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Determinants of Smallholder Maize Farmer's Perception on Use of Improved Weed Control Technologies in Eswatini

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Abstract

Environmental concerns, increase labour cost and increase in demand for food has urged farmer to use the most economic and concomitant method to their farming objectives. Therefore, this study focused on ascertaining maize farmer's perceptions on the weed control methods they choose and the socio-economic characteristics that determine these perceptions. This study was conduct countrywide in the four agro-ecological zones of Eswatini. Primary data was collected from 240 randomly selected maize farmers in the four Agro-ecological Zone of Eswatini. Factor analysis was used to estimate principal components about farmer's perception on the different weed control methods. Multiple regression method was used to ascertain the socio-economic factors determining farmers' perceptions. Farmers were interviewed about their perception on the usage of herbicides and integrated weed control method. The five likert scale of attitudinal statements related to herbicide and integrated weed control methods was developed. Four principal components were generated by the analysis from the positive attitudinal statement on the use of herbicides. These include productivity and economical, inclusive and confidence, knowledgeable and readiness, environmental impact. Farmer perceived that herbicides are associated with increased productive, can be used with confidence, farmers were ready to use herbicides, on the other hand, farmers perceived herbicides to have a negative impact on the environment. The socio-economic drivers of these farmers' perceptions included sex of the farmer, education level, farming experience, access to agricultural trainings, amount of farm incomes and group membership. Integrated weeding method (hand hoe weeding + herbicide use) was perceived to be labour saving, productive and has no harm on the environment. The socio-economic drivers of these farmers' perception towards the use of integrated weed control method included group membership and education. The study recommends that government should increase the number of extension officers to extend extension contact to more farmers, thus improve information sharing to farmers on best agricultural practices. Sensitization workshops, trainings and On-farm demonstration related to the usage of the improved weed control technologies is desired to increase farmers' access to knowledge about the use of these improved weeding technologies.

Keywords: herbicides, integrated weed control, perception, factor analysis, weed control

1. Introduction

Insufficient weed control measures are a major crop production constraint in developing countries. The strong negative impacts that weeds have on crop yields, and hence farm profits, create a demand for cost-effective weed management strategies. The current weed control method widely practiced by smallholder maize farmers in Swaziland is grossly inadequate in bringing these weeds under control (Rwelamra, 2000 and IRD, 2013; Gesine et al., 2017; Mncube and Mloza-Banda, 2018,). Small-scale maize farmers in Swaziland are still using the traditional methods of weed control. The traditional farming system in the country is depended mostly on hand tools, and weed is controlled by a combination of manual methods i.e. slashing, burning and hoes weeding. However, the challenges of declining labour availability for agriculture, and increasing labour costs are forcing farmers to look for alternative weed-control methods. Adoption of herbicides by farmers has been emphasized, given their ease of application, high efficacy, and low cost relative to alternative methods (Pingali et al., 1997; Nicole & Thierfelder, 2017). Rwelamira (2000) and Mncube and Mloza-Banda, (2018) also commended that

herbicides ensure timely weed control and assisting in controlling perennial weed. However, the use of herbicides has been accompanied globally by the potential buildup of herbicide-resistant weeds, weed species population shifts, and concerns about environmental contamination and impacts on human health (Johnson and Mortimer, 2005; Gesine et al., 2017). Some studies have associated this concerns to farmer's lack of proper knowledge and some attitudinal perception on herbicides.

In considerations of the environmental alarms, integrated weed control method has been used as an alternative by farmers. This method helps in reduction of the usage of herbicides that can have negative impact on the ecosystem. This method has also been applauded for economic ability. Mashingaidze and Chivinge (1998) and Gesine et al. (2017) labeled this method as the environmentally friendly method and accessible to resource-poor farmers. They further emphasized that IWM is grounded on promoting agronomic and management practices that will provide the crop a competitive advantage against weeds. This practice includes a combination of other management practices including early planting, intercropping, narrowing of inter row spacing, application of herbicides and selection of competitive maize variety. The reduced herbicide dosages is more lucrative to poor smallholder farmers because when used costs a fraction of the full label recommended dosage (Mashingaidze & Chivinge, 1995; Nicole & Thierfelder, 2017; Gesine et al., 2017; Mncube and Mloza-Banda, 2018)

