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Tillage Management as a Method of Weed Control in Mangweni, Nkomazi Local Municipality, South Africa

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ABSTRACT

The objective of the study was to determine the influence of tillage management strategies on weed control, assess the impact of weed in crop production; and examine farmers' adoption behaviour in the use of modern weed control methods. The study employed a survey of a randomized sample of 160 farmers in Mangweni in Mpumalanga Province. Logistic regression model was adopted to analyse data collected from farmers. The results show that farmers are aware of the menace of weeds in terms of cost. Results also reveal that farmers who had lesser weed count in their crop field were involved in practicing zero tillage. Furthermore, some socio-economic predictor variables were found to have influence on the adoption of modern weed control methods. Significant variables were age (*P-value* =.008), education (*P-value* = .056), household size (*P-value* = .005), income (*P-value* = 047) and number of children (*P-value* = .016). The paper recommend that, for farmers with low resources, zero tillage remains a viable option and needs to be evaluated further for weed control purposes. A good understanding of decision making process will assist to intensify adoption of new methods of weed control. Farmers' capacity building should be enhanced through training as this will allow for well-informed decision making.

Keywords: Tillage management, weed count, adoption behaviour, conservation

INTRODUCTION

Agriculture in Sub-Saharan Africa accounts for nearly one-third of the continents GDP, with two-third of the population relying on agriculture for household income. Interestingly, almost 90 % of the population rely on agriculture for subsistence [1]. In Africa, agriculture is 2-4 times directly linked to alleviating poverty in contrast to other sectors of the economy [2]. In South Africa, the role of agriculture is very important given the increase to prominence of concerns over food security and poverty alleviation. The agricultural sector contributes less than 2.5% to the country's GDP with 4.6% employment of the total labour force [3]. The effects of weeds in Africa surpasses the world average. In Africa, yield losses from weeds infestation range from 25% to entire crop failure, depending on the available control measures employed, weed management adopted, and

tillage practices used by farmers [4]. However, the nature and intensity of weeds constraints defer according to the crop ecosystem while weed management practices are dependent on the biophysical and socioeconomic variables. Weeds have been an aspect of concern in crops and livestock production in South Africa. This is so because weeds compete with crops for soil nutrients, light and water. Generally, weeds impact negatively on crops and livestock production in term of cost and reduction of quality[5]. The natural, physical, chemical and biological strategies of weed control has continued to increase production cost, worsened by labour scarcity. Shared agronomic factors that exacerbate the menace of weeds include inadequate soil tillage, seed contamination, poor quality seeds, inadequate water management and poor fertiliser management [6]. Weeds decreases farm efficiency as they attack crops, pastures and constitute nuisance to pasture field for livestock. Weeds compete with crops for water, soil nutrients and daylight, bringing about decreased farm output and poor yield quality [7]. Famers adopts several strategies to control weeds on their field, notably the tillage management which assist to recycle soil nutrients and reduce weeds proliferation. Tillage practice have been recognized to influence weed occurrence by changing the physio-chemical characteristics of the seedbed and can also affect the floristic composition of weeds through changes to seed distribution within the soil [8];[9].
Study by [10] found that in wheat cultivation, with the adoption of zero tillage (ZT), a decline in weed density was recorded as soil remains intact and soil surface stayed covered by leftover plant materials as compared to other tillage types [11] [12].

In another study by[13]; [14]; [15], found that adopting ZT and early sowing accounted for reasonable weed reduction on wheat field while higher yield was recorded for wheat cultivated under ZT [16]. Numerous studies have also shown that weed control remain problematic in field with reduced tillage practices. However, the effect of the adoption of tillage on some weeds are specie-specific, hence generalization cannot be made. As the use of tillage for weed control and the adoption of other cultural practices exist, research become imperative to unravel weed control strategies and adoption behaviours of farmers in Mangweni, Nkomazi Local Municipality, South Africa. The purpose of the present study therefore, is to determine the influence of tillage management strategies on weed control, assess the impact of weed in crop production; and examine farmers' adoption behaviour in the use of modern weed control methods.

