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Full Length Research Paper

Effect of social dynamics on technology adoption in urban, sub-urban and rural farming communities in the Limpopo Province of South Africa

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This study looked at the measurement of social dynamics, differentiating between the main types of social dynamics and employed factor analysis to aggregate indicators of social dynamics into bonding, bridging, and linking social dynamics. Using discriminant analysis, the role of these types of dynamics on technology adoption was analyzed. The study found that all three types of social dynamics, bonding, bridging and linking affect technology adoption to some extent but bridging which includes trust shared norms and ownership of assets was the most predominant across the three areas: urban, sub-urban and rural. The study recommends more research investments in understanding the bridging outcome of social dynamics on adoption of technologies for further guide to agricultural interventions.

Key words: Agricultural technology, social dynamics, discriminant analysis.

INTRODUCTION

An integral part of sustained poverty reduction efforts is the use of improved high yielding variety seeds and sustainable use of natural resources (Kabubo-Mariara et al., 2007). At the farmer level, although there are many factors that influence adoption and use of these technologies, studies have shown that rural communities that are characterized by strong social dynamics have faster rates of technology diffusion and improved environmental management (Claridge, 2007; Woolcock and Sweetser, 2007). According to Woolcosk and Sweetser (2007), social dynamics influence the use of technologies differently; for example, technologies that are knowledge intensive may require different forms of social dynamics than those that are labour or input intensive. Studies on the links between social dynamics and agricultural technologies have, however, not differentiated the different forms of social dynamics and how these influence the adoption and utilization of different technologies.

This study looks at the empirical measurement of social dynamics, using this to differentiate the different forms of social dynamics, and analyzes how these different forms influence the adoption of recommended technologies. The study postulates that different types of social dynamics facilitate networking among households, which results in accumulation of knowledge and in technology adoption. This study contributes to the current debates in social dynamics by providing an empirical, quantitative method for the measurement of the different forms of social dynamics and the relationships that these have with the use of improved technologies by smallholder farmers.

Objectives

(i) Assess differences in social dynamic variables among adopters and non-adopter households using the test of equality between group means.
(ii) Employ exploratory factor analysis to determine if more than one factor (or construct) best represents the social dynamic characteristic items using factor analysis.
(iii) Determine the social dynamic characteristics associated with adopters or non-adopters of technology using discriminate analysis.

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Table 1. Group means of variables employed in the analysis.

Variable	Technology adoption		All	P-value
	Yes	No		
Extent of trust among farmers	1.872 (0.336)	1.282 (0.451)	1.549 (0.498)	0.000
Household farm labour	1.263 (1.247)	1.046 (0.987)	1.44 (1.116)	0.055
Dwelling to support and resources (ha)	1.816 (0.902)	1.648 (0.833)	1.724 (0.868)	0.056
Network with financial institutions for credit	1.542 (0.500)	1.431 (0.496)	1.481 (0.500)	0.027
Membership of formal and informal clubs	1.385 (0.488)	1.755 (0.431)	1.587 (0.493)	0.000
Transport for easy network	1.385 (0.488)	1.755 (0.431)	1.587 (0.493)	0.000
Shared norms among farmer groups	1.536 (0.500)	1.421 (0.495)	1.473 (0.500)	0.023
Membership of Farmers' Association	1.553 (0.499)	1.449 (0.499)	1.496 (0.501)	0.040
Membership of Church group	1.547 (0.499)	1.440 (0.498)	1.489 (0.501)	0.033
Membership of traditional structures	1.531 (0.500)	1.431 (0.496)	1.476 (0.500)	0.047
Membership of localised structures	1.380 (0.487)	1.741 (0.439)	1.577 (0.495)	0.000
Total household income (Rand) per year	1 112.377 (1 073.271)	913.618 (789.304)	1 003.689 (932.836)	0.035
Number of cases (n)	179	216	395	

Standard deviations in brackets.

