The Comparative Role of Intervening Variables in Understanding Farmers' Adoption Behavior

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Abstract

The paper compares the influence of intervening variables and the characteristics of the farmer and the farm (independent variables) on the adoption behavior of farmers for recommended maize agronomic practices. The purpose was to indentify the most important determinants associated with behavior change. A total of 107 farmers out of a population of 214 were randomly selected from two adjoining districts of South Africa and Lesotho. Chi-square and correlations and regression analyses were used to determine the relationship between the independent (characteristics of the farmer and farm) and intervening variables.

Clear differences occur between the independent variables (which included age, gender, education, farm size and total area under maize cultivation) in regard to their influence on adoption behavior, but these influences also vary significantly between the practices. It was also found that an independent variable can have a big influence in the adoption of one of the recommended practices but not on the others. In general, their influence is limited, and together their total contribution in explaining the variance in adoption (R^2) varied between about 20 to 40 percent. The influence of the intervening variables, which are primarily need, perception and knowledge related, was much more consistent and much bigger, measured both as correlations and regressions. The total contribution (R^2) of intervening variables varied between 50 and over 70 percent, which clearly supports the research hypothesis, namely that their prediction and explanation value in terms of behavior is much bigger than that of independent personal and environmental factors.

Key Words: Adoption, Intervening variables, Behavior change, Decision-making, Innovations

Introduction

It is widely acknowledged that agricultural development depends to a great extent on how successful knowledge is generated and applied, and it is also probably universally recognized that behavioral change among farmers is one of the prerequisites of the agricultural modernization process (Leagans and Loomis, 1971). The extent and speed to which farmers adopt available innovations therefore impacts substantially on progress in productivity growth, however, it is a common phenomenon that, farmers like all other entrepreneurs do not adopt innovation simultaneously as they appear on the market (Dierdeen, Meijl, Wolters and Bijak, 2003). The non-adoption of innovations by farmers, according to Röling (1988), spurred a series of studies into the "resistance to change" phenomena by rural sociologists, social psychologists and anthropologists in the early 1950s and 1960s.

Until quite recently, behavioral changes with respect to the adoption or non-adoption of technologies were explained largely by the "dominant paradigm" of the diffusion process and the concept of adopter categories made famous by E. M. Rogers after the Ryan and Gross (1943) studies on the diffusion of hybrid corn studies (Röling, 1988) and by economic models until the emergence of Simons (1975) 'satisficing' concept (Burton, 2004). According to Röling (1988), although much of the dynamism in extension and the social consequences of extension can be understood on the basis of a sound understanding of the diffusion processes, most of the research in this area did not allow conclusions to be drawn about causality, and interpretations were left to the imagination of the researcher. Another problem with the diffusion research was that they drew ex-post conclusions but were unable to provide ex-ante suggestions for effective intervention strategies (Röling, 1988; Düvel, 1991).

The economic model, on the other hand, was based on the profit maximization notion, that farmers' decisions were influenced largely by economic goals. From the perspective of Burton (2004), the emergence of the "behavioral approach", to explain behavioral change, followed the realization that people do not necessarily indulge in economically optimal decision-making but are influenced by cultural, social and psychological factors. Since then a number of researchers have attributed farmers behavioral changes to factors such as goals, attitudes, values (e.g Gasson, 1973; Gillmor, 1986; Coughenour and Swanson, 1988; Beedell and Rehman, 2000; Burton, 2004). Katona (1975), however, argued that variables such as motives, attitudes, e.t.c., intervene between the environment and economic behavior and that it is important to incorporate psychological and subjective variables in any analysis in order to understand economic processes. The role of intervening variables in mediating economic behavior has been confirmed by studies carried out by Maital, Maital and Schwartz (1977) and Ekehammar (1978), among others.

The concept of intervening variables offering explanation to behavior is not entirely new. It was coined by E. C. Tolman in his study of purposive behavior. The intervening variables are inferred processes between the independent variable and the dependent variables. G Katona may be credited for introducing the concept into economic theory, studies conducted by G. H. Duvel are also, perhaps, path breaking in so far as farmers adoption behavior is concerned. Empirical research following on the Düvel's earlier works have confirmed the validity of intervening variables in farmers' decision making (e.g., Düvel 1975,1991, 1994, 1995, 1998; Düvel and Scholtz, 1986; Düvel and Botha, 1999; Habtermariam and Düvel 2003, 2004). These studies have focused and confirmed that, the intervening variables have far bigger prediction value on farmers' behavior.