Given the rationale of these different weeding alternatives in yielding higher yields, farmers have been recommended to use these improved methods (FAO-UN undated). However, some farmers are reluctant to move out of the traditional methods that a less productive. This kind of attitude towards new practices can be associated with the value that the farmers have placed upon that farming practice and the amount of knowledge an individual has about that agricultural practices. These perceptions placed against the farming practices influence farmers' decision making process. These attitudes and perceptions are associated with difference in human personalities. It can be argued that in the decision-making process of a farmer, a combination of economic, sociological and psychological considerations are all factors. Thus, this study focused on ascertaining the attitude and perceptions that farmers associate with these improved weeding practices as well as determine their socio-economic attributes that influence their decision making process on these methods.

2. Material and Methods

The study was carried out in all the four Agro-ecological Zone of Eswatini namely; Highveld, Middleveld, Lowveld and the Lubombo Plateau. The targeted respondents were farmers who mainly sell their maize to the National Maize Corporation (NMC). The focus of the study was quantitative. The study used a cross sectional approach, using farmers production information of the 2014/15 cropping season. A sample of 240 farmers was used. In selecting the sample, farmers were stratified according to the four Agro-ecological zones, simple random sampling was then employed. Structured questionnaires with statements regarding farmer's attitudes and perceptions on the use of herbicides and integrated weed control technologies were then administered. Factor analysis approach was then used to estimate principal components regarding farmer's perception about each weeding technology. The reason for using the Principal Components Analysis (PCA) is its ability to yield robust results (Padilla-Fernandez and Nuthall, 2001; Kibirige, 2013; Jolliffe and Cadima, 2016; Patel et al., 2018). To determine the socio-economic drivers of farmers' perceptions towards the use of herbicides and integrated weed control methods, estimated average scores generated from each principal component were used as dependent variables and socio-economic characteristics as independent variables.

2.1 Factor Analysis

The factor analysis method estimate farmers' perceptions with regards to the herbicides and integrated weed control method. This analysis clustered together related attitudinal statements regarding the usage of herbicides and or integrated weed control method. The clustered perception statements give a summary of the individual statements. The reason for using the Principal Components or factor analysis is its ability to yield robust results (Padilla-Fernandez & Nuthall, 2001; Kisaka-Lwayo & Obi, 2012; Kibirige, 2013 Jolliffe and Cadima, 2016; Patel et al., 2018). Following Kibirige (2013), the principal component (PC) of a given dataset of P numeric variables can be presented mathematically as:

$$PC_n = f\,(a_{ni}X_i, \ldots\ldots\ldots\ldots a_{1j}X_j)$$

Where *PC or factor* is the principal component, n represents a number greater than one. The *PC* can take different forms of measurement and these include continuous variables, quantity of related products of values that make up a component, and weighted values or generated values from the component loading; $a_{1j}$is the regression coefficient for the j^{th} variable and it is known as the eigenvector of the covariance matrix between variables, while X_j is the value of the j^{th} variable. Explicitly the equation can be written as:

$$PC_1 = a_{11}X_1 + a_{12}X_2 + \ldots\ldots a_{1j}X_j$$

Where PC1 = the first principal component. X_1 and X_2 are the first and second independent variables of PC1 in the linear additive model needed to derive the principal component, and the a_{11} and a_{12} are coefficient (component loadings) associated with the X_1 and X_2 variables.

The impact of socioeconomic characteristics on the farmers' perceptions on the different weed control method was estimated using average factor scores and multiple regression analysis. The multiple regression analysis uses a standard factor scores generated from factor analysis, and these scores were regressed on farm and farmers' socio-economic characteristics. The factor score *(FSij)* was estimated using individual farmers' average scores from all the related statements *Xn* of each factor loading. Thus,

$$\text{FSij} = \frac{\times}{n}\left(\sum_{i=1}^{n} x1 + x2 \ldots\ldots xn\right)\ldots\ldots\text{..average factors score model}$$

The multiple regression model with the factors scores as a dependent and farmer socioeconomic characteristics as explanatory variables is as follows:

$$\text{FSij} = \beta_0 + \beta_1\text{HHSZE} + \beta_2\text{AGE} + \beta_3\text{EDUC} + \beta_4\text{MJOCUP} + \beta_5\ \text{EXPE} + \beta_6\text{GENDER} + \beta_7\text{FARMINCOM} + \beta_8\text{CREDIT} + \beta_9\ \text{GROUP} + \beta_{1O}\text{TRAING} + \text{e}$$