METHODOLOGY

The study was done at Mangweni community situated at Nkomazi Local Municipality in Ehlanzeni District, Mpumalanga Province South Africa with longitudes 31°49'E and latitude 25°44'S.The study considered each household as a unit of analysis. From the determinate population of 160, the sample size was conceived using 5% margin of error with 95% confidence interval. Following this set values, a sample size of 120 household was selected and deemed adequate to balance the required level of reliability and cost. Samples were randomized and data collection techniques used were structured and semi-structured questionnaires, interviews, personal observation, focus group discussion and field measurements.

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Figure 1. Map of Nkomazi Local District showing Mangweni
Source: Own survey map 2019

At first a reconnaissance survey was initially undertaken and the prepared questionnaire items were pretested using 10 households, with relevant adjustments and screening made before the final questionnaire was administered. The questionnaire item was divided into 4 sections, prepared to accomplish the socio-demographic characteristics of the respondents and the 3 main objectives of the study. The first section covered the socio-economic characteristics of the respondents. The second section of the questionnaire elicited information on impact of weeds as production constraints in crop production while the third section included the influence of tillage management practices on weed control and the fourth section dealt with smallholder farmers' adoption behaviour in the use of modern weed control methods.

The data were analysed using both the descriptive and inferential statistics involving the mean, frequency, variance and standard deviation. The IBM-SPSS Statistics software was used to analyse quantitative data collected from the sample household. In the fourth section of the questionnaire, logistic regression was used to analyse adoption behaviour of farmers. The dependent variable was binary with an assigned value of 1 if a household adopt the use of modern technology in weed control and 0 otherwise. The socio-economic characteristics comprising of eleven independent variables in the study were operationalized as follows:

Table 1: Predictor variables hypothesised with their operational description and measurement

Independent variable and code	Operational description	Unit of measurement
Gender (GENDER)	Household: Male or female	1 = Male; 2 = Female
Age (AGE)	The number of years a person has lived	1= 20 -30; 2 = 31 - 40; 41 – 50…….. 6 = 71 and above.
Marital status (MARITSTAT)	The state of being married or not married	1 = Married; 2 = Single; 3 = Widow; 4 = Widower; 5 = Divorced
Education (EDUC)	Level of education achieved	1 = No school; 2 = primary school; 3 = secondary school; 4 = tertiary
Farm experience (FARMEXP)	Number of years in farming	(< 5years) = 0, (6 – 10years) = 1, (11-15years) = 2, (16 – 20years) = 3 (> 20years) = 4
Household size (HHOLDSIZ)	Number of family members	Actual number
Income (INCOME)	Amount realised from farming over a period	Actual amount in Rand (local currency)
Number of children (NUCHILDR)	Number of biological family member	Actual number
Farm size (FARMSIZ)	Estimates of size of farming area	Actual number in acres
Employment status (EMPLOSTAT)	Working	1 = employed; 2 = self-employed; 3 unemployed
Number of farm assistant (NUFARMAST)	The number of family members and others that assist in the farm	Actual number

RESULTS AND DISCUSSIONS

Socio-economic characteristics of farmers in the study area

Table 2 show the socio-economic characteristics of respondents in Mangweni, Nkomazi Local Municipality, South Africa. Results revealed that 21.7% of the respondents were male while 78.3% were females. The domination by females' respondents among the farmers could be as a result of the males' migration to urban centres in search in of white collar job. This findings is corroborated by the study by [17] who asserted that women's productive role and time devoted to agriculture has been acknowledged as equal to those of men in alleviating poverty and achieving food security. Also, the result lead credence to the study of [18] who stated that women are the pillar of agricultural sector. Furthermore, women's contribution to food security surpasses their agricultural production levels because of the supportive role offered at household level. Women

invest more in the family as compared to their male counterparts [19]. Studies on gender shows a progressive relationship between women's empowerment and feeding outcome (Van Den [20].