This paper complements this work through a comparative analysis of the influence of the characteristics of the farmer and the farm (personal and environmental variables) and intervening variables to determine factors that are important to the adoption decision making process and also explores a new variable – subjective norm.

The Purpose

The objectives of the research were (a) to compare the influence of independent and intervening variables on the adoption of liming, fertilizer application, top-dressing and the use of improved seed in maize cultivation among farmers and; (b) to evaluate the relevance of subjective norm in adoption behavior found to be important in other fields of planned change (Ajzen and Fishbein, 1980).

Conceptual Framework

The conceptual framework or model assumes a chain of causality where the independent variables have an effect on the intervening variables which in turn affect the dependent variable. In the present case (Fig 1), personal and environmental variables are regarded as independent variables. Need tension, compatibility, awareness, efficiency perception, prominence and normative beliefs are considered as intervening variables. This categorization is based on a modified version of the Duvel (1991) model 'The relationship between behavior-determining and behavior dependent variables in agricultural development".

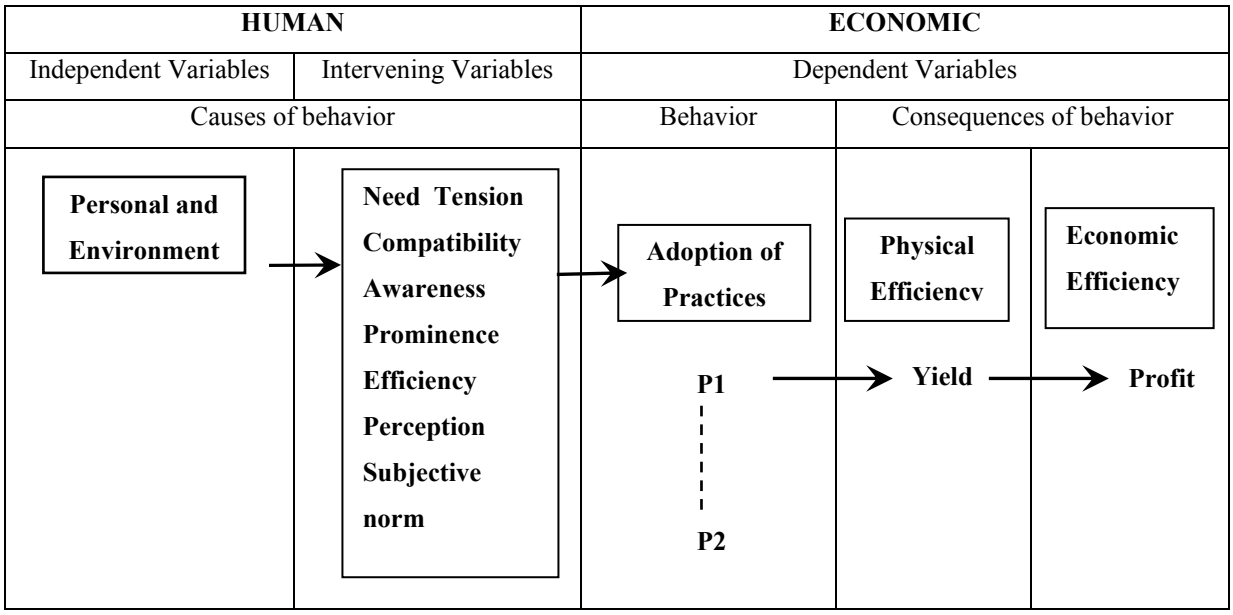

Figure 1. The Relationship between behavior-determining and behavior-dependent variables in agricultural development (after Düvel, 1991)

The intervening variables are psychological constructs and are denoted intervening since they are regarded as (i) mediating or transmitting the effects of the antecedent causal factors – the personal and environment to the variable behavioral outcomes, and (ii) having a causal effect on the behavioral outcome. This assumption is reflected in the arrows in Fig 1. The outcome variable is the behavior change. According to the model, the change is an effect of all the prior

causal factors – personal and environment and the intervening of which the latter is the immediate precursor to behavior.