Where FSij = regression factor analysis scores; HHSZE = household size, AGE = Age of the farmer (years), EDUC = education level of the farmer (years in school), MJOCUP = source of employment of the farmer, EXPE = farming experience (years) of the farmer, FARMINCOM =farming income (E), CREDIT = access to credit, GROUP= group membership, TRAING =access to training on agricultural technologies, EXTSN = access to extension services, GENDER= gender of respondent, β = coefficient parameters to be measured; e = error term

3. Results and Discussions

3.1 The Principal Components for Farmers' Perception on the Use of Herbicides

Factor analysis was conducted on the data of the 24 herbicides usage positive attitudinal statements. It was worth using this method to condense the 24 attitudinal related statements into fewer well explained principal components. During the analysis, some statements were dropped to achieve better results that correspond with the minimum Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy value above 0.60 and the Bartlett's Test of Sphericity. The KMO value for this particular analysis was 0.850 (Table 1) and passed the Bartlett's Test of Sphere with no autocorrelation among variables. Also, the Eigen values of the variance for selecting optimal number of principal components were above the recommended value of 1. Four principal components were generated from twenty attitudinal statements (Table 1).

Table 1. Estimated principal components for farmers perceptions on the use of herbicides

Item	Varmax factor	Eigen values	% of variation
Factor 1 (productivity and economical)		6.17	27.96
Herbicides are effective in controlling weeds	0.649		
Herbicides are not expensive	0.327		
Herbicides reduce cost of production by cutting labour costs	0.566		
Herbicides enhance in increasing maize productivity	0.786		
Use of herbicides saves time	0.307		
Use of herbicides save money for farmers	0.520		
You have enough knowledge about the use of herbicides	0.412		
Herbicides use increase my economic returns from farming	0.746		
Factor 2 (inclusive and confidence)		**2.19**	**9.16**
Herbicides do not cause any crop injuries	0.530		
Herbicides are good for all people regardless of the education status	0.698		
Herbicides use is for all people including the rich and poor	0.688		
Use of herbicides save money for farmers	0.368		
Herbicides use does fit in my farming system or objectives	0.347		
I can use herbicides regardless of family opinion	0.628		
I can use herbicides regardless of community and friend's opinion	0.600		
I will extend this technology even to the next generation	0.540		
Factor 3 (Knowledgeable and readiness)		**1.61**	**6.71**
You have enough knowledge about the use of herbicides	0.578		
I have all the necessary equipment needed to use herbicides	0.301		
Herbicides use does fit in my farming system or objectives	0.501		
I can use herbicides regardless of family opinion	0.340		
Factor 4 (Environmental impact)		**1.49**	**6.21**
Excessive use of herbicides do not destroy the soil structure and nutrients	0.528		
Perception on environment influence my decision	0.784		
I consider environmental impact when using herbicides	0.803		

Source: Computed own survey data 2018

The first factor explains a variation of 27.96 % in the farmers ranking of their perceptions. This principal component best described farmers' perception about herbicides being productive and or economical. This factor constitutes 8 of 20 farmers' attitudinal statement with an estimated coefficient above 0.30. Among the statements that makeup this principle component include farmers' having enough knowledge about the use of herbicides, herbicides use increase my economic returns from farming, herbicides are not expensive, herbicides reduce cost of production by cutting labour costs, herbicides enhance in increasing maize productivity, use of herbicides saves time, use of herbicides save money for farmers, and herbicides are effective in controlling weeds. This perception can be regarded as productive and economical. All the economic statement about the use of herbicides among farmers constituted this perception, this gives a highlight that farmers consider herbicides to be associated with increased economic returns.