Table 2. Socio-economic characteristics of households in the study area

Variable (N =120)	Frequency	Percentage
Gender of household:		
Male	26	21.7
Female	94	78.3
Total	120	100
Age:		
20 – 30 years	19	16.1
31 – 40 years	17	14.4
41 – 50 years	16	13.6
51 – 60 years	36	30.5
61 – 70 years	14	11.9
≥71 years	16	13.6
Total	120	100
Marital status:		
Married	43	35.8
Single	64	53.3
Widow	12	10.0
Divorced	1	.8
Total	120	100
Level of education:		
No school	32	26.7
Primary	31	25.8
Secondary	44	36.7
Tertiary	13	10.8
Total	120	100
Household size:		
1 - 2	4	3.3
3 - 4	19	15.8
5 - 6	41	34.2
≥ 6	56	46.7
Total	120	100
Source of income:		
Income from off-farm activities	26	21.7
Self-employed	5	4.2
Unemployed	9	7.5
Farming	48	40.0
Social grant	8	6.7
Pension	21	17.5
Remittance	3	2.5
Total	120	100
Employment status:		
Employed	30	25.0
Self-employed	31	25.8
Unemployed	59	49.2
Total	120	100
Number of children:		
1	20	16.7
2	19	15.8

3	18	15.0
4	23	19.2
5	11	9.2
≥ 6	29	24.2
Total	120	
Farm experience:		100
0 - 1 year	20	16.7
2 - 5 years	41	34.2
6 - 10 years	30	25.0
11 - 20 years	21	17.5
21 - 30 years	5	4.2
31 - 40 years	2	1.7
≥ 41 years and more	1	.8
Total	120	100
Farm size:		
≤ 1 acre	77	64.2
1 - 2 acres	14	11.7
3 - 5 acres	12	10.0
≥ 5 acres	17	14.2
Total	120	100.0
Number of assistant:		
1 labour	78	65
2 labour	17	14.2
3 labour	8	6.7
4 labour	6	5.0
5 labour	6	5.0
≥ 5	5	4.2
Total	120	100.0

The age distribution of farmers reveals that 30.0% were between the ages of 51 – 60 years, 15.8% aged between 20 -30 years while 14.4% and 13.6 % had age of between 31-40 and 41-50 years respectively. This implies that majority of the farmers are in their active productive years with an advantage of increasing food production. Findings further reveal that 53.3% of the farmers were single, 35.8% married, 10.0% widows while 0.8% were divorced. The level of education of the farmers were investigated and result revealed that 46.7% had secondary education, 10.8% tertiary, 26.7% no formal education, while 25.8% had primary education. The size of household was moderately high; with 46 % of the farmers having household size of more than 6 members while 43.2% had household members of between 5 and 6. However, 3.3% of farmers had household members of 1-2 while 15.8% had between 2 to 4 household members. The source of income of the respondents were from farming 40%, 17.5% pension and 6.7% social grant. However, income from non-farm activities were 26%. The indication here is that most farmers engage in off-farm activities to complement their earning from the farm. Majority of the respondents (49.2%) interviewed considered themselves as unemployed even though they are in one way or the other engaged in agricultural activities while 25% were employed. Interestingly, 25.8% agreed that they are self-employed. From the focus group discussion, it appeared that lack of encouragement and support from government accounted for their disillusioned assertion. Many did not consider agriculture as employment not withstanding their daily involvement in agricultural production. The respondents who had more than 6 children in a household were 9.2%, and 15.8% had 2 in a household. Respondents with 3, 4, and 5 children were 15%, 19.2% and 9.2% respectively. Result from the study indicated that 34.2% of farmers had farm experience of 2 – 5 years while 30% of

farmers had 6 -10 years' experience. In addition, farmers who had 31-40 years (1.7%), 21 – 30 years (4.2%), 11- 20 years (17.5%) and 0-1 years (16.7%) of experience were in the majority. The size distribution of farm land cultivated by the respondents reveal that 64.2% had less than 1 acre of land while majority had between 1-5 acres. However, 14.2% of farmers had more than 5 acres of land, used for agricultural production. Farm labour is necessary to assist farmers in their daily farm activities. The level of agricultural intensification in the area is very low as many respondents are involved in subsistence agriculture. Findings from the study reveal that 65% of respondents had one farm assistance while 14.2% had two farm assistance. Respondents who had 4 and 5 farm assistance were 5% of the total household interviewed.