METHODOLOGY

Study area and data collection

The study was carried out in the Limpopo province of South Africa, which comprises six districts, Capricorn, Vhembe, Mopani, Bohlabela, Sekhukhune and Waterberg. A four-stage cluster sampling technique was used to select a total of 395 farming households from Urban, Sub-urban, and Rural areas. In the first stage of clustering, Capricorn district was selected based on the criteria that it shares geographical boundaries with all the five districts, same Sepedi language and form the central area of the province.

In the second stage, three municipalities were purposefully selected from the Capricorn district. These were selected from urban (Polokwane), sub-urban (Molemole) and rural (Lepelle). The districts were selected purposefully based on the fact that several research and social dynamics institutions are working in those districts to promote different types of technology adoption. In the third stage, a sample of eight farming communities or locations in the local municipalities were purposefully selected from target areas working within the Agricultural Research Council funded maize technology adoption projects implemented by the Department of Agriculture and Nature Conservation. The fourth stage involved random selection of 395 farming households from within the selected eight farming households. A semi-structured questionnaire was used to collect information on key variables of social and human dynamics. For social dynamics variables, respondents were asked a set of questions relating to households relationships with others in and outside their communities (Table 1).

The survey ran concurrently across the selected areas during the month of October 2008. The month of October was adopted based on experience from October household Surveys that are undertaken by the Statistics South Africa (SSA) annually. According to SSA (2006) during this period, the population tends to be stable in terms of mobility.

Discriminant analysis

Technology adoption status of household heads was given the value of 1 or 0 otherwise if household head used one or two of the following recommended technologies: use of fertilizer alongside with high yielding variety maize seeds, irrigation, measures to control soil erosion (e.g. contour ploughing), measures to control land degradation (e.g. decrease in stock numbers).

Household heads were categorized into adopters and non-adopters of technology status using the above description. Social dynamic variables associated with adopters and non-adopters were isolated using discriminant analysis. This technique weights and combines discriminating variables measuring characteristics on which groups of cases are expected to differ in a linear function that maximizes differences between the groups (Morrison, 1967). The linear discriminant equation is similar to the multiple regression equation (Morrison, 1967).

The discriminant model employed can be specified simply as:

$$D_i = b_{i1} X_1 + b_{i2}X_2 + b_{i3}X_3 + \ldots, b_{in}X_n$$

Where:

D_i = the ith score on the discriminant function;
b_i = coefficients estimated from the data;
X_i = values of the independent variables.

The dependent variable was ' technology adoption', a dichotomous variable which indicated whether households reported using two or more of recommended farm management systems to improve maize production: high yielding variety seed, irrigation, fertilizer application, early ploughing, or any other technology in the 2006-2007 farming season on their crops. The hypothesis was that social dynamic characteristics associated with technology adoption would predict whether or not a household was in one of the two groups. To develop taxonomy, variables were refined through factor analysis in order to identify the most important social dynamic patterns. A combination of minimum Eigen values criterion and screen tests were used to determine the number of factors.

Factor analysis

Factor analysis is used in this paper to identify concealed types of social dynamics that exist and that are manifested in features of social organizations. Factor analysis can concurrently manage large sets of variables with unknown interdependencies by using

Table 2. Factor structure of variables.

Variable	F1	F2	F3	Communalities
Extent of trust among farmers		0.977		0.955
Household farm labour				
Size of dwelling to support and resources (ha)			0.724	0.531
Network with financial institutions for credit			0.754	0.570
Membership of formal and informal clubs	0.990			0.982
Ownership of transport for easy network		0.984		0.969
Shared norms among farmer groups		0.984		0.969
Membership of Farmers' Association	0.969			0.939
Membership of church group	0.943			0.890
Membership of traditional structures	0.972			0.946
Membership of localised structures	0.980			0.961
Total household income (Rand) per year				
Statistics				
Eigen value	4.741	3.479	1.095	
% of variance	43.100	31.626	9.953	
Cumulative % variance accounted for	43.10	74.726	84.679	

Note: F1= Bonding; F2= Bridging; F3 = Linking; N=395.

correlations to group sets of variables (Rummel, 2007) where each group represents a single hidden factor.

