INFLUENCE OF ENVIRONMENTAL KNOWLEDGE ON WOMEN SMALL SCALE FARMERS ADOPTION OF CONSERVATION AGRICULTURE. NAKURU COUNTY, KENYA.

Abstract

This paper examines the influence of environmental knowledge on women small-scale farmers on adoption of conservation agriculture (CA) in Nakuru County. Kenya as one of the developing countries is in Africa faced with numerous problems particularly food insecurity, hunger, poverty, diseases and biodiversity loss as a result of conventional agriculture practiced under poor backdrop of environmental knowledge. To alleviate all these problems mentioned above, the alternative method of agricultural practice should now aim at improving conservation agriculture which was discouraged long time ago. But environmental Knowledge to adopt conservation agriculture is needed as better option for maximum agricultural yields and protection of the environment. CA adoption in Nakuru County by women small scale farmers wasclaimed to be low and there was inadequate research documentation regarding this claim. To find out why CA adoption was low in the study area, the research sampled three sites; Naivasha, Rongai and Njoro selected purposefully for differences in ecological characteristics. The sample size of 360 women farmers were randomly selected from a target population of 120,000 women farmers of which, 120 were selected from each of three Sub Counties. Descriptive survey design using structured questionnaires; interview schedule, personal observation and focus group discussion were used to collect data. Statistical package for social sciences (SPSS version 20) was used in the data processing and analysis. Descriptive statistics; frequency distributions, means, proportions, percentages and inferential statistics; Chi-square, ANOVA, Bonferroni test at alpha value ($p < 0.05$) level were employed to test the hypothesis. The findings concluded that knowledge of the environment influenced women farmers' adoption of CA and that CA adoption uptake was low. The following are recommendations; Policy and decision makers use the results to develop land and agricultural policies, provide incentives to promote women small-scale farmers, use new emerging technologies to speed up adoption of CA in order to realize food security and conservation of the environment in Nakuru County and Kenya.

Key words:*Environmental knowledge, women small -scale farmers, adoption, agriculture*

Introduction

New innovations in developing countries face increasingly new complex challenges,that hinder farmers from maximizing their food production particularly women small scale cohorts (Ngwira, F.H. Johnsen, J.B. Aune,M. Mekuria, and C. Thierfelder 2014). Poverty, low food production, diseases and loss of biologicalresources are characterized as major problems facing those working institutions attaining global development today in developing countries. There is urgent need for new mechanisms to foster diffusion of innovation and to strengthen ways of disseminating information to agricultural stakeholders with a view to empowering smallholder farmers and other vulnerable groups facing food insecurity (Saya, 2017). Several studies have indicated that, conservation agriculture (CA) is becoming a better