Impact of weeds on cost of production

The impact of weeds on farm production was investigated using a Likert scale ranging from Very High, High, Undecided, Low and Very Low. Table 3 shows the cost implication of weeds on the crop field. Findings reveal that 15% of the respondents interviewed were undecided. The implication of this response is that they did not quantify the cost emanating from the menace of weeds. This result is not surprising because most of them are subsistence farmers who do not hire labour to remove weeds on their farm. Nevertheless, 22.5% of the respondent asserted that the menace of weeds in terms of cost on their farm is very high while 27.5% also agreed that the threat of weed is high with increased cost of farm operations. This result is supported by the study of [6] who found that weeds increase vastly the cost of crop production. However, 22.5% and 12.5% of the respondents agreed that weeds impact on their production cost minimally. From the focus group discussion, it was found that these group of respondents who has lesser weed count are involved in practicing ZT on their farm. This result is corroborated by the study of [21] who found that reducing tillage intensity assist in weed reduction per unit area of land. Their findings further revealed that weed infestation was almost twice under conservation tillage (CT) as compared to the ZT.

Table 3. Impact of weeds on cost of production

Variable (N=120)	Frequency	Percentage
Very high	27	22.5
High	33	27.5
Undecided	18	15.0
Low	27	22.5
Very low	15	12.5
Total	120	100

Impact of weeds on farm income in the study area

The table below show the distribution of respondents on the impact of weeds on farm income. Findings reveal that 20.8% and 27.5% of the respondents posited that weed infestation really impact on their income generated from farming while 21.7% and 10.8 asserted that the impact on farm income was low. This finding is supported by [5] who found that weeds influences farm returns, reduce quality of farm produce and increase cost of production.

Table 4. Impact of weeds on farm income in the study area

Variable (N=120)	Frequency	Percentage
Extremely high	25	20.8
High	33	27.5
Undecided	23	19.2
Low	26	21.7
Very low	13	10.8
Total	120	100.0

Methods of weed control

The methods of weed control in the area appears diverse and it include mixed method, chemical biological, and physical and tillage system.

Table 5. Methods of weeds control used by respondents in the study area

Variable (N=120)	Frequency	Percentage
Mixed method	11	7.50
Chemical method	19	14.17
Biological method	6	0.83
Physical method	79	72.50
Tillage method	5	5
Total	120	100

The findings of the study shows that 72.5% of the farmers use physical method of weed control. The physical method of weed control has been the closest traditional method used by farmers in the area. Result further reveal that 14.17% of famers who adopt the chemical control method were mainly sugar cane commercial farmers. The sugar cane farmers were able to partner with the cane Growers Association for the supply of weedicides for their farm. The farmers who adopts mixed method of weed control were 7.50% while 5% embrace the use of tillage system. The biological method of weed control were seldom used by the farmers mainly because of inadequate skill and information. However, 0.83% of the farmers adopt the biological method of weed control.

Tillage management strategies

Conservation tillage practices used by farmers in the study area

The conservation tillage practices were commonly used in the area, where 66.7% of the respondents practice crop rotation while respondents for mulching and cover cropping was 4.2%. Most farmers involved in the use of conversation tillage were mostly farming vegetables, sugar cane and grains. From the focus group discussion, the researcher became aware that the farmers know the advantages of tilling the soil before planting. They orated that it helps improve aeration, improves rooting depth and infiltration. Also, farmers affirmed that the surge in organic matter content in the soil is as a result of ZT and crop rotation practice.

Table 6. Number of respondents adopting conservation tillage in the study area

Variable (N=120)	Frequency	Percentage
Mulching	20	**5.6**
Crop rotation	80	**88.9**
Cover cropping	20	**5.6**
Total	120	**100**

This findings agree with [22] and [7] that tillage is done purposely to control weeds, improve rooting depth as well as to increase soil fertility and organic matter content of the soil. The common modern tillage practices used are zero tillage, minimum tillage, mulching and cover cropping.