The ultimate goal of factor analysis was to explain the covariance relationships among the variables in terms of some unobservable and non measurable random factors. Factor analysis is a means of describing groups of highly correlated variables by a single underlying construct, or factor that is responsible for the observed correlations. Then, once the groups of correlated variables are identified, interpretation and labelling of each factor is needed.

According to Brooks et al. (2008) consider an observable multivariable normally distributed random vector X with mean μ and covariance matrix Σ. Let X consists of p random variables. We want to create a factor model that expresses Xi as a linear combination of common factors F1, F2… Fm, and p additional terms ε1, ε2, …,εp called errors or specific factors.

The factor model can be specified as:

$$
\begin{aligned}
X1 &= \mu 1 + a11F1 + a12F2 + \ldots + a1mFm + \varepsilon 1 \\
X2 &= \mu 2 + a21F1 + a22F2 + \ldots + a2mFm + \varepsilon 2 \\
&. \qquad\qquad\qquad . \\
&. \qquad\qquad\qquad . \\
&. \qquad\qquad\qquad . \\
Xp &= \mu p + ap1F1 + ap2F2 + \ldots + apmFm + \varepsilon p
\end{aligned}
$$

The coefficient aij is called the loading of the j th factor on the ith variable, thus the matrix L is the pxm matrix of factor loadings. The measure of the total variance of xi explained by the m common factors can be expressed as $\sum_{j=1}^{m} a_{ij}^2$ called communality. Social dynamics variables in this study were analyzed using the factor analysis method with Varimax rotation. By default, only factors with Eigen values greater than one are retained in the analysis (Table 2) as this entails that the factor is accounting for a greater proportion of the variance than the original variable and hence it facilitates better interpretation. In addition, only variables with factor loadings greater than 0.7 were retained. Using factor score regression described above, a new data set representing each household sampled was generated and this was used to incorporate three social dynamic variables in the discriminant analysis model to analyze the relationship between the social dynamics factors existing and the use of improved agricultural technologies. Onyx and Mullen (2000) have similarly used factor analysis to group social dynamics variables.

RESULTS AND DISCUSSION

The means for all variables employed in the analytic models are presented in Table 1. The first objective of the study was to assess differences in social dynamic variables among adopters and non-adopter households. The means of the variables indicate statistical significant differences in all the variables at least at the 5% level of significance (Table 1). The figures appear to reflect the social dynamic realities of farming communities in the Limpopo province.

The second objective was to employ exploratory factor analysis to determine if more than one factor (or construct) best represents the social dynamic characteristic items described in Table 1. An orthogonal rotation (VARIMAX) of the initial principal component factor matrix yielded three factors. The results are presented in Table 2. All, except two original variables exhibited factor loadings >0.7 on at least one factor. According to Morrison (1967) these loadings may be considered conservative to give a meaningful interpretation. The three factors (F) were labelled, F1= Bonding; F2 = Bridging and F3 = Linking. The two additional items (household farm labour and total household income) that did not uniquely load on either factor but are theoretically important were also included in the analysis.

From the analysis of social dynamics variables used in the Factor Analysis, three underlying factors of social dynamics emerged (Table 2). The first factor yielded an Eigen value of 4.741 and accounted for 43.1% of variance in the data. This factor was termed "Bonding Social Dynamics." This is because different variables that facilitate creation of cohesion among people in a community have high positive loadings. This includes membership of formal and informal clubs (0.990), membership of farmers' association (0.969), membership of church group (0.943), membership of traditional structures (0.972) and membership of localised structures (0.980).

