User Acceptance Of Ipm Approaches: A Case Of Vegetable Farmers In Albert Luthuli,South Africa

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Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 10 May 2021

ABSTRACT

The integrated pest management is a robust model in response to the effects of the use of pesticides. The intention to adopt the integrated pest management approaches as farm management practice amongst vegetable farmers was the primary objective of this study. The study used principal component analyses to simplify the statements elicited from 600 farmers using the theory of planned behaviour which includes attitude, subjective norms and perceived behavioural control. The study applied the modified theory of planned behaviour approach to illustrate factors influencing farmers' extant intentions to adopt integrated pest management. The ordinal regression model-polytomous universal model was used for analysis. The findings indicated that there are heterogeneity of factors influencing the intention to use integrated pest management in farming practice. However, government policy response does not constitute an important driver of intention to use integrated pest management. The study concluded that the intention to adopt integrated pest management practices is governed by both psychological and social milieus. Furthermore, the potentials of farmers and diversity of available resources must be accentuated in agricultural policy planning to raise the intention to adopt integrated pest management.

Keywords: Approaches, Integrated pest management, Theory, Planned behaviour, Intention, Adoption, Agriculture, Ordinal, Assessment, Resources

INTRODUCTION

The primary aim of agriculture in Sub-Saharan Africa is to produce enough food for the teeming population, generate income and alleviate poverty. In the past 5 decades, Sub-Saharan Africa has witnessed substantial development in agricultural practice -crops and animal breeding, weed control, soil and water conservation and farm intensification (Makundi, 2006). However, despite this seeming developmental discourse, challenges pose by pest and diseases remain rife and discouraging. Pest and diseases accounts for losses of about 36% of the possible yield, and in storage, another 14% are lost (FAO 1973). The problems created by other invasive species on animals and crops, humans and environment have justified the need for awareness about conserving the natural fauna and flora which are symbiotic for human existence. The movement of plants and animal around the world has been encouraged owing to the removal of trade restrictions, therefore, global level management of sanitary and phytosanitary measures (SPS), initiated through World Trade Organization (WTO-SPS) and operated via International Plant Protection Convention (IPPC), Office International des epizooties (OIE), and Codex Alimentarius Committee (CAC) have been put in place (Meyer, 2003). Crop protection in Sub-Saharan African is mainly dependent on the use of pesticides and other chemicals because it is considered by farmers as most effective and faster ways of reducing pest population on the field. However, the indiscriminate use and application of pesticides have caused numerous problems ranging from ecosystem disturbance, resurgence of known pest, pollution of environment, labour cost to resistance in pest to pesticides. These challenges lead to a new way of thinking with respect to pest control. Therefore, the term integrated pest management (IPM) approach encompasses effective practices and principles that provides efficient, cost-effective way of pest management evolved (Ehler, 2006).

The concept of IPM

Pests generally has been a nuisance to crops, human and animals. Therefore, humans have made concerted effort for the control of pest within and outside the environment of habitation. The reliance on pesticides as the only method of control have given rise to the development of insect resistance, and negative impacts on human health and pollution of the environment. The integrated pest management (IPM) as a robust model,originated over 60 years ago in response to the effects of the use of pesticides. The tactical response employed in IMP include the biological, mechanical or physical, cultural, and chemical methods (El-Shafie,2019). The biological IPM method of control is the action of predators, pathogens on a host population or organism to allow a lower balance position, thanwould prevail in the absence of these agents (Stephen, 2009).The biological control also involves introducing natural enemies of a pest in an environment to prey on the pest. While the mechanical or physical IPM method include heat and sterilization of soil, and the use of screen barriers, fences, light traps and nets (Hill, 2008). Furthermore, the cultural IMP technique, involves the cultivation of resistant varieties of crops, the variation of planting and harvesting period, crop rotation and trap crops. In addition, cultural practices do not only inhibit pest development in the environment but assist in the prevention and build-up of pest population (Hill, 2008). Cultivation practices can also assist in the destruction of pest through the exposure to the heat of the sun and predators in the environment. The picking and cleaning of crop remains after harvest commonly referred to as phytosanitation may also help in destroying the eggs and larvae of pest (Faleiro2006, Nagoshi, et.al 2017). The push-pull cultural method which involves deterring pest away from a plant (push) through allomones which serves as deterrent and at the same time gets attracted (pull) by kairomones to trap crops where they can be conveniently removed or destroyed (Cook et.al, 2007). The sterilization of insect is another biological advanced technique that is environmentally justified for IMP. The chemical IPM control method involves the use of chemical only when it very necessary to bring pest population below a level that it cannot cause economic loss. The regulatory method of IPM entails the use of quarantine and other restrictions to avoid insect pest within the population.