The adoption and use of modern tillage practices

Table 8. The adoption and use of modern tillage practices

Variable (N=120)	Frequency	Percentage
Zero tillage	1	0.8
Minimum tillage	6	5
Mulching	24	20
Cover cropping	16	13.3
Other	73	60
Total	120	100

Table 8 shows the adoption and use of modern tillage practices available in the area. Findings reveal that 20% of the respondents adopt and use modern tillage practices considered as a means of reducing weed infestation. Although ZT system is considered as one the common way of weed reduction, only 0.8% of the respondents adopt the method. However, majority of farmers (60%) use varieties of local methods in the reduction of weeds in their crop field. Farmers adopting the use of cover cropping was 13.3% while 5% use minimum tillage. The study of [23] found that farmers' adoption behaviour revolves around factors such as knowledge, resistance to change, literacy levels, perceived benefits of modern practices, and perceived costs of a farming practice.
3.6 Logistic regression showing relationship between households' socio-economic characteristics and adoption of modern weed control methods.

Table 9 presents the logistics regression depicting the relationship between households' socio-economic characteristics and adoption of modern weed control methods. In consideration of the model used, a *Nagelkerke* R^2 of 0.582 and overall correctly predicted percentage of 81.1% were obtained. However, the following variables: age, education, household size, income and number of children were found to influence the adoption of modern weed control method as illustrated in table 9. Age of the farmers was significant with a *p-value* of .008 but negatively related to adoption behaviour. The results suggest that, for every unit increase in age of household there is 11.488 decreases in the log odds of adoption of modern weed control method. In a similar vein, the variable education was also significant with a *p-value* of .056 but negatively associated with adoption of modern weed control method. The level of education of a farmer increases his ability

to analyse information and use ideas that are applicable to adoption of new technology [24]; [25]; [26]. The result imply that, for every unit increase in household level of education, there is 2.133 decreases in the log odds of adoption of modern weed control method.

Table 9 Logistic regression showing the relationship between household's socio-economic characteristics and the adoption of modern weed control method

Independent variable	B	S.E	Wald	df	Sig.	Exp(B)
GENDER	.120	.950	.016	1	.900	1.127
AGE	-11.488	4.348	6.980	1	.008**	.000
MARITSTAT	-21.688	40192.747	.000	1	1.000	.000
EDUC	-2.133	1.475	3.645	1	.056*	.034
FARMEXP	-13.975	40192.792	.000	1	1.000	.000
HHOLDSIZ	-9.400	3.377	7.746	1	.005**	.000
INCOME	7.367	3.707	3.949	1	.047**	1582.362
NUCHILDR	7.519	3.114	5.829	1	.016**	1842.736
FARMSIZ	4.745	3.253	2.127	1	.145	114.959
EMPLOSTAT	-3.222	2.216	2.114	1	.145	.040
NUFARMAST	-3.805	3.253	1.124	1	.289	.022
-2 Log likelihood	78.776[a]					
Nagelkerke R^2	.582					
Cox & Snell R^2	.404					
Percentage correctly predicted	88.1					

Note:

- Significant variables affecting adoption behaviour at 0.01(**), and 0.05 (*) levels of significance.

This result is substantiated by the study of [27] who found that compared to employee younger than 30 years, an older workforce is negatively related to the probability of technology adoption. Alexander and van [28] also found that adoption of genetically modified maize increased with age for younger farmers as they gain experience and increase stock of human capital but declines with age for those farmers closer to retirement. As farmers grow older there is an increase in risk aversion and decreased interest in long term investment in the farm [29] and Adesina and [30]. The household size is significant retaining a *p-value* of .005 but negatively related to the likelihood of adopting modern method of weed control. This finding lead credence to the study of [24]; who found that larger household have the ability to reduce labour constraints required during introduction of new technology. Farmers' income was significant (p-*value* = .047) and positively related to the probability of adopting modern method of weed control. This result reveals that, for every unit increase in farm income there is 7.367 increases in the log odds for the adoption of modern method of weed control. This result is supported by the study of [31]; [32] who found that access to credit promotes the adoption of risky technologies through relaxation of liquidity constraints. The number of children in the house hold was significant with a *p-value* .016 and positively related to the likelihood of embracing modern method of weed control. The implication of this result is that for every unit increase in the number of children in the household, there are prospects for farmers to adopt modern method of weed control.