Methodology

A total of 107 farmers out of a population of 214 were randomly selected in two adjoining districts of South Africa and Lesotho, and interviewed between July and September 2007, using a validated, pre-tested structured questionnaire. Chi-square, correlations and regressions were used to determine the relationship between the independent and dependent variables. The independent variables (characteristics of the farmer and farm) which are more personal and environmental in nature were, location of respondents, membership of farmers association, gender, age, educational attainment, experience in farming, occupation, time spent in farming, total land area and size of area under maize cultivation whilst the intervening variables were need and perception related. These are efficiency perception (PE), need tension (NT) need compatibility (NC) awareness (Aw) and prominence (Pr). Another variable include is subjective norm (Sn). Their measurements are described below.

Efficiency perception. Farmers were asked to estimate their own efficiency on scales developed for the various practices used in the study. The enumerator also rated the farmers on the basis of the extent to which farmers have adopted the practice in its entirety (adoption quotient.)

PE = A-B
Where
A = represents enumerators assessment
B = represents farmer's own assessment

Based on this calculation farmers were categorized into three groups as: 1- under rating representing positive numbers or respondents who rated themselves below their actual level of adoption practice; 2- no perception discrepancy representing respondents whose rating were the same as the enumerator; and 3 over-rated represented by negative numbers or respondents who rated themselves higher than their level of adoption practice

Need tension. Farmers were asked to indicate their present and aspired level (or goals) of practice adoption. It is expected that the higher the goal or level of aspiration above the current level, the higher the need tension. Farmers were then grouped into three categories namely: 1-low; 2-medium; and 3-high need tension.

Need compatibility. Need compatibility is a measure of whether the recommended solution fits into or is conducive to the need situation of an individual or contributes towards the attainment of his/her need. This variable was measured by requesting the respondents to estimate the level of production efficiency they would have attained if they had used (or not used) the recommended practice. The percentage change from the current production efficiency were then calculated using the formula below. Respondents were categorized into 1-low, 2-medium and 3-high need compatibility based on the results obtained.

NC=C –B/B*100

Where
NC=percentage change in production efficiency
B=Current production efficiency
C=Production efficiency respondents would have attained if they had (not) used the recommended practice

Awareness. Awareness refers to the farmer's knowledge of recommended practice in the area and it was measured by requesting respondents to state what the recommended practice implied.. This was scored on a nominal scale of 1-correct answer and 2-wrong answer

Prominence. This concept is synonymous with Rogers (1984) of relative advantage and refers to the degree that one practice is more or less advantageous or prominent than another (usually the recommended one). Respondents were asked to indicate what they regarded as the best practice relative to their own practices. They were then categorized into low, medium and high prominence

Subjective norm. Ajzen and Fishbein (1980) define subjective norm as a person's belief of how important others think a task should or should not be perform. It is the perception of social pressure to perform the behavior (Godin, Conner and Sheeran, 2005)

The scale for the measurement of the subjective norm in this study follows procedures outlined by Ajzen (1980, 2006) to identify (i) the salient referent; and (ii) motivation to comply. Subjective norm was measured by similar items suggested by Ajzen (2006) on a 7-point Likert-type scale that ranged from 1 (extremely likely) to 7 (extremely unlikely). These were (i) 'Most people who are important to me think I should apply do or apply' and; (ii) 'In general how much do you want to do what most people who are important to you think you should do.

Dependent Variable

Interventions in extension focus mainly on adoption behavior with respect to the recommended practices for optimizing sustainable outcomes in terms of physical (e.g yield) and economic (e.g profit) success. The study was based on the use of recommended practices for maize production, namely, liming, basal and top dressing and improved seed. The dependent variable therefore was whether the respondents adopt the recommended practice for these technologies.

Method of Analysis

The data collected were coded and analysed using the statistical package (SPSS). Descriptive statistics such as frequencies, percentages and means were done as a first step towards the determination of distribution of variables and to summarize large amounts of information. Chi-square analyses were used in combination with two dimensional contingency tables to establish significant differences between various categories or groups. This also allowed for the identification of relationship other than linear correlations. Bivariate correlation analyses were employed to assess the existence, magnitude (strength or degree) and kind (negative or positive) of relationship that exist between the independent and dependent variables. This was achieved by computing the correlation coefficients and significance or probability. Multiple

linear regression analyses were also used to investigate the effect of various independent variables (predictors) on the dependent (outcome) variable. The regression analysis was also an indicator of how well one or more of the independent variables predict the value of dependent variables and to asses the degree to which the various independent and intervening variables contribute towards the variance of the dependent variable.