43 optionin mitigating environmental degradation and contributing significantly towards
44 increasing food production and protecting the environment over conventional agricultural
45 methods which have fuelled the problems (Kassam and Derpsch, 2012).
46 Further research studies have established that, environmental factors such as climate change,
47 land use changes, acidification of rain, emerging new diseases and extension methods require
48 well rounded environmental knowledgeof CA adoption in Africa by farmers particularly
49 women smallholders (Kimani, *et al*, 2015). Level of environmental knowledge has significant
50 impact on agricultural production and biodiversity in the study area, especially among
51 women smallholder farmers. This paper deals with women small scale farmers' knowledge
52 on environment as significant contributor to CA adoption (Kimani, *et al*, 2015).
53 Theories and frameworks for the adoption of agricultural innovations emphasize the role of
54 Extrinsic and intrinsic factors, affecting the adoption of CA and decision makes process. For
55 any agricultural technology to be adopted, the knowledge of the environment on soil, water,
56 climate and nature of land is very significant for its implementation stages and production
57 results. Likewise farmers attitude, knowledge, perception, culture among others should be
58 well understood and their applications done appropriately.It is recommend that future studies
59 aiming to understand the adoption process of conservation agriculture innovations and its
60 adoption in Africa South of Sahara should take into account both sets of variables (Pelum
61 2016). Women in Sub- Saharan Africa are mostly affected by environmental factors because
62 they are the main producers of food and good environmental stewards. It has been observed
63 that 80% of farmers practice small-scale production and out of this, over 70% of small scale
64 farmers are women (Kimani, *et al*, 2015). Other studies found that, knowledge on
65 environmental functions for a farmer is vital (Pelum,2013). A farmer who has the knowledge
66 of the environment stands a better chance insucceeding in agricultural production and
67 conservation of the natural resources which play animportant role in controlling his/ her
68 activities. Conservation agriculture requires farmers tounderstand changes in their
69 environments (Wall, et al, 2013). Conservation agriculture is more knowledge intensive than
70 traditional low input systems. This is partly because it is new, but also because of the need for
71 a farmer to understand the basis of the system so that CA can be adoptedin particular
72 conditions integrated with use of other methods such as applied in chemical weed control,
73 and the need for good farm and crop management(Pelum, 2016). Smallholder farmers are
74 often poorly linked to knowledge systems external to the community. Overcoming this
75 barrier and increasing the knowledge base of the smallholder farmers in Africa is probably
76 the biggest hurdle to overcome in achieving widespread adoption of conservation agriculture
77 in the continent (Seline *et al*,2014). Success will not only depend on enhancing the
78 knowledge of conservation agricultureadoption among researchers but focusing more on the
79 farmers. Extension agents are very important in the knowledge flow and the farmer is the
80 target of change towards food production and environmental quality. It will also require the
81 development of local innovation systems incorporating agents representing as many as
82 possible of the principal components of the local agricultural value chains using their own
83 comparative advantages and information networks to remove bottlenecks to farm productivity
84 (Wall *et al*, 2013).
85 Other studies indicate that, women have learnt the importance of biodiversity and the
86 farmersexperiment with varieties of other plants in their farms. They also increase animal
87 speciesnumber for wealth purposes. Greater inclusion of indigenous communities and
88 indigenouswomen further validates the significance of women knowledge on environment
89 (UN WomenWatch, 2016). It is well documented that, women possess wealth of biodiversity
90 knowledgeand hence, are good stewards of the environment. Drivers of farmers' knowledge
91 of agrobiodiversity management and analysis of how farmers' knowledge and their current
92 farmingcontexts may guide future farming systems in Benin are critical in food production. It

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93 wasfound that, farmer's knowledge of agro biodiversity management correlated with
94 theinvolvement in integrated crop-livestock-tree and agro forestry systems (Alcade, *et al*.,
95 2015).

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97 Environment is very dynamic and any lack of knowledge present itself and manifest in the
98 way a farmer handles it. The environment can be made sustainable or unsustainable through
99 human practices such as agriculture. A farmer needs to have a deep understanding of rhythms
100 of nature in order to remain productive. Farming with sound knowledge of the environment
101 leads to better yield and management of other adverse factors that may affect farming input
102 and output. Knowledge on conservation of natural resources such as wise use of soil to
103 maintain its fertility, protecting wildlife for ecosystem function and understanding the need to
104 increase forest cover is essential for every farmer (Seline, 2014). In this objective, ten
105 indicators were tested, analyzed and discussed. To realize this objective, specific aspect
106 relating to environmental knowledge were rated against the adoption of CA by farmers before
107 the overall effect was determined. The items were weighted in terms of frequencies before
108 cross-tabulation was carried out. Analysis was done on each question item and thereafter a
109 combination of all the items was analysed to give the overall relationship (Pelum, 2016).

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111 The Government of Nakuru County Report (2015) established that, women in the region
112 particularly small scale farmers are being equipped with relevant knowledge and skills to
113 enhance their leadership and organizational capabilities to be achieved, and now these
114 women are drivers of their own social and economic transformation.High land degradation in
115 the county coupled with human population surge has led to food scarcity, poverty, and loss of
116 biodiversity. To alleviate further environmental degradation, appropriate agricultural
117 technologies need to be developed and implemented and integrated system use of modern
118 farming methods be selected with a lot of precaution. With the increasing rate of
119 modernization and urbanization, women farmers in the county are less knowledgeable of
120 integrating environment with agricultural practices which are yielding economic production
121 biodiversity conservation. There is a lot of land degradation in Nakuru County due to
122 deforestation, pollution, accumulated wastes, poor agricultural methods that pose as threats to
123 sustainability of the environment in the study area. Women have goodknowledge of the
124 environment and would avoid situations where they ignorantly destroybiodiversity by
125 agricultural practices. No available research in Nakuru County to establish towhat extent
126 women farmers are knowledgeable about environmental dynamics and the need to conserve
127 nature and increase their food production (Nakuru County Report, 2016). Due to lack of
128 information on the study area, the researcher felt there was need to build a body of
129 knowledge by filling the gaps on the study subject by finding out the extent of women
130 farmers' environmental knowledge and influence on CA adoption. The following items were
131 selected for study; enlightenment on soil erosion control measures, minimal tillage, soil
132 conservation strategies, practice of agro forestry, soil control measures, crop rotation,
133 protection of wetlands, protection of wild life, enlightenment to increase forest cover,
134 benefits of using manure, need for environmental conservation. The information gathered
135 will be helpful to the women farmers improve their knowledge by avoiding practices leading
136 to destruction of the environment and increasing food production. The government would
137 also be informed to make policies on empowering famers to adopt CA, which is claimed to
138 be environmental friendly through creating sustainable communities.