A variance of 9.16% on the second factor was also explained by 8 attitudinal statements. This factor accounts for class or status and confidence in farmers' use of herbicides. All the statements related to this principal component have scored higher coefficients, above 0.3. These statements include: herbicides being good for all people, rich or poor and regardless of educational status, herbicides fit farmers' farming system and objectives

and they will extend this technology to the next generation regardless of opinions. In addition to economic importance, and farmers' status and confidence perceptions, four attitudinal statement (having knowledge about herbicide, have all necessary equipment needed and herbicides does fit my farming objective) showed a sense of readiness in farmers to use herbicides. These statements constitute the third principal component and this perception can be described as farmers' knowledge about herbicides. The related attitudinal statements to this perception suggest that farmers perceive that they have knowledge related to herbicides. The attitudinal statement on this factor was explained by a variation of 6.17 %. Environmental impact perception (factor or principal component 4) was also among farmers' perceptions. The attitudinal response from the farmers showed that they perceive that herbicides have some impact on the environment. The attitudinal statements that explain farmers' perception of herbicide use and its impact on environment include; excessive use of herbicides do not destroy the soil structure and nutrients, farmer considers environmental impact when using herbicides, and perception on environment influence farmer's decision when using herbicides.

3.1.1 Ranking Farmers' Perceptions on Herbicides

The perception was ranked based on farmers' responses. The ranking was done to access the importance of farmers' four perceptions when using herbicides. Average scores of the four perceptions were generated using Microsoft excel. The average scores in Table 14 show that farmers were more concerned with the environmental impact of herbicides having the highest score of 3.47.. Farmers' perception on the economic and productivity of herbicides use was ranked second with an average score of 3.11, followed by inclusive and confidence with a score of 3.00. Farmers seem to be having less access to information and equipment necessary for herbicide use since the average scores related to perceived farmers' knowledgeable and readiness to use herbicide scored only 2.67. The 5 likert scale used shows that farmers disagree with is perception since the score is below 3.

Table 2. Average scores for the four farmers' perceptions on herbicides

Principal component (PC)	Average scores	Ranking
Environmentally impact	3.47	1
Economic and productivity	3.11	2
Inclusive and confidence	3.00	3
Knowledgeable & Readiness	2.67	4

Source; computed own survey data 2018

3.1.2 The Relationship between Farmers' Socioeconomic Characteristics and Farmers' Perceptions on Herbicides Usage

A multiple regression model was used to establish the relationship between farmers' characteristics and the principal component elucidated on the previous section. The dependent variables (principal components) were average scores of the principal components generated from the average score of the attitudinal statements that constitute each principal component. The results from the regression analysis indicated a significant relationship between farmers' characteristics and perceptions on herbicides use. There was low extent of autocorrelation recorded within the regression models since results demonstrated a Durbin-Watson statistics greater than 1. Three regression models related to farmers perceptions on herbicides economic and productivity, inclusive and confidence and knowledgeable and readiness were all significant at 1% level while the overall regression model related to farmers' perception on the use of herbicides and its impact on environment was significant at 5%.

Determinant of farmers' perceptions on herbicides being economic and productivity includes farmer's sex, education, and experience in farming, training (farmers' trainings on improved production technology), group membership and farming income. Gender and experience had a positive and a significant impact on farmers' productivity perception at 5% level. While education and farming income had a positive and significant impact at 1% level (Table 3). Training and group membership had a negative and significant impact on farmers' perceptions on productivity at 5% and 1%. Since the study indicated that, there were more women farmers interviewed than males, women are more likely to perceive the use of herbicide to be productive and economical compared to males. Further, the results can be interpreted as: human capital is very important in using herbicides for increased productivity and more economic benefits derived from smallholder maize farming business. This is explained by results, which indicate that farmers with more farming experience and higher education level were more likely to perceive use of herbicide important for increased productivity and generation of profits.

Furthermore, farmers who earn more income from farming were more likely to perceive use of herbicide productive and economical. On the contrary, training and group members negatively influence farmers' perception of herbicide's contribution to increased yields and incomes yet theoretically one would think otherwise. This may imply that farmers receive either negative information related to herbicide use from group members and trainers on the future yields or farmers' poor application of disseminated information by these agents.

Table 3. Farmers' socio-economic characteristics associated with farmers perceptions on herbicides use