In sum, IPM system approaches incorporate biological, physical, and other operational issues to meet phytosanitary requirements. These system approaches and proceduresincludes endorsement of pest free zones; pest free areas for production; quarantine areas and treatments; programmes such as cultural, mechanical, physical, biological and chemical to control pest; packing-house procedures involving the washing and inspection of fruits. Others include inspection of consignment and certification by phytosanitary officials; consignment subjected to sampling inspection and tracing of inputs (fruits) to places of origin, packing facilities and orchard. However, the EU framework of 2009, recognised the following principles for IPM as follows: prevention and suppression; monitoring; decision-making; nonchemical methods; pesticide selection; reduced pesticide use; anti-resistance strategies; and evaluation(Bajwa & Kogan 2002, Carson,1962).

Interestingly, acceptance of IPM approaches in relation to the control of pest by vegetable farmers and the assessment of adoption, justifies the imperative of this study. The study attempts to use the theory of planned behaviour (TPB) as the theoretical framework to illustrate user acceptance of IPM approaches with respect to vegetable farmers inAlbert Luthuli, South Africa.

Conceptual Framework of the Study

The conceptual framework of the study emanated from the theory of planned behaviour (TPB) as propounded by Ajzen, (1991). The theory illustrated that intention predicts human behaviour, and also dependent on the belief held by a person towards a specific behaviour. TPB is however, centred on three dimensional constructs namely:attitude, subjective norm, and perceived behavioural control. The attitude dimension encompasses the extent to which an individual agrees to or disagree with a particular behaviour. Subjective norm entails the social pressure exerted by peers to perform a specific behaviour while the perceived behaviour embodies perception of the ease of adopting a new innovation. TPB framework is appropriate and organised, butallows for flexibility which translates into adoption decision in agriculture (Kelly and Kelley, 2013; Borges, et.al, 2014; Lalani et al., 2016). Thus, the flexibility of TPB permits the addition of known variables if the extrapolativeinfluence of the model is improved by such addition (Ajzen, 1991). TPB, left substantial percentage of emptiness with no clarification of the detail meaning of intention and behaviour (López-

Mosquera, et al., 2014), and consequently, the authors of this paper therefore, extended the model by the addition of some variables.

The amalgamated variables were firstly, the "perceived resources"-the degree to which the user of information or innovation has access to the resources to his benefit and aid in the adoption of IPM (Zeweld et al. 2017). Farmers needs resources (finance, labour, skills, technical infrastructures, etcetera) to initiate change and adopt IPM. In their study Beegle et.al, (2000) found that procurement of resources was necessary for the adoption of soil testing and subsequent use of fertilizer. Preceding studies (Monaghan et al., 2007), found that resources were amongst the limiting factor in the adoption of nutrient management plan (NMP), so the study used this model and encapsulated perceived resources.

Secondly, the socio-economic characteristics which include age of farmer, farm size, level of education, contact with extension services and policies enacted by government are also recognised as impacting on farmers' intention to adopt IPM. Studies by (Agholor 2020; Forouzanfaret al., 2015; Borges and Lansink, 2015) found that some socio-economic variables are associated with adoption behaviour of farmers. Moreover, farmers contact with extension services have also been found to influence the adoption behaviour of farmers. In a study by Agholor (2018) farmers who had access to information services, were interested to continue farming in Shiloh irrigation scheme. This study included policy issues as a variable that may influence intention to adopt the use of IPM by farmers in the area. It is hypothesized in this study that user acceptance to adopt IMP will be dependent on adherence to policy framework. The study of Daxini, et.al (2019),posited that farmers who were not adhering to the nutrient management policy were more inclined to the adoption of water quality measures put in place. Therefore, the study attempt to incorporate socio-economic factors, contact with extension services and policy environment as independent variables in the model (Figure 1).