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143 **Objective**
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145 The objective is to explain the influence of environmental knowledge on adoption of
146 conservation agriculture, among women small scale farmers in Nakuru County.
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148 **Methodology**
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150 The research study on the influence of environmental knowledge on women small scale
151 famers was conducted using descriptive survey design. The descriptive survey design wasthe
152 best for this study as the study had specific objective that it aimed to answer. The specific
153 Objective formed the framework for the adoption of CA. The study described the variables as
154 they are without manipulation (Ker linger, 2005). Descriptive research is not only restricted
155 to fact finding but may often results in formulation of important principles. And also enables
156 the analysis of different variables as well as giving room for the researcher to describe
157 adoption of innovations and technologies in agricultural production and environmental
158 management in Nakuru County Kenya.
159 The population of Nakuru County at the time of research was approximately 1.7 million
160 people according to estimated statistics (Kenya Population Analysis Report, 2014).The
161 population of each sub-county selected was; Njoro 195,253, Rongai 155,745
162 andNaivasha269, 632. The target total estimates of women small scale farmers population
163 was estimated at120,000. Out of the target population, a sample size of 390 women farmers'
164 was elected forinterviews. The study used purposive sampling to pick on the 3 out of 11 sub
165 counties namely; Naivasha, Rongai and Njoro. The sub counties exhibit different ecological
166 characteristics and are highly vulnerable to land degradation particularly, soil erosion, climate
167 change, human settlements, industrial pollution, deforestation and land use changes. Of the
168 390 women farmers, 130 came from each sub county by simple random selection. The 390
169 sampled from the target farmers population of 120,000 was proportionate and would take
170 care of the sampling errors and provide a level of accuracy and confidence level of 95%. The
171 respondents were picked from both churches and self-help groups present in the sub
172 counties.Nine churches and nine self -help groups were used to pick the small scale
173 womenfarmers using simple random selection. From this a certain number of respondents
174 from eachstudy station were determined.
175 Data collected was analyzed according to the main objective. The collected data was coded,
176 cleaned and finally entered in a computer system using Statistical Package for Social
177 Sciences (SPSS version 20). The target population units analyzed in this study were women
178 farmers (adopters, incomplete adopters and non-adopters) in Nakuru County.
179 The quantitative data collected was tabulated and analyzed according to their frequency and
180 Percentages.
181 Qualitative analysis involved measure of central tendency (Cross tabulations,
182 proportions,means and percentages). Chi- Square was used because the data were categorical
183 and showing if there would be any relationships between the variables. ANOVA model was
184 used to determine the statistical significance of the means at $p < 0.05$ level and whether to
185 reject or
186 accept null hypothesis. *Post hoc* tests were used to test if the mean differences really existed.
187 Qualitative data was analyzed by determination of patterns and trends from the open ended
188 test items and interviews from respondents. The analyzed data were then presented in tables,
189 graphs.
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Results and Discussions

The research findings indicate that, out of 360 women small scale farmers in the study, 54 farmerspracticed CA, 204 practiced conventional farming and 387 practiced both CA and conventionalfarming. The decision by women farmers to adopt CA or not to adopt depended on environmental knowledge.