Results and Conclusions

Relationship Between Characteristics of the Farmer and Farm (independent variables) and Adoption of Recommended Maize Agronomic Practices

Table 1 is a summary of the correlations showing the relationship between the independent variables and adoption of maize agronomic practices. The results show that size of the farm and area under maize cultivation are the only independent variables that consistently correlated significantly with adoption of recommended maize agronomic practices, use of improved seeds, lime and fertilizer applications. The association between the remaining variables seems to be more dependent on the type of recommended practice. For example location was found to be significantly associated with the adoption of fertilizer and top-dressing practices but not with lime and the use of improved seed.

Table 1
Correlations Between Independent Variables and Adoption of Recommended Maize Agronomic Practices

			Fertilize					
	Lime		r		Top-dressing		Seed	
Variable	R	p	R	p	r	P	r	p
Farm location	-0.210	0.139	-0.326	0.001	-0.375	0.002	-0.197	0.043
Farmers assoc	-0.289	0.040	-0.182	0.063	-0.056	0.572	-0.056	0.572
Gender	0.102	0.478	0.020	0.839	-0.177	0.070	-0.177	0.070
Age	-0.031	0.828	-0.086	0.378	0.071	0.471	0.071	0.471
Education	0.036	0.805	-0.156	0.110	-0.081	0.407	-0.081	0.407
Experience	-0.193	0.174	0.165	0.091	0.079	0.423	0.079	0.423
Occupation	-0.108	0.450	-0.207	0.034	-0.098	0.317	-0.098	0.317
Time Spent	-0.089	0.534	0.036	0.717	0.074	0.451	0.074	0.451
Farm size	0.245	0.083	0.302	0.002	0.278	0.004	0.278	0.004
Maize area	0.181	0.203	0.333	0.000	0.332	0.000	0.332	0.000

Membership of Farmers' associations was also found to be related to lime and fertilizer application at 5% and 10% levels of significance, respectively.

Relationship Between Intervening Variables and Adoption of Recommended Maize Agronomic Practices

Compared to the independent variables, five out of the nine intervening variables, namely: prominence, awareness, need compatibility, efficiency perception and need tension were consistently found to be highly significantly associated with the adoption of recommended maize agronomic practices at 5% level (Table 2).

Table 2
Correlations Between Intervening Variables and Adoption of Recommended Maize Agronomic Practices

	Lime		Fertilizer		Top-dressing		Seed	
Variable	*r*	*p*	*r*	*p*	*R*	*P*	*r*	*p*
Prominence	0.491	0.000	0.247	0.011	0.317	0.010	0.268	0.006
Awareness			0.628	0.000	0.421	0.000	0.382	0.000
Need Compatibility	0.598	0.000	0.453	0.000	0.567	0.000	0.236	0.015
Efficiency								
Perception	0.435	0.001	0.506	0.000	0.257	0.039	0.460	0.000
Need Tension	0.791	0.000	0.781	0.000	0.754	0.000	0.607	0.000
Close Friends	-0.011	0.939	0.086	0.383	0.063	0.618	0.159	0.106
Members of assoc	0.152	0.288	-0.227	0.020	-0.073	0.564	-0.082	0.403
Most people	0.290	0.039	0.150	0.125	0.196	0.117	0.158	0.107
Extension	-0.265	0.060	-0.140	0.153	0.207	0.099	-0.126	0.199

This is an indication that at least some of them stand in close causal relationship with behavior. This applies in particular to needs tension with r-values of 0.791 for lime, 0.781 for fertilizer, 0.754 for top dressing and 0.607 for the use of improved seeds.

Total Influence of Characteristics of the Farmer and Farm on Adoption of Recommended Maize Agronomic Practices

Tables 3 represents the findings of regression analyses to determine the total influence of the independent variables. It shows the limited contribution of the independent variables on the adoption of recommended or maize agronomic practices.