Conceptual Framework of the Study

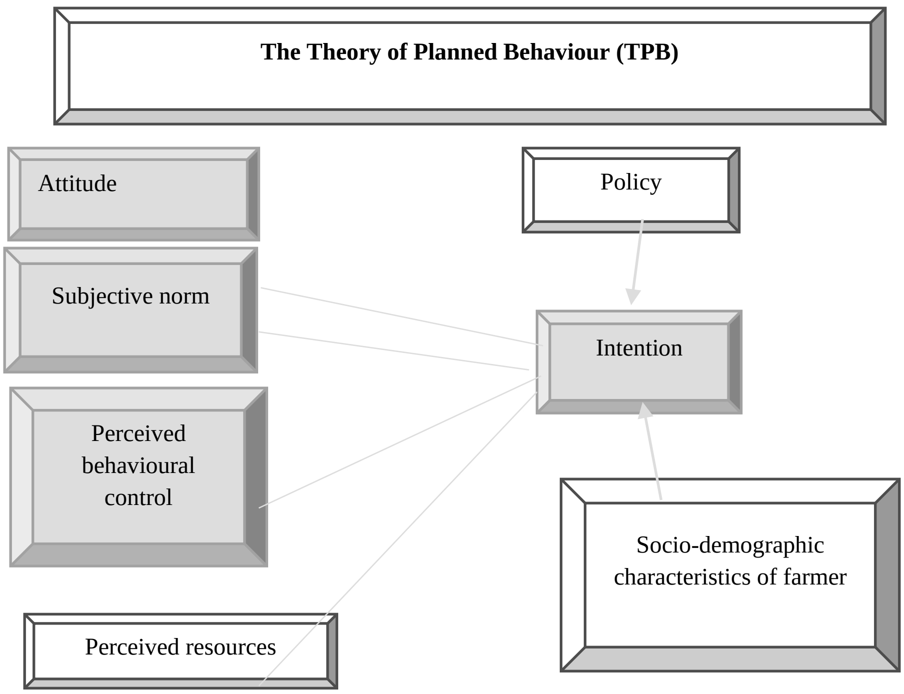

Figure 1. Conceptual framework based on the theory of planned behaviour used for the purpose of this study

METHOD

Study Sample

The sample used for the study comprised of a total of 600 farmers in Albert Luthuli Local Municipality, who were either smallholders, subsistence and commercial farmers in vegetable production in the area.

Instrument used for the study

The data employed to elicit information from respondents were derived from a structured and semi-structured questionnaire survey of 600 farmers. The questionnaire was categorised into two sections. The first section centred on socio-economic demographic involving age, level of formal education, farm training, farm size, farm experience and contact with agricultural extension advisors. In the second section, were list of statements prepared and respondents were requested to give their informed opinion on a 5-point Likert scale (Strongly agree = 5; Agree = 4; Undecided = 3; Disagree = 2; Strongly disagree = 1) to indicate farmers' belief and intentions towards user acceptance of IMP. The 5-point Likert scale assumes recognition in previous studies (Gorton *et al*. 2008; Adnan *et al*., 2017). However, the list of statements given to the respondents were based on information obtained from the reconnaissance survey and were planned to capture the three dimensions of attitudes, subjective norms, and perceived behavioural control plus the variable perceived resources in line with TPB (Figure 1). Therefore, for the intentions to adopt IPM, respondents evaluated 9 statements with respect to personal belief, 4 statements for subjective norms, 4 statements for perceived behavioural control and 6 statement for perceived resources.