Table 1: Overall Mean Effects of environmental knowledge on adoption of CA

	N	Mean	Std. Deviation	Std. Error
Conventional	204	3.1873	.23891	.01673
CA	27	3.4704	.15396	.02963
Both	129	3.0357	.31888	.02808
Total	360	3.1542	.28885	.01522

The results in Table 1 indicate that farmers who are knowledgeable about environmentalissues are more likely to adopt CA practices. This is indicated by the high mean (3.47) among
farmers practicing CA compared to the other two groups. However to determine whether there was a significant difference in the means, ANOVA was carried out. The results are presented in Table 1

Table 2: ANOVA Test. Overall Effect of Environmental Knowledge on Adoption ofCA

Sum of Squares	df	Mean	Square F	Sig.
Between Groups	4.735 2	2.367	33.511	.000
Within Groups	25.219	357	.071	
Total	29.954	359		

The results in Table 3 showed that there was significant difference ($p< .05$) in the means of the three groups of farmers. Thus the null hypothesis which stated that there is no statistical Significant difference between environmental knowledge and influence on farmers' adoption of CA was rejected. This implies that there is a relationship between the farmers' knowledge on environmental issues and their adoption of CA practices.

To determine where the differences existed, *post-hoc* analysis was carried out using Bonferronitest. The results are presented in Table 3

**Table 3: Bonferroni Test Differences in the Means.**

(I) type of farming	(J) type of farming	Mean Difference	(I-J) Std. Error	Sig.
Conventional	CA	-.28312(*)	.05443	.000
	Both	.15160(*)	.02990	.000
CA Conventional		.28312(*)	.05443	.000
	Both	.43471(*)	.05625	.000
Both	Conventional	-.15160(*)	.02990	.000
	CA	-.43471(*)	.05625	.000

* *The mean difference is significant at the .05 level.*

The results have shown that, environmental knowledge to a great extent influence women farmers' adoption of CA. The null hypothesis which stated that there is no significant influence
of knowledge of the environment on women farmers adoption of CA has been rejected and

243 Environmental knowledge to a great extent influence women farmers adopt CA practices.
244 The figure 1 indicate that out of the indicators measured and tested minimum tillage crop
245 rotation protection of wetlands wildlife scored the highest while manure benefits scored the
246 lowest. The percentages responses to CA of all the indicators are above 50% meaning they all
247 influence women farmers adopt of CA.
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249 **The figure 1 shows percentage results of women response to indicators of knowledge of**
250 **environment.**
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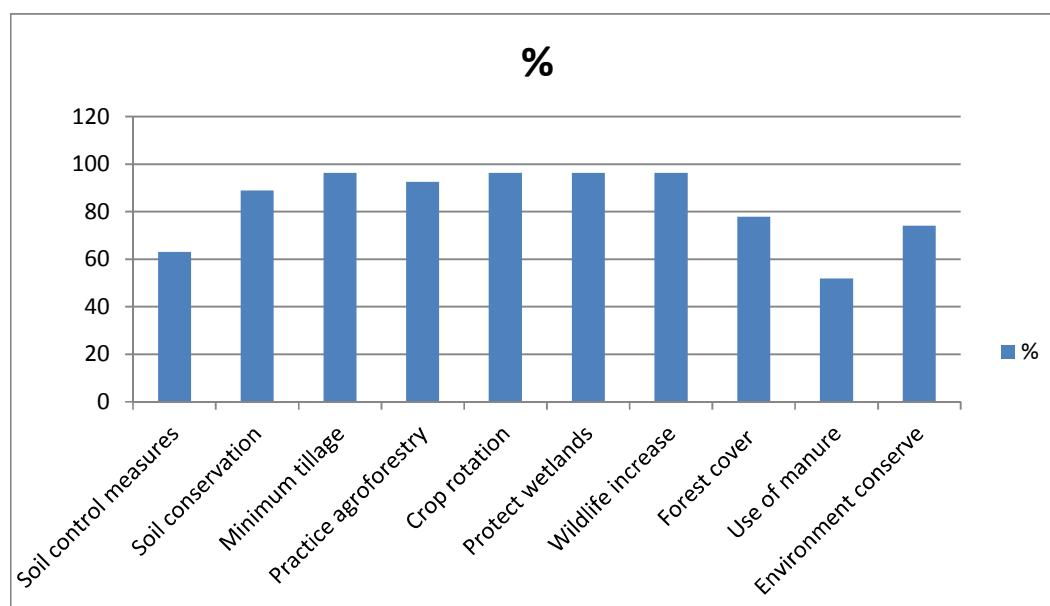
252
253
254 The figure 1 show that minimum tillage crop rotation and wildlife increase scored the highest
255 while soil control measures and use of manure were least regarding women knowledge of the
256 environment.
257 CA practices focus on best ways of increasing food production and protecting the
258 environment. It is imperative for farmers to have deep knowledge on ecosystem functions so
259 that they are able to practice farming methods which add value to the environment. Women
260 are known to have deep ethno indigenous knowledge on the environment and are good
261 managers of the environment. If women are given training on CA technologies they would do
262 better than men farmers.
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264 **Discussions**
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266 The knowledge of the environment influence on CA adoption was analyzed.
267 The study found that, farmers especially women are aware of environmental conservation
268 andsustainability. 80% of the women farmers practice conservation of the environment. The
269 roleof field staff help farmers continuously on; soil conservation, riparian protection to
270 maintainquality and quantity of flow of rivers for caring for aquatic life and human
271 consumption, safehandling of pesticides, safe disposal of pesticide containers, HIV/Aids /
272 STS, drug andsubstance abuse, lifestyle diseases, gender issues, soil fertility management,
273 agro forestry. Itwas noted that whether farmers practice CA or not, but they have some
274 moderate information.
275 The NGOS who help farmers in this study area are; Africa Conservation Tillage Network
276 Sustain Net – mainly for CA, FAO – sponsor some CA projects, Seeds of Gold Egerton

