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# EFFECT OF CONSERVATION AGRICULTURE ON MAIZE PRODUCTION IN SAMIA SUB COUNTY OF BUSIA COUNTY KENYA

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**Abstract.**

This study sought to establish the effect of conservation agriculture practices on maize production in Samia Sub County. The study sought to establish the effects of conservation agriculture on maize production guided by three specific objectives namely: effect of minimum tillage, mulching and use of cover crops on maize production within Samia Sub County. The study used descriptive design since it encouraged the use of multiple worldviews by combining inductive and deductive thinking. This design also facilitated the description of the effects of conservation agriculture practices employed in maize production. Purposive sampling was used to collect data from 252 respondents who were chosen using purposive sampling from two groups namely; small holder farmers and community facilitators and agricultural extension officers. Data collection instruments included a questionnaire for farmers and a key informant(s) interview guide Data collected was cleaned, coded and analyzed with the aid of the Statistical Package for Social Sciences and the results presented in frequency distribution tables and narratives organized and discussed under the specific objectives of the study. The findings of the study revealed that there was an increase in maize production when minimum tillage and use of cover crops was employed whereas mulching had little or no effect on the increase of maize production in Samia Sub County. The major challenge faced by the small holder farmers'

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respondents was pest and weed control in their farms with lack of fences affecting the few that practiced mulching. The study recommended the following to ensure increased production: formation of small farmer groups to enable them access information easily from them the agricultural extension officer and the community facilitators, adoption of the push pull technology to combat weed and pest infestation of their maize fields and finally fencing off of pieces of land under maize crop to avoid destruction from foraging animals.

***Key words: conservation agriculture, minimum tillage, mulching, use of cover crops.**

**Introduction.**

Demand for maize as food has continued to rise with global production reaching over 840 million metric tons in 2010, (Lobell, Hammer, McLean, Messina, Roberts and Schlenker 2013). Despite continued growth in overall production, concerns have been raised about the ability to maintain rates of production increase in the face of climate change, (Lobell et al 2013). Maize is considered an economically and politically important cereal crop both in Asia and Africa and despite the importance of maize in Sub Saharan Africa, production remains low, (Logrono and Lothrop 1996).

In Kenya the production of maize stands at 28million bags against a requirement of 34 million bags annually, (KNBS 2009). Most small holder farmers use rudimentary farming practices leading to low maize production. In Samia sub county, maize production has been on sharp decline and this is attributed to poor conventional farming practices that lead low productivity. For Samia Sub County to increase it maize production, there is need to adopt conservation agriculture practices.

**Statement of the Problem**

Over 90% of farming in Kenya is based on conventional practices such as soil inversion, where crop residue is burned or fed to livestock, and a low level of fertilizer applied, (Kaumbutho and Kienzle, 2007). According to the Department of Agriculture Busia County (2017), maize production in Samia sub-county has been on the decline with 163,000, 41, 580, 38,900 bags

being harvested in 2014, 2015 and 2016 respectively. This has been attributed to the persistent use of conventional agricultural practices against an ever changing climatic condition. The idea of agricultural sustainability centers on the need to develop technologies and practices that do not have adverse effects on environmental goods and services, and that lead to improvements in food productivity.

**Research Objectives**

The main objective of this research was to establish the effect of Conservation Agriculture on maize production in Samia sub-county, Busia Kenya.

**Specific Objectives**

The following specific research objectives were:

1. To assess the effect of minimum tillage on maize production in Samia.
2. To establish the effect of cover crops on maize production in Samia.
3. To explore the effect of mulching on maize production in Samia.

**Minimum tillage**

Through minimum tillage, soil moisture is conserved and in turn it helps in the germination of maize.According to Tow, Cooper, Partridge, and Birch (2011), conservation agriculture advocates for adoption of reduced or zero tillage.Most of the agricultural benefits of zero tillage on maize production relate to increased organic matter in the soil. This results from the combination of eliminating soil disturbance in conventional tillage.There is an increase in biomass from improved crop productions through greater diversity of types of organic matter from cover crops, reduced erosion and differences in the assimilation and decomposition of soil organic matter from reduced surface soil temperatures and increased biodiversity

Conservation tillage practices such as minimum tillage have been observed to result in better soil structure and have higher soil organic carbon compared to conventional tillage practice, especially at the top soil depths (Kihara, Bationo, Mugendi, Martius, and Vlek 2011). Combined with crop residue applied as mulch, reduced tillage also conserves available rainwater important for crop growth. Such rainwater is currently lost in the magnitude of 70–85% from cropping

systems in sub-Sahara Africa through soil evaporation, deep percolation and surface runoff. The additional mulch produced by the crops could play a key role in reducing runoff and direct evaporation from the soil and often reduces the emergence of weeds.

According to Basch, Friedrich, Kassam,andGonzalez-Sanchez (2015), conservation agriculture is an approach to managing agro-ecosystems for improved and sustained productivity.This leads to increased maize productions while preserving and enhancing the resource base and the environment. Conservation agriculture is characterized by three linked principles, namely:Continuous minimum mechanical soil disturbance, permanent organic soil cover, diversification of crop species grown in sequences and or associations.