Procedure adopted

The study used principal component analyses to simplify the statements included in TPB components which includes attitude, subjective norms and perceived behavioural control. When responses are linked or identical, then they 'mean the same thing' and PCA recognises a reduced number of similar components that shows variations in responses (Jolliffe, 2002). Therefore, the statement used to obtain responses about attitude (personal belief) towards the use of IPM were reduced to 4. The loading of the statements was "IPM increase profit" and "IPM increases productivity" The subjective norm category relates to respondents' perception about social pressure or peer pressure to adopt the use of IMP. The statements that satisfied this variable include: "other farmers encourage me to do so" and "other farmers discourage me from doing so". The perceived behavioural category entailed statements indicating the extent of easiness at which a respondent can perform a pre-determined behaviour. For instance, statements like: 'I am sure I have the capability to use the right type of pesticides" and "it is within my control to do so". Finally, perception category relates to access to resources. It indicates the farmers' perception about whether he/she has sufficient resources, such as time and finance, to adopt or implement IPM in the farm practice in question. The categories from each PCA were taken as the explanatory variables in regression analysis used to examine the factors that influence user acceptance of IMP. The socio-demographic and background factors were the independent variables (farm size and system, farmer age, formal and agricultural education, contact with an agricultural advisor, participation in a discussion group and policy) while the independent variables used was the user intention to accept or reject IPM. Since the statements prepared to measure the variables were not only based on ordered 5-point Likert scale, but with more than two response category, then the ordered regression model was employed for data analysis.

The model

The study employed the ordinal regression model commonly referred to as Polytomous Universal Model (PLUM),similar to the generalized linear model. Ordinal model was deemed appropriate for this study, in that, it assists to determine whether a collection of independent variables, predicts the ordinal dependent variable (Koletsi, (2017). Ordinal regression predicts the extent of an outcome that is observed as: strongly agree,agree, undecided, disagree, and strongly disagree base on two or more independent variables (Agresti, and Kateri, 2017).

Consequently, the responses "strongly disagree", "disagree" and "undecided" were grouped into the category "I have no intention" and labelled as 0 and the responses "agree" and "strongly agree" were grouped into the category "I have intention" and labelled as 1. Since there are now only two stages of response, the following model is employed to explore the relationship between the hypothesized and additional variables on the probability that a farmer indicates a "yes" response (positive intention) to use IPM, which can be expressed as follows:

Regard Y_i as ordinal response with q categories as in Strongly agree = 5; Agree = 4; Undecided = 3; Disagree = 2; Strongly disagree = 1, for observation i .

Where i = 1….n, the ordered model (Fernandez, et.al 2019) for the likelihood that Y_i takes the category $K(K = 1 \ldots\ldots q)$ is characterised by the following log odds:

$$Log \; \frac{p\,(Y_i = K/\chi_i/)}{P\,(Y_i = K/\chi_i/)} = \alpha_k + \theta k \beta^1 x_i, \; i = 1, \ldots, n, \; k = 2, \ldots, q, \quad (1)$$

Where the addition of monotone non-decreasing constraints:

$$O = \theta_1 < \theta_2 < \ldots\ldots < \theta q = 1 \quad (2)$$

confirms that the response Y_i, is ordinal (*Fullerton, et.al, 2016*). And so, the vector χ_i
is a set of predictor variables (covariates) for observation i and can be categorical orcontinuous;However, the $P\times 1$ vector of parameters β represents the effects of $\chi_i$onthe log odds for the category K, relative to the baseline category of Y_i parameters. The model treats the first category as the baseline category, with $\{a_2 \ldots a_q\}$ as the intercepts, and $\{\O_1, \O_2 .., \O_q\}$ are the parameters which can be explained as the 'scores' for the categories of the response variable Yi. Then, restrict $^a{}_1 = \O_1 = 0$ and $\O_q = 1$ to ascertain identification. With this, the response likelihood probabilities are as follows:

$$\theta_{ik} = P\,(Y_i = K/\chi_i) = \frac{exp\,(^a{}_k + \theta_k\,\beta\chi_i)}{\Sigma_e^q = 1\; exp\,(\alpha_l + \theta_l\,\beta\chi_i)} \quad for\; K = 1, \ldots\ldots, q \quad (3)$$

The model was adopted for the study because it shows the level of an outcome than the logit model (Agresti, 2017).