University,KALRO formerly KARI were found to be helpful in creating awareness to the women small scale farmers.

Women are known to have knowledge about environment. It is not clear if woman's knowledge of the environment helps them in farming practice. For any innovation regarding farming techniques, women to women contacts provide a better extension method in CA adoption.Farmers who adopted CA fully were influenced by Knowledge of the environment. Focusgroup discussions also voiced that the women farmers were generally influenced by knowledge of the environment.

The overall mean awareness of climate change was, CA adopters 3.47, non-adopters, 3.18 and incomplete adaptors 3.03. This explains that the mean of CA was higher in CA adopters hence extension methods influence women farmers adoption of CA. There could be other reasons why non-adopters did not adopt CA; could be age, education level size, of farms, equipment costs among others. Knowledge of the environment is very vital in the understanding of environmental dynamics which affect farmers daily.

It was also noted that most of the women farmers are educated and younger hence have to someextent have environmental knowledge. They are aware of the importance of planting trees, useof manure to protect soil and increase fertility, mulching, to conserve water, crop rotation tomaintain soil fertility, ripping to have little effect on soil structures and soil organisms whichare helpful in soil fertility, growing of drought resistant crops to cope with climate change.

Wildlife conservation is a problem because, most farmers have small farms less than 3 acres

Conclusions

The study established that knowledge of environment examined, significantly influenced womensmall scale farmers' adoption of conservation agriculture. The null hypothesis presentedfor testing was rejected at alpha value $p < 0.05$. Age, educationlevel and size of farms also influenced farmers adopting CA. The low rate of adoption inNakuru County by women farmers is therefore attributed to the degree of environmental knowledge. The study also provides explanation that, women farmers who did not adopt CA mayhave been influenced by other factors other than the one under study. It was observed thatgenerally the adoption of conservation agriculture was very low in Nakuru County. 15% ofthe farmers sampled fully adopted conservation agriculture and the rest did not adopt or triedboth systems for their own security reasons. Through discussions and interview schedules,women farmers adopters embraced CA because; it maintains soil fertility for a long time,prevent and control pollution, use minimal pesticides and herbicides, safe from food diseasesgot from crops when chemicals are used a lot, costs less, mitigate climate change, increasebiodiversity and conserve indigenous plants and animals that provide various ecosystemservices.

Recommendations

1. The ministry of agriculture should develop agricultural programs towards conservation agriculture.

2. Establish agricultural policies to encourage women farmers adopt conservation agriculture which is proving to provide higher benefits and conserving the environment for sustainable farming production.

3. The NGOs targeting women farmers are doing a good job but there is adisconnect when it comes to information sharing from their research. They need to share freely what affects women from adoption of CA.

4. Women small scale farmers seminars and training should be held within close proximity so that farmers especially women could attend with little cost. This will minimize cost for travel, meals, hotel charges and time for women who are always busy.

5. Ministry of agriculture and agricultural expert groups should use religious services opportunities to sensitize farmers the need to shift from industrial farming to conservation farming.

6. Women small scale farmers in the County lack moral and technical support and discouraged by government extension services because when the women farmers contact them, they do not have transport to visit in the field. The county government should have enoughcapitolto promote CA.

7. When farmers should have access to ICT, Smartphones and emergingtechnologies to create awareness and learn from other farmers' who are successfully practicing CA.

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