CONCLUSIONS AND RECOMMENDATION

The study examined tillage management as means of weed control. The objectives of the study were as follows: to assess the impact of weed in crop production, determine the influence of tillage management strategies in the control of weed and to determine the relationship between households' socio-economic characteristics and adoption of modern weed control methods. Findings revealed that farmers noted that the menace of weeds in terms of cost is very high. The study found that farmers who had lesser weed count in their field were involved in practicing ZT. It was also discovered that weed infestation really impact on income realised from farming activities. The traditional physical method of weed control were given prominence by the farmers. The relative advantages of zero tillage and crop rotation practices as a means of soil conservation by farmers were acknowledged. Furthermore, the study found that five predictor variables (age, education, household size, income and number of children) were found to influence the adoption of modern weed control method. The implication here, was that a significant relationship exist between age, education, household size, income, number of children, and adoption of modern weed control methods. However, other predictor variables such as gender, marital status, farm experience, farm size, employment and number of farm assistance were not significant.

The paper recommend that, for farmers with low resources and inputs, ZT can be a viable option and needs to be evaluated further for weed control purposes. The implication of conservation tillage for soil quality and fertility should also be considered. A good understanding of decision making process will assist to speed up adoption of new methods of weed control and innovations thus resulting in increased agricultural production. Farmers' capacity building should be enhanced through informal education and training as this will allow for well-informed decision making.

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REFERENCES

[1] World Bank, The World Bank and Agriculture in Africa. 2013.
[2] United Nation, World population prospects: The 2012 revision.,2013.
[3] Statistics South Africa, Labour Markets Dynamics in South Africa, Pretoria, 2015.
[4] van Rijn, P., *Weed management in the humid and sub-humid tropics*. Amsterdam: Royal Institute, 2000.
[5] Byrne, R., Spink, J., Freckleton., R., Neve, P., and Barth, A Critical Review of Integrated Grass Weed management in Ireland., *J. Agric. food Res.*, 2018.
[6] Gianessi, L. The increasing Importance of herbicides in Worldwide crop production., *Pest Manag. Sci.*, 2, 12, 1099, 2013.