RESULTS

The description of variables used in the study are presented in table 1. The descriptive demographic characteristics of farmers (n = 600) represents the sample used for the study. The average age of farmers as indicated in the table was 42.22 years (SD = 1.40) while level of formal education of was 94% (SD = 0.96). Result also show that farmers who received farm training were 21% (SD = 0.82) whereas, farmers as whole in the sample recorded 75% (SD = 1.22) farm experience. Furthermore, average farm size was 52% (SD = 0.55) while farmers who had contact with advisors were 85% (SD = 1.21). Finally, farmers who were aware of government policy in relation to IPM adoption were 68% (SD = 0.46).

Table 1. Demographic characteristics and variables used in the analysis

Independent (explanatory) variables	**Description**	**Mean**	**Std. deviation**
Attitude	Ordinal response variable based on 5-point Likert-	3.90	1.36

	scale		
Subjective norm	Ordinal response variable based on 5-point Likert-scale	2.33	1.22
Perceived behavioural control	Ordinal response variable based on 5-point Likert-scale	2.70	1.44
Perceived resources	Ordinal response variable based on 5-point Likert-scale	4.12	1.13
Age	Age of farmer in years (1= < 20yrs, 2 = 20-30yrs, 3 = 31-40yrs, 4 = 41- 50yrs, 5= 51-60yrs, 6= ≥ 61yrs	42.22	1.40
Level of formal education	Formal education obtained (1= No school, 2=Primary, 3=secondary, 4=tertiary)	1.94	0.96
Farm training	Informal agricultural training (I =Yes, 2 = No)	2.21	0.82
Farm experience	The number of years in farming (1 = < 5yrs, 2 = 5-10yrs, 3 = 11-15yrs , 4 = ≥ 16 yrs	2.75	1.22
Farm size	Size of farm measured in acres (1 = < 1acre, 2 = 1 – 5acres , 3 = 6-10 acres, 4 = 11-15 acres, 5 = ≥ 16 acres)	1.52	0.55
Agric Advisor	Contact with agriculture advisors (1 = yes, 2= No)	3.85	1.21
Government policy	Adherence to government rules & regulations(1=Yes, 2 = Otherwise)	1.68	0.46

The factors affecting vegetable farmers' intentions to accept IPM as farming practice

The ordinal regression model (Table 2) indicate Chi-Square of 451.365, Pearson 321.415, Deviance 249.115, -2 Log Likelihood 253.559 and Pseudo R-Square: Cox and Snell 0.571, Nagelkerke 0.773 and McFadden 0.631 which implies that the model has adequate explanatory power and a good fit.

In table 2, the result indicates that attitude, which is a component of TPB is significant with β= 2.582 and positively (*P-value = 0.001*) related to intention to accept IPM. The variable subjective norm shows a significant and positively relationship to the adoption of IPM with a *P-value= 0.003* and β= 5.707. The perceived behavioural control variable is significant (*P-value = 0.000*) with β= -6.793which imply that it is negatively related to the adoption of IPM. The perceived resources which is added variable showing perception of farmers on available finances to undertake IPM was also significant (0.002) but negatively related to the acceptance of IPM with β= -3.254. The age, level of formal education, farm training, farm experience was significant at *P-value*= 0.000 respectively. However, level of education (β=10.169), and farm experience (β=3.982) were positively related to acceptance of IPM while age was negative with β =0.-4.618. The farm size *(P-value =0.001)* and agricultural advisors *(P-value*= 0.005) also had positive influence in the use of IPM with β=5.060, and β=-1.898 respectively.

Table 2.Results of polytomous universal model used for determining farmers' intention to accept IPM

	Coefficient(β)	Std. Error	Wald	df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TPB:							
Attitude	2.582**	.748	11.912	1	.001	1.116	4.048
Subjective norm	5.707**	1.915	8.884	1	.003	1.954	9.460
Perceived behavioural control	-6.793***	1.835	13.704	1	.000	-10.390	-3.197
Added TPB variable:							
Perceived resources	-3.254**	1.075	9.160	1	.002	-5.361	-1.147