**Cover crops**

A cover crop is any living ground cover that is planted into or after a main crop and then commonly slashed before the next crop is planted (Hartwig and Ammon, 2002). Living mulches are cover crops planted either before or with a main crop and maintained as a living ground cover throughout the growing season.

Cover crops help promote biological soil tillagethrough their rooting; the surface mulch provides food,nutrients and energy for earthworms, arthropods andmicro-organisms below ground that also biologicallytill soils. Hobbs et al (2008), proposes the use of deep-rooted cover crops to help to relievecompaction under zero-tillage system.

Gupta and Sayre (2007), state that conservation agriculture maintains a permanent or semi-permanent organic soil cover. This can be a growing crop or dead mulch. Its function is to protect the soil physically from sun, rain and wind and to feed soil biota.

**Mulching**

Mulch tillage as a practice is based on the principle of causing least soil disturbance and leaving the maximum of crop residue on the soil surface and at the same time obtaining a quick germination, and adequate stand and a satisfactory yield (Lal 1974).

According to Tolk, Howell and Evett (1999), tillage practices that maintain crop residues on soil surface help reduce evaporation of soil water which can benefit high water use crops such as maize. The crop residues on soil act as a screen from the high temperatures. Tolk et al (1999), further postulate that the maize production increase in the Southern plains of USA was generally credited to increased water content in the soil due to reduced evaporation. The need by farmers in Samia Sub County to embrace use of mulch is great since the area tends to experience high temperatures that is not favorable for optimum maize production.

Lal (1974) investigated the effect of mulching on maize yield in luvisol and cambisol tropical soils during 1970–72. The increase in grain yield by mulching was 46, 52 and 22 per cent respectively, for 1970, 1971 and 1972. From the investigation, mulched plants had higher growth rate and vigor and chlorotic symptoms of nutritional disorders were observed only for unmulched plants. Mulching significantly decreases the maximum soil temperature. In the initial stages of crop growth, temperature differences of as much as 8°C were observed between mulched and unmulched plots at a 5-cm depth. Mulched plots also have a higher soil moisture content. Increase in grain yield by mulching is attributed primarily to a decrease in soil temperature and partly to improved soil moisture regime.

## RESEARCH DESIGN AND METHODOLOGY

### Research Design

This study adopted the descriptive research design with both quantitative and qualitative approaches. Descriptive research is an attempt to collect data from members of a population in order to determine the current status of that population (Mugenda and Mugenda, 1999). This design was appropriated to the study since it facilitates the description of the characteristics and the relationship between maize production and conservation agriculture practices employed. Descriptive research describes “what is” and is concerned with conditions or relationships that exist, opinions that are held, processes that are going on, effects that are evident or trends that are developing (Best and Khan, 1993).

**Sample and Sampling Techniques**

According to Kothari (2004) a sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or the procedure the researcher would adopt in selecting items for the sample. Kothari further argues that a sample design may as well lay down the number of items to be included in the sample like the size of the sample.

Kothari (2004) states that a sample refers to the number of items to be selected from the universe to constitute a sample. Krejcie and Morgan (1970) have provided a table of determining sample size for different populations (Appendix IV). The table is based on a formula which gives a sample size that when drawn randomly from a finite population size, is such that the sample was within ±0.5 margin of error of the population proportion with a 95% level of confidence. Therefore, the sample size for the study was 276 respondents.

Sampling refers to the selection of some part of an aggregate or totality on the basis of which a judgment or inference about aggregate or totality is made. Having adequate numbers of subjects is one consideration, but the method of obtaining the sample is even more critical (Draugalis and Plaza, 2009).

Purposive sampling technique was adopted to ensure that only farmers practicing conservation agriculture were selected. The inherent bias of this method contributed to its efficiency, and the method stays robust even when tested against random probability sampling. According to Tongco (2007), choosing purposive sample is fundamental to the quality of data gathered; thus, reliability and competence of the informant must be ensured. This also strengthens Kothari's view of some designs being relatively more precise and easier to apply than others hence researchers should select a sample design which is reliable and appropriate for their research study.

**The effect of conservation agriculture on maize production in Samia Sub County, Busia County -Kenya.**

To establish the effect of minimum tillage on maize production in Samia various statements were drawn. The statements were likert scaled on level 1 to 5, whereby 1= no extent, 2= little extent, 3= undecided, 4= great extent and 5= very great extent. The results are as presented in table 4.1

Table 4.1:

| **Extent to which minimum tillage has affected maize production in your farm** | | | |
|---|---|---|---|
| | Frequency | Percent | Cumulative Percent |
| No extent | 5 | 2.0 | 2.0 |
| Little extent | 135 | 54.4 | 63.7 |
| Undecided | 18 | 7.3 | 9.3 |
| Great extent | 60 | 24.2 | 87.9 |
| very great extent | 30 | 12.1 | 100.0 |
| Total | 248 | 100.0 | |