person (m$_2$)	Z_1	1 408	3 217	740	**	1 583	2 397	1 317	*	1 111	2 102	788	**
Number of migrant labourers	Z_2	1,65	1,71	1,63		1,64	2,2	1,46	**	1,67	2,13	1,52	
Number of cattle	Z_3	3,37	5,12	2,72		3,33	6,2	2,39	*	3,66	6,73	2,65	**
Farmer visits official	Z_4	0,14	0,41	0,04		0,15	0,47	0,04		0,15	0,47	0,04	*
Official visits farmer	Z_5+	0,24	0,41	0,17		0,41	0,73	0,3		0,23	0,47	0,15	
Years of study: member of family	Z_6+	1,98	2,12	1,93		1,92	2,33	1,78		2,05	2,73	1,83	
Sex: M(1)/F(O)	Z_7	0,51	0,24	0,61	**	0,46	0,4	0,48		0,48	0,27	0,54	
Age: Farmer	Z_8+	53,1	55,1	52,4		52,77	53,47	52,54		51,41	51,53	51,37	
Years worked elsewhere	Z_9+	13	8,5	14,7		11,3	6,47	12,87		12,87	9,67	13,91	
Years of study: Farmer	Z_{10}+	0,59	0,24	0,72		0,51	0,8	0,41		0,69	0,27	0,83	
Non-farming income (R)	Z_{11}+	503	398	541		480	411	502	**	490	417	513	
Transport costs: fertiliser (R)	Z_{12}	0,48	0,89	0,33	*	0,43	0,83	0,3		0,46	1,15	0,23	**
Transport costs: vegetable seed (R)	Z_{13}	0,15	0,27	0,11		0,11	0,29	0,05		0,15	0,32	0,09	*
Phosphate content (p.p.m.)	Z_{14}+	6,9	7,76	6,59		6,9	7,93	6,57		7,33	9,33	6,67	
Potassium content (p.p.m.)	Z_{15}+	98,94	110,18	94,78		97,16	6,57	94,39		104,79	124,07	98,5	

Remarks:

* Five percent level of significance
** One percent level of significance
+ Socio-economic variables which do not have significant values for all three innovations

TABLE 5 - Standardised coefficients of the discriminant variables

		Innovation type							
		Labour-saving		Land-saving		Combination step-by-step		Combination direct	
		Coefficient	Rank No.	Coefficient	Rank No.	Coefficient	Rank No.	Coefficient	Rank No.
Tillable land area per permanent member of the family (m²)	Z_1	0,90	1	0,69	1	0,85	1	0,84	1
Number of adult migrant labourers in family	Z_2			0,64	2	0,27	3	0,24	3
Number of cattle in possession of family	Z_3	0,46	2	0,40	3	0,28	2	0,29	2
Number of visits to an agricultural extension officer	Z_4	0,29	4	0,34	4	0,26	4	0,22	4
Number of visits by an agricultural extension officer	Z_5	0,33	3					0,16	5

The discriminating power of the discriminant functions is given in Table 6.

TABLE 6 - Criteria of the discrimination power of the discriminant function

	Innovation type			
	Labour-saving	Land-saving	Combi-nation-step-by-step	Combination direct
Characteristic value of function	0,67	0,42	0,84	0,86
Canonical correlation (%)	63	54	68	68
Percentage farmers in known groups correctly classified:				
- Accepters	66,7	72,2	72,2	66,7
- Non-accepters	88,2	78,4	90,0	90,0
- All farmers	82,6	76,8	85,3	83,8

The characteristic value is the origin from which a function (characteristic vector) is derived. With two groups only one vector is derived which reflects the maximum contribution to the total difference between the two groups. The larger the part of the total difference explained by the variables, the larger the characteristic value. The canonical correlation reflects the ratio between the function and the groups and expresses the power of the function to differentiate between the accepters and the non-accepters. The discriminatory powers of the functions compare well with the results of similar functions. Yapa and Mayfield's (1977) analysis showed a characteristic value of 0,31 and a canonical correlation of 49%. The function correctly classified 74% of all the farmers in known groups. A discriminant function used to classify farmers with a view to providing credit help correctly classified 71% of all cases (Errunza *et al.*, p. 235).

Furthermore, it was found that 93% of the farmers first started using land-saving technology before any type of labour-saving technology was used. The reason for this is the relative indivisibility and higher costs connected with the use of labour-saving types of technology, for example a tractor. It also shows that the availability of land was the limiting factor in times when the opportunity cost of the time devoted to agricultural production in terms of migrant labour income were not yet so high.

CONCLUSIONS AND APPLICATION OF FINDINGS

The formulation of a policy based on the identified obstacles rests on the assumption that the selected socio-economic variables influenced the technology variables, and not vice versa. This assumption appears to be valid, because the comprehensive innovation criteria were compounded from types of innovations about the application of which a decision must be taken annually. The level of utilisation of these innovations should therefore reflect the effect of the obstacles when decisions were being made concerning the use of innovations.