Farm characteristics:							
Age	-4.618***	.818	31.838	1	.000	-6.222	-3.014
Level of education	10.169***	1.867	29.668	1	.000	6.510	13.828
Farm training	-10.493***	.936	125.560	1	.000	-12.329	-8.658
Farm experience	3.982***	.871	20.886	1	.000	2.274	5.690
Farm size	5.060**	1.591	10.116	1	.001	1.942	8.179
Agric advisors	-1.898**	.683	7.722	1	.005	-3.236	-.559
Contextual variable:							
Policy	-.421	.377	1.250	1	.264	-1.160	.317
Model statistics:							
Model Chi-Square	451.365						
Goodness-of-Fit:							
Pearson	321.415						
Deviance	249.115						
-2 Log Likelihood	253.559						
Pseudo R-Square:							
Cox and Snell	0.571						
Nagelkerke	0.773						
McFadden	0.631						

DISCUSSION

The study applied the modified TPB approach to illustrate factors influencing farmers' extant intentions to adopt IPM in farm practice. The findings from the ordinal logistics regression indicated that there was heterogeneity of factors across the regression, influencing the intention to use IPM in farming practice. However, government policy response does not constitute an important driver of intention to use IPM.

Findings indicates that attitude, which is the first component of TPB is significant and positively related to intention to accept IPM. This result suggest that farmers may voluntarily adopt the use of IPM because they are aware of the benefits of IPM in farming. This finding is corroborated by previous studies (Martinez-Garcia et.al, 2013) who found that attitude is a precursor to the adoption of agricultural practices. Subjective norm shows a significant and positive relationship to the adoption of IPM in farming practice. This finding suggests that farmers do not make decisions independently from social and peer influences but instead, they intermittently refer to their benefactor or opinion leaders for advice (Burton, 2004, Agholor, 2016).

Perceived behavioural control variable is significant but negatively related to the adoption of IPM. This finding surmise that farmers who has technical know-how and alsoperceive the use of IPM as easy and simple are more likely to adopt the use of IPM in any farm practice. This finding lead credence to the study of Wall and Plunkett (2016) who found that a level of technical expertise, awareness and support is needed to increase the level of adoption and application of fertilizer. Perceived resources which is an added variable indicating perception of farmers on availability of finances to undertake IPM was also significant but negatively related to the acceptance of IPM. The finding suggests that farmers who are certain of labour, money, and necessary farm infrastructure to adopt the use IPM practice are more likely to do so. However, this finding contradicts the result of the study of Zeweld et.al, (2017), who found no significant relationship between farmers' resources and adoption of sustainable agricultural practice.

Findingsindicate that several farm characteristics influence intention to adopt IPM. Age, according to the findings is significant but negatively influence intention to adopt IPM. This result suggests that for every unit increase in age, there are probability of a decrease in adoption of IPM. This result disagrees with the findings of Agholor and Nkosi (2020), who found that the age of farmers is positively associated with adoption of water conservation practice. The education level of farmers was found to be significantly and positively related to the adoption of IPM while farm training which is intertwined with level of education is also positive but negatively related to adoption of IMP. This finding shows that with increase in education level of farmers, there is corresponding increases in the log-odds of adoption of IPM. This finding is supported by the study of Hoang, (2020), found that educated farmers adopt the use of information communication technology more than the uneducated farmers. Farm experience was found to be significant and positively influence adoption of IMP. Consistent with this finding, Adekunle et.al, (2015) also found that experienced farmers are more informed are likely to adopt innovation. Furthermore, farm size was found to be significant but positively influence the adoption of IPM. The underlying explanation here, is that farmers with larger farm size are predisposed to risk and therefore, adoption of IMP becomes imperative for farm business success. Moreover, findings reveal that agricultural advisors have significant influence in the adoption of IPM. This finding suggest that agricultural education and advisory services raises awareness of the inherent benefit of IPM.

CONCLUSION

In conclusion, the intention to adopt IPM practices is governed by both psychological and social milieus. Therefore, in order to encourage farmers to adopt IPM, there is a need to continually make farmers aware of the benefits of IPM. Furthermore, farmers' potential and diversity of available resources must be accentuated in agricultural policy planning to raise the intention to adopt IMP.

ACKNOWLEDGEMENTS
The author acknowledges NRF for sponsoring the study as part of honours project work of Fannie Masina and UMP for the ethical clearance granted for the purpose of this study.

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