[7] Leah, J., M.D., Andrew, J., Prince, K.S. Assessing the Economic Impact of Inversion Tillage, cover crops and herbicides Regimes in Palmer Infested Cotton, USA: Windsor, 2016.
[8] Arif, M.A., Marwat, M., Khan, K.B. Effects of tillage and zinc application methods on weeds and yield of maize, *Pak J Bot.*, 39, 1583–1591, 2007.
[9] Chauhan, D.E., Johnson, B.S. The role of seed Ecology in improving weed management strategies in the tropics, *Adv Agron*, 105, 221–262, 2010.
[10] Khaliqi, G., Shakeel, A., M., Matloob, M., Hussain, A., Tanveer, S and Murtaza, A. Influence of tillage and weed control practices on growth and yield of wheat, *Phiippine J. Crop Sci.*, 3, 38, 2013.
[11] Streit, M., Bernasconi, A., Sergeev. L., , Cruz., Steinmann-zwicy, A. Mgm 1, the earliest sex-specific germline marker in Drosophila, Reflects expression of the gene esg in male stem cells., *Int. J. Dev. Biol.*, 46, 1, 159–166, 2002.
[12] Khaliqi, G., Shakeel, A., Matloob, M., Hussain, A., Tanveer, S., and Murtaza, A. Influence of Tillage and weed control practices on growth and yield of wheat, *Phiippine J. Crop Sci.*, 3, 38, 2013.
[13] Frank, G., Singh, A.C., Mcroberts, S., Nehra, N., Godara, A.S., S., Malik, S., Marshall, R.K., Minor seed bank studies: Longevity, seedlings emergence and seed production as affected by tillage regime. *Weeds Res*, 47, 73–83, 2007.
[14] Erenstein, V., Laxmi, O. Zero Tillage impacts in India's rice-wheat systems: A review. *Soil Till Res.*, 100, 1–14, 2008.
[15] Usman, A. The impact of service quality on students' satisfaction in Higher Education Institutes of Junjab, *J. Manag. Res.*, 2, 2, 2010.
[16] Bhardwaj, A., Singh, A.K., Singh, R.K., Singh, Y.., Misra, G., Singh, D., and Kumar, M. Weed management in in zero till sown wheat., *Indian J. Weed Sci.*, 36, 175–177, 2004.
[17] Agholor, A.I. Gender Gap in Sub-Saharan Africa, Reminiscence of Rural Extension and Advisory services: Delineation, Challenges and Strategies., *S.Afr.J.Agric*, vol. 47, 3, 46–60, 2019.
[18] Nsoanya, M., Nenna, L.N. Adoption of Improved Cassava production technologies in Anambra East Local government Area of Anambra.," *J. Res. Natl. Dev.*, vol. 9, no. 2, pp. 36–42, 2011.
[19] World Bank, World development report: Gender Equality and Development. 4391, 2012.
[20] Van Den Bold, S., Quisumbing, M., and Gillespie, A.R.. Women,s Empowerment and Nutrition, Washington DC USA, 1294, 2013.
[21] Khaliq, K.., Hof, L., Prinzinger, C., Pfenninger, R., Bohning-Gaese, M. Global variation in thermal tolerance and vulnerability of endotherms to climate change. Proceedings of Royal scoiety B., *Biol. scinces J.*, 28, 1789, 2014.
[22] Wang, I., Diffusion and Acceptance of recommended farm practices for increased food prodcution, Seoul National University, Korea, 1971.
[23] Dessort, R., Bareiro, F.J., and Bravel, H.J.Behavioural factors affecting the Adoption of sustainable farming practices: Apolicy oriented review.," *Eur. Rev. Agric. Econ.*, vol. 46, 3, 417–471, 2019.
[24] Mignouna,M., Manyong, B., Rusike, M., Mtabazi, J., and Senkundo, S. Determinants of Adopting Imazapyr-resistant maize technology and its impact on Household income in Western Kenya., *AgBioforum*, 14, 3, 158–163, 2011.
[25] Lavison, R. Factors Influencing the Adoption of Organic fertilizers in Vegetable production in Accra., University of Ghana, 2013.
[26] R. Namara, R., Weilgamage,R.E., and Barker, P. Prospects for Adopting System of Rice Intensification in Sri Lanka: A socio-economic Assessment. Colombo, Sri Lanka, 2013.
[27] Meyer, J. Workforce Age and Technology adoption in small and medium-sized service firms, *Small Bus. Econ.*, 37, 305–324, 2011.
[28] Alexander, T., and Van Mellor,C. Determinants of corn root resistant corn adoption iN Indiana, *AgBioforum*, 8, 4, 197–204, 2005.
[29] Mauceri, V., Alwang, M., Norton, J., and Baarera, G. Adoption of Integrated pest management technologies: A case of Potato Farmers in Carchi, Ecuador., Rhode Island, 2005.
[30] Adesina and Zinnah . Technology characteristics, farmers' perception and adoption Decisions: A Tobit Analysis in Sierra Leone, *Agric. Ecomnomics*, 9, 1993.
[31] Mohamed, A, and Temu, K. Access to credit and its effect on the adoption of agricultural technologies: A case of Zanzibar, *African Review of money finance and Banking*, 2008, 5, 45–89.
[32] Mwangi, S, and Kariuku, M. Factors determining new agricultural technology by smallholder farmers in developing countries countries., *J. Econ. Sustain. Dev.*, 6, 5, 2015.

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