The extremely high positive loading on membership of formal and informal clubs, implies that participation in community activities is enabled by an environment where there is high cooperation between and among the people. These findings concur with studies by Bowles and Gintis (2002) that bonding social dynamics generally refers to willingness to live by norms and bylaws of one's community. Bonding social dynamics as seen from the factor loadings is a characteristic of within-group relations, the extent to which people within the same group or community cooperate with each other, participate in joint activities, and the extent to which they trust one another. Bowles and Gintis (2002) define bonding social dynamics as the connectedness that exists between individuals within local groups and communities or what they refer to as local connections. It is the links between people that have similar outlooks and objectives. These connections may take many forms, such as exchange of information, exchange of gifts and reciprocity, helping each other out and working collectively toward a common goal. Bonding social dynamics is linked to high levels of trust, reciprocity, and community action and was also expected to have a positive relationship with technology adoption.

The second factor of social dynamics that emerged with high positive loadings was associated with bridging social dynamics. This factor had an Eigen value of 3.479 and accounted for 31.626% variation in the data. Variables loading onto this factor include trust among farmers (0.977), ownership of transport for easy network (0.984) and shared norms among farmer groups (0.984). All these variables have aspects of links or networking across groups and with outside organizations. The bridging social dynamics implies links across groups, across communities, and with other organizations. This type of social dynamics was expected to have positive relationship with knowledge-intensive technologies that require sharing of information on their use, training, or visiting other farmers, research institutions, and other organizations where these technologies are developed or demonstrated. It is not surprising that all the variables had loaded highly on the same factor as empirical evidence has shown that one of the key roles of social dynamics service providers is to help farmers or community members empower themselves to form groups that are organized for development.

The third factor emerged with high positive loadings and was associated with linking social dynamics. This factor accounted for 9.953 of the variation in the data with an Eigen value of 1.095. Variables loading onto this factor include size of dwelling to support and resources available to farmers (0.724) and networking with financial institutions for credit (0.754) with an Eigen value of 1.095 and 9.953% of variance. The two variables have aspects of links or networking across groups and with outside organizations. The linking social dynamics implies links across groups, across communities, and with other organizations. This type of social dynamics was expected to have positive relationship with technologies that require the availability of support and resources, network with financial institutions for credit support and other organizations where these technologies are developed or demonstrated. The two variables loaded highly on the same factor. Empirical evidence has shown that one of the key roles of linking social dynamics is to help farmers empower themselves to form groups or cooperatives in order to obtain credit from financial institutions.

The third objective was to determine the social dynamic characteristics associated with adopters or non-adopters of technology of households that would predict whether or not a household was in one of the two groups. The relevant information is contained in the standardized canonical discriminant function coefficients for each of the three residence specific models (Table 3). The model statistics indicate more than 70% classification in each farming community, suggesting that the model used was appropriate. The findings demonstrate that firstly, there are net differences in the impact of social dynamics services and household farm labour programs on technology adoption status on farming communities. Secondly, the relative advantage or disadvantage of rural, urban, or sub-urban areas is not constant across all measures of the impact of social dynamics services and household farm labour programs on adopters and non-adopters of technology. This implies that it is inappropriate to speak generally about the low adoption of agricultural technology in rural farming communities or the high technology adoption of agricultural programs in urban or sub-urban farming communities. Indeed, the results suggest that future studies of the social dynamics of adopters and non-adopters of technology by households should be developed using cause/residence specific models. By doing so, it may be possible to build inductively, an understanding of the general types of social dynamics to which different residence sectors of the community are particularly prone (Adam and Roncevic, 2003).

Table 3 shows that the relative explanatory ability of the models is largely consistent with theoretical expectations with the pooled data. All independent variables exhibit

Table 3. Standardized canonical discriminant function coefficients (Dependent variable = Technology adoption status).