variables	**Economic and productivity**		**Inclusive and confidence**		**Knowledge & Readiness**		**Environmentally impact**	
	β	P-value	β	p-value	β	p-value	β	p-value
constant	3.00***	0.000 (5.984)	3.23***	0.000 (6.289)	2.23***	0.000 (4.057)	3.826***	0.000 (7.128)
Age	-0.003	0.570 (-0.560)	0.003	0.610 (0.516)	0.005	0.330 (0.963)	-0.002	0.720 (-0.347)
gender	0.25**	0.020 (2.035)	0.27***	0.010 (2.504)	.0240**	0.040 (2.065)	-0.036	0.750 (-0.319)
HH size	0.000	0.550 (0.578)	-0.003	0.830 (-0.219)	-0.002	0.910 (-0.109)	-0.008	0.600 (-0.521)
education	0.22***	0.000 (3.335)	0.17***	0.010 (2.594)	0.33***	0.000 (4.650)	0.135*	0.051 (1.961)
employment	0.010	0.850 (0.189)	0.028	0.550 (0.534)	0.041	0.470 (0.720)	0.079	0.150 (1.429)
experience	0.012**	0.040 (2.095)	0.007	0.250 (1.153)	0.009	0.130 (1.518)	-0.005	0.400 (-0.831)
training	-0.37***	0.000 (-3.217)	-0.408***	0.000 (-3.513)	-.290 **	0.020 (-2.329)	-0.147	0.220 (-1.210)
Credit access	0.120	0.420 (0.803)	0.069	0.650 (0.453)	0.058	0.720 (0.356)	0.029	0.860 (0.182)
Group membership	-0.26**	0.030 (-2.073)	-0.366***	0.000 (-2.853)	-0.47 ***	0.000 (-3.390)	-0.185	0.160 (-1.379)
Farm income	3.34***	0.000 (3.130)	3.65***	0.000 (3.344)	5.40***	0.000 (4.620)	1.067	0.880 (0.142)
Model summary	R-2= 0.19 F=6.66***		R-2=0.21 F=7.26***		R-2=0.27 F=9.99***		R-2=0.33 F=1.81**	
Durbin Watson	1.4		1.4		1.8		1.3	

*Source: Results from SPSS (Version 20) generated from field survey, 2018. Where ****, **, * represents significance at 1%, 5% and 10% level, respectively: β = estimated coefficients and p-value = probability value. (....) = t-value*

The second principal component (inclusive and confidence) had a positive and significant relationship with farmer's sex, education, and farming income at 1% level respectively. Training and group membership had a negative and significant impact at 1% level on this component. Thus, these results suggest that female farmers, with higher education level and earn more incomes from the farming perceived to have more confidence in the use of herbicides and also perceived that herbicides can be used regardless of the income status of the farmer. The negative correlation between group memberships and this component showed that farmers belonging to

farmer groups turn to have less confidence in herbicide use than individual farmers. This can be attributed to farmers in groups who tend to rely on the workforce provided by the group members for weeding. Moreover, group members may easily influence each other to continue using the weeding methods they are conversant with, other than adopting new and unfamiliar methods.

The third principal component of knowledge and readiness to use herbicides had a positive and significant relationship with farmers' sex and education at 5% level respectively. This show that female with a higher education level perceived to be more ready to use herbicides. They had some of the necessary equipment and information needed when applying this method. In reference to the results of generated principal components, an increase in education level, farmers got equipped with more knowledge on herbicides use. The fourth principal component of farmers' perceiving herbicide use as environmentally impact had a positive relationship with education at 5% level of significance. This suggests that the higher the education level of the farmers the more likely they have a better understanding of herbicides interaction with the environment. They were able to read instructions and understand them clearly, and follow every precautions associated with them in terms of environmental impact.

3.2 The Principal Components for Farmers' Perception on the Use of Integrated Method

The factor analysis was performed on the data about positive attitudinal statements that were related farmers' perceptions on their use of integrated weed control method. This analysis was used due to its ability to explain variance within integrated weed control (positive) attitudinal statements. Factor loadings method was employed to elicit factors that explain statistically the variances within the statements, and the principal components were generated. Three factors were extracted. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (0.615) was above the recommended minimum value of 0.60. Also, the Bartlett's test of sphericity test indicated the worthiness of proceeding to the factor loading stage. Based on the correlation on the farmers' attitudinal statements regarding perceptions on integrated weed control, three broad farmers' perceptions (principal components) were extracted (Table 4). The first principal component that explains farmers' perception was described as labour saving based on the related statements. Labour related statements formed this factor and these included integrated method save time, save money for farmers, reduce cost production cost by cutting labour costs, reduce farmers' dependent on labour for weeding, input market accessibility closer to farmer and increase economic returns. The same farmers show some confidence about this method as they were more willing to communicate it to other for its adoption. This principal component had a percentage variation of 24.67 % (Table 16) from within and an Eigen value of 5.18.