Variables Z_4 and Z_5 should not be used in formulating a policy for use in agricultural extension. The reason for this is that the value of the variables was largely settled after decisions about the use of the technology variables had already been taken. However, they can be used in classifying cases of unknown origin.

Variables Z_1, Z_2 and Z_3 represent deeper seated phenomena which adversely affect modernisation of Black subsistence agriculture. The variables Z_1 (land area per person) can be taken as an indicator of the influence of pressure of population in the area. The number of cattle in possession of a family (Z_3) is the second most important variable identified and represents the importance of wealth in accepting technology. Cattle serve as the most important asset and reflect a farmer's financial strength (Crotty, 1980, p. 119).

The number of migrant labourers in a family (Z_2) represents the importance of education and training because it has a direct influence on the earning potential of migrant labourers in the labour market. Furthermore, Z_2 indicated a significant positive correlation with the number of years of study by any member of the family except the farmer.

The identified obstacles are in fact closely integrated. The obvious solution to the problem of an excessive pressure of population appears to be urbanisation. The Amaci area shows a pressure of population of 156 persons per square mile whereas it is estimated that 60 persons per square mile can be satisfactorily supported by subsistence agriculture (Simkins, 1983, p. 92). The "urban pull" should be strengthened by the creation of employment opportunities in the industrial and informal sectors and suitable amendments to restrictive measures in respect of the informal sector are necessary. Urbanisation should make the enlargement of farming units possible, provided persons who become urbanised give up their rural land use rights in exchange for security in urban areas. Housing and pension schemes provided by the State and also the private sector should contribute to solving the problem.

The "rural push" should be assisted by increased education and training. The earning power of persons in the rural area should be increased in this way.

The enlargement of farming units will also promote the average size of herds and so reduce a further limiting factor in acceptance. The provision of credit facilities and alternative investment possibilities (such as savings societies) are also suggested. The derived discriminant function can also be used for the future classification of farmers, for example in the screening of applicants for credit by credit institutions that require an acceptable return on loans. The State's extension service can also use this speedy, cheap method of classification, for example to identify and group accepters and non-accepters with a view to differentiated development aid.

A farmer can be classified by substituting his values for the socio-economic variables expressed in the discriminant function and calculating his discriminant value. The non-standardised form of the discriminant function is used in such a case to avoid problems connected with the standardising of data. By adding a constant a discriminant value identical with that of the standardised function will be obtained. Farmers with discriminant values larger than the mid-point between the group averages can be regarded as accepters and negative values indicate non-accepters. Where the opportunity cost of faulty classification is high, for example in granting credit, a cut-off point with a higher positive value can be chosen.

BIBLIOGRAPHY

CROTTY, R., 1980. *Cattle, Economics and Development.* Slough: Commonwealth Agricultural Bureaux

EISENBEIS, A.R., 1977. Pitfalls in the Application of Discriminant Analysis in Business, Finance and Economics. *Journal of Finance*, vol. 32, no. 3, pp. 875-900

ERRUNZA, V.H., CALANTONE, R.J., RENFORTH, R.W. & STRACHAN, H.W., 1981. Rural Credit: A Micro Synthesis of the Salvadorean Experience. *Journal of Development Economics*, vol. 8, pp. 227-239

FEDER, G., JUST, R. & SILBERMAN, D., 1981. *Adoption of Agricultural Innovations in Developing Countries: A Survey.* Staff Working Paper No. 444. The World Bank, Washington D.C.

GENSTAT, 1977. *A General Statistical Program.* Statistics Department, Rothamsted Experimental Station, Hapenden, Hertfordshire

HOPE, K., 1968. *Methods of Multivariate Analysis.* London: University of London Press Ltd

KENDALL, M.G., 1957. *A Course in Multivariate Analysis.* London: Charles Griffin and Company Ltd

KLECKA, W.R., 1975. *Statistical Package for the Social Sciences SPSS.* New York: McGraw-Hill Book Company, 2nd edition

NIE, N.H., HADLAI HULL, C., JENKINS, J.G., STEINBRENNER, K. & BENT, D.H., 1975. *Statistical Package for the Social Sciences SPSS.* New York: McGraw-Hill Book Company, 2nd edition

NIEUWOUDT, W.L., 1977. Interrelationships amongst efficiency measures: A Note. *Journal of Agricultural Economics*, vol. 28, no. 1, pp. 77-81

SIMKINS, C., 1983. *Urban Rural Interaction in South Africa.* Editor P.H. Spies. Stellenbosch: Unit for future studies, University of Stellenbosch

YAPA, L.S. & MAYFIELD, R.C., 1978. Non-adoption of Innovations: Evidence from Discriminant Analysis. *Economic Geography*, Vol. 54, No. 2, pp. 145-156