Table 3
Regression Analysis of the Influence of Independent Variables on the Adoption of Recommended Maize Agronomic Practices

Variable	Lime			Fertilizer			Top Dressing			Seeds		
	β	*t*	*p*	*β*	*t*	*p*	*β*	*t*	*p*	*β*	*t*	*p*
Constant		1.593	0.119		2.752	0.007		3.217	0.002		2.566	0.012
Farm Location	-0.136	0.585	0.562	-0.173	-0.798	0.427	-0.261	-1.084	0.283	-0.147	-0.691	0.491
Farmers Assoc	-0.245	-1.382	0.175	0.048	0.401	0.690	0.013	0.099	0.921	0.066	0.570	0.570
Gender	0.263	1.622	0.113	0.136	1.287	0.201	0.077	0.645	0.522	0.141	1.354	0.179
Age	0.128	0.766	0.448	-0.073	-0.712	0.478	-0.462	-3.871	0.000	-0.097	-0.951	0.344
Education	-0.052	-0.300	0.765	-0.112	-1.068	0.288	0.121	0.935	0.354	-0.120	-1.157	0.250
Experience	-0.305	-1.894	0.065	0.136	1.401	0.164	0.025	0.205	0.838	0.152	1.586	0.116
Occupation	0.233	0.958	0.344	0.086	0.477	0.634	-0.050	-0.248	0.805	0.075	0.416	0.678
Time Spent	-0.204	-0.858	0.396	-0.068	-0.436	0.664	0.026	0.138	0.891	-0.070	-0.455	0.650
Farm Size	0.185	0.626	0.535	0.108	0.470	0.639	0.015	0.065	0.948	0.138	0.610	0.543
Maize Area	0.047	0.167	0.868	0.191	1.029	0.306	0.081	0.398	0.692	0.195	1.060	0.292
	R^2=0.173; p0.325			R^2=0.173; p0.044			R^2=0.399; p0.001			R^2=0.191; p0.020		

The results indicate except for top- dressing where the characteristics of the the farmer and farm contribute about 40% to the explanation to total variation, the rest all fall below 20 %. This is an indication that factors other than the selected independent variables could account for the adoption behavior of the respondents.

Total Influence of Intervening Variables on the Adoption of Recommended Maize Agronomic Practices

The intervening variables, on the other hand, showed a high degree in explaining variation in the adoption behavior in all the production practices studied (Table 4). The power of explanation ranged from 51.7% in the case of adoption of improved seed practices to 77.7% for the use of lime.

Table 4
Regression Analysis of the Influence of Intervening Variables on the Adoption of Recommended Maize Agronomic Practices

Variable	Lime			Fertilizer			Top Dressing			Seeds		
	β	*t*	*p*	*β*	*T*	*p*	*β*	*t*	*p*	*β*	*t*	*p*
Constant		-2.430	0.020		3.600	0.001		-1.211	0.231		0.309	0.758
Prominence	0.478	4.562	0.000	0.012	0.214	0.831	0.129	1.715	0.092	0.024	0.299	0.766
Awareness	-0.007	0.082	0.935	-0.332	-5.5280	0.000	0.167	2.130	0.038	0.133	1.622	0.108
Need Compatibility	0.234	2.552	0.015	0.143	2.414	0.018	0.184	2.108	0.040	0.051	0.642	0.522
Efficiency Perception	0.168	1.943	0.059	0.018	0.282	0.778	0.131	1.776	0.081	0.354	4.493	0.000
Need Tension	0.478	4.562	0.000	0.600	9.419	0.000	0.576	7.204	0.000	0.495	5.071	0.000
Close Friend	-0.038	-0.366	0.716	-0.045	-0.613	0.541	0.005	0.051	0.960	0.001	0.006	0.995
Members of Assoc	0.175	1.767	0.085	-0.025	0.317	0.752	-0.161	-1.902	0.062	0.005	0.064	0.949
Most People	0.070	0.743	0.462	0.111	1.506	0.135	0.090	0.931	0.356	-0.049	-0.484	0.630
Extension Agent	-0.031	0.376	0.709	-0.013	-0.162	0.872	0.139	1.891	0.064			
	R^2=0.777; p=0.000			R^2=0.744; p=0.000			R^2=0.743; p=0.000			R^2= 0.517 p = 0.000		

The results provide strong evidence in support of the contention that, the intervening variables are the likely precursors of decision making through which the influence of independent variables become manifested in behavior.

Educational Importance and Implications

The results open the way for the search for more intervening variables with the potential to extend the epistemology of extension science. The intervening variables offer a more practical meaning for the analysis of extension interventions, as they are factors that can be influenced to bring about behavior change compared to the independent variables. The results also show that need, perception and knowledge related variables are more important in influencing decisions on adoption than social factors exerted by the subjective norm.

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