Table 4. Estimated principal components for farmers perceptions on integrated method

Item	Varimax factors	Eigen values	% of variation
Factor 1 (labour saving)		**5.180**	**24.67**
Integrated weed control is not expensive	0.584		
Integrated weeding reduce cost of production by cutting labour costs	0.744		
Integrated weeding is good for the environment	0.383		
Integrated weed control input market are accessible closer to farmers	-0.400		
Use of integrated weeding saves time	0.675		
Use of integrated weed control method save money for farmers	0.737		
Integrated usage reduce dependent on labour for weeding	0.625		
Integrated weeding increase my economic returns from farming	0.507		
Integrated weeding does fit in my farming system or objectives	0.317		
Factor 2 (productivity)		**2.137**	**1.568**
Integrated weeding is effective in controlling weeds	0.378		
Integrated weeding is good for the environment	0.379		
Excessive use of integrated weeding do not destroy the soil structure and nutrients	0.301		
Integrated weed control do not cause any crop injuries	0.559		
Integrated weed control enhance in increasing maize productivity	0.517		
Integrated weed control input market are accessible closer to farmers	0.513		
You have enough knowledge about the use of integrated weeding	0.567		
Integrated weeding increase my economic returns from farming	0.310		
Integrated weeding does fit in my farming system or objectives	0.400		
I have all the necessary equipment needed in integrated weeding	0.645		
Factor 3 (environmental concerns)		**1.568**	**7.47**
Perception on environment affect my decision on use of integrated	0.870		
I consider environmental impact when using integrated method	0.859		
Integrated weeding increase my economic returns from farming	0.310		
I will extend this technology even to the next generation	0.353		

Source; computed own survey data 2018

The second perception was described as productivity and was explained by 10.18% variation on its attitudinal statements. Verimax factor coefficients above 0.3 were also considered. The 12 statements on this perception showed a positive association of integrated weed control method and increased productivity on maize. Farmers highlighted that this method is effective in eradicating weed infestation, and it does not cause any crop injuries when practiced. In addition, farmers applauded this method that is suitable for their farming objectives of getting higher yield in an economic way as well as delaying weed resistance to herbicides. This perception embraced even the other two principal components because it shows that some farmer applaud it for it economic purpose and environmental friendliness. The third principal component describes farmers' perception regarding environmental considerations when choosing integrated weed control method. In this component the variation in the explanatory variable is 7.47% with the Eigen value of 1.58. This perception was labelled as environmental concern. The result from the analysis highlighted that farmers do consider the environmental issues when choosing this weed control method.

3.2.1 Ranking Farmers' Perceptions on Integrated Weed Control Method

Using Microsoft excel, the average scores of the three principal farmers' perception on the usage of integrated

weed control method were generated. The average scores were ranked against an original score of 5 from the initial likert scale. Table 5 gives the rankings of the principal components, this ranking gives the idea on which principal component is highly considered important by farmers about integrated weed control method. The results in Table 5 show that farmers perceive that integrated weed control method is environmentally friendly. This means they choose to use integrated weed control method to reduce environmental degradation. Moreover, the overall sores when all statements related to the given principal component are estimated, farmers disagree that integrated weed control method is labour saving (2.52) and productive (2.76).

Table 5. Average scores for integrated method principal components

Principal component	**Average score**
PC 1- Labour saving	2.52
PC 2- Productivity	2.76
PC 3- Environmentally friendly	3.12

Source; computed own survey data 2018

3.2.2 The Relationship between Farmers' Socioeconomic Characteristics and Farmers' Perceptions on Integrated Weed Control

Determinants of farmers' perceptions on the use of integrated weed control method were estimated using multiple regression models, and the Durbin-Watson statistical test to identify the level of autocorrelations within the models. Table 6 presents results from the estimated multiple regression models. The coefficients (β) and the p-values to establish the relationship and significance between the dependent and the independent variables are presented in the Table 6. The results in Table 6 shows that the regression model for principal component 1 was significant at 10 % level, principal component 2 was significant at 1% level and principal component 3 was significant at 5% level. The Durbin-Watson results indicated a low autocorrelation among the independent variables.