	Polokwane (Urban)	Molemole (Sub-urban)	Lepelle (Rural)	All
Household farm labour	1.044***	0.889***	1.078	0.975***
Total household income	0.240***	-0.143	-0.135	0.062**
Bonding social dynamics (PC1)	0.078**	0.030	-1.519	0.128**
Bridging social dynamics (PC2)	0.201***	-0.210***	0.932***	0.017***
Linking social dynamics (PC3)	0.246***	0.109	-0.335	0.187***
Number of cases (n)	134	154	107(1)	395(1)
Statistics				
Eigen value	0.965	0.343	0.297	0.562
Canonical correlation	0.701	0.506	0.478	0.600
Wilks Lambda	0.509	0.744	0.771	0.640
Chi-square	87.496	44.133	26.632	174.232
df	5	5	5	5
P-value	0.000	0.000	0.000	0.000
% grouped cases correctly classified	82.8	74.0	72.0	78.7

Missing cases in brackets; Test of equality of group means: ***P < 0.01; **P < 0.05; *P < 0.10.

significant discriminating powers on household technology adoption status in the pooled sample analysis. However, with regard to individual farming community-location specifics, differences emerge. All independent variables in the pooled sample analysis were significant at the 1% or 5% levels. The implication is that social dynamic variables, bonding, bridging and linking all contribute to the separation of technology adoption into adopters and non-adopters. In urban areas, all the three elements of social dynamics elements are the most significant factors, while in sub-urban and rural areas only the bridging social dynamic variable is significant. The implication is that bridging social dynamics variable is significant in all selected farming communities that is, urban, sub-urban and rural.

CONCLUSIONS AND RECOMMENDATIONS

The use of various technologies depends on socioeconomic variables and the existence of different dimensions of social dynamics. Social dynamics is especially important in determining whether households have access to, and therefore use, different technologies. Although different studies have looked at social dynamics in terms of membership in groups, this study shows the need to differentiate different kinds of social dynamics as they influence technology adoption differently. There is, therefore, a need to develop multiple indicators for measuring the different forms of social dynamics and how these forms influence research and development outcomes. Bonding, bridging, and linking social dynamics all influence technology adoption, a trend that might be observed for other studies in technology adoption. The study recommends investments, especially by development organizations, in strengthening these different forms of social dynamics by supporting local kinship or community groups that generate social dynamics, promoting farmer access and links with external organizations that can act as sources of information and technologies for farmers, as well as links with other farmer associations and groupings from whom they can learn.

REFERENCES

Adam F, Roncevic B (2003). Social dynamics: recent debates and research trends. Soc. Sci. Inf. 42(2): 155-183.

Bowles S, Gintis H (2002). Social dynamics and community governance. Econ. J., 112(l): 419-436.

Brooks A, Shoecraft A, Franklin A (2008). Education by Nation: A Multivariate Statistical Analysis. Winston Salem State University, Winston Salem, NC 27110. USA.

Claridge T (2007). Social dynamics. [online] URL: www.gnudung.com.

Kabubo-Mariara J, Linderhof V, Kruseman G, Atieno R, Mwabu G (2007). Household welfare, investment in soil and water conservation, and tenure security: evidence from Kenya. Poverty Education and Environmental Management Working Paper No. 06-06. PREM, Amsterdam, The Netherlands. [online] URL: http://www.prem-online.org/index.php?p=publications&a=show&id=120.

Morrison DF (1967). Multivariate Statistical Methods. (Second Edition), MacGraw- Hill Book Company, NY,

Onyx J, Mullen P (2000). Measuring social dynamics in five communities. J. Appl. Behav. Sci., 36(1): 23-42.

Rummel RJ (2007). Understanding Factor Analysis. Extracted from R. J. Rummel. 1970. Applied factor analysis. Northwestern University Press, Evanston, Illinois, USA. [online] URL: http://www.hawaii.edu/powerkills/UFA.HTM.

Statistics South Africa (2006). Household Survey, Pretoria.

Woolcock M, Sweetser AT (2007). Social dynamics: the bonds that connect. Asian Development Bank (ADB), Manila, Philippines. [online] URL: www.adb.org.