Farmers' characteristic (group membership) indicates a negative and significant influence on the first principal component of labour saving at 5%. These results suggest that farmers' belonging to groups are less likely to perceive integrated weed control method as labour saving, maybe since it involves both hand hoe weeding which requires more labour in addition to herbicide application in the fields. The results further showed a positive and a significant impact of education on principal component 2, education variable was found to be significant at 10% level. Thus, the more educated the farmer the more likely to perceive integrated weed control method as productive. These farmers were able to apply this method without causing crop injuries and destroying the soil structure, thus, they are being able achieve their objectives of getting higher yields.

Table 6. Farmers' socio-economic characteristics associated with farmers perceptions on integrated weed

variables	Labour saving		Productivity		Environmentally friendly	
	(β)	P-value	(β)	p-value	(β)	p-value
constant	2.660***	0.000	2.927***	0.000	4.834***	0.000
		(6.043)		(7.205)		(8.325)
Age	0.005	0.292	0.007	0.101	-0.001	0.910
		(1.057)		(1.645)		(-0.118)
gender	-0.031	0.743	0.103	0.232	0.022	0.860
		(-0.328)		(1.200)		(0.178)
HH size	0.011	0.407	0.012	0.334	-0.021	0.230
		(0.83)		(0.969)		(-1.212)
education	0.072	0.202	0.089*	0.088	0.012	0.880
		(1.278)		(1.177)		(0.156)
employment	0.02	0.663	0.014	0.739	0.052	0.340
		(0.436)		(0.334)		(0.869)
experience	0.001	0.914	0	0.974	-0.005	0.430
		(0.109)		(0.032)		(-0.799)
training	-0.129	0.196	-0.142	0.124	-0.214	0.110
		(-1.296)		(-1.545)		(-1.626)
Credit access	-0.01	0.938	-0.073	0.548	-0.213	0.180
		(-0.078)		(-0.601)		(-1.335)
Group membership	-0.270**	0.015	-0.324***	0.002	-0.405***	0.000
		(-2.451)		(-3.187)		(-2.788)
Farm income	8.38	0.371	1.146	0.185	-1.227	0.320
		(0.896)		(1.328)		(-0.995)
Model summary	R-2 =0.032		R-2 =0.097		R-2 =0.051	
	F=1.79 **		F=3.56***		F=2.28**	
Durbin Watson	1.7		1.8		1.7	

*Source: Results from SPSS (Version 20) generated from field survey, 2018. Where ****, **, * represents significance at 1%, 5% and 10% level, respectively: β = coefficients, p-value = probability value and (...) = t-value.*

Results further revealed that farmers belonging to groups are more likely not to perceive integrated weed control method as important for improved productivity, since variable group membership had a negative and significant influence on farmers' productivity perception with regards to integrated weed control method. The analysis of this study also revealed a negative and significant relationship between principal component 3 of environmentally friendly and group memberships at 1% level. This results suggests that farmers belonging to groups are more likely to perceive that environmental issues are not important to consider when a farmer practices integrated weed control method.

4. Conclusion and Recommendations

Capacity building on the most efficient weed control method remains as one of the cornerstone for the improvement of food security level in developing countries. The study indicated that farmers are not knowledgeable about herbicides usage thus they are not sure if herbicides are economic, increase production and inclusive. More so, they are not sure about its environmental impact. Farmers' sex, education level, farming experience, access to agricultural trainings, farm incomes and group membership had an influence on farmers'

perception on herbicides usage.

Farmers perceive integrated weed control method (hoe + herbicides), as more efficient, productivity and generating better economic returns. Moreover, farmers' applaud this method to be environmentally friendly. Farmer's level of education and group membership significantly contributed in shaping farmers' attitudes about integrated weed control method.

The study recommends that government and non-governmental organizations should provide sensitization workshops, trainings and on-farm demonstration services on the usage of the modern weed control technologies to improve on farmers' knowledge about herbicide use and integrated weed control methods. This is thought to reduce on farmers' burden of weeds responsible for low productivity, low farm incomes and hence increasing rural food insecurity and poverty. Government should also increase the number of extension officers to improve on the contact hours with farmers, and this thought to catalyze information sharing with farmers on the best agricultural practices. Improved access to farm loans and promotion of gender equality access to information related to herbicide weed control method is desirable. Since group membership negatively influence the use of these improved weeding method, government and other development stakeholders should consider other strategies for mobilizing technology adoption other than group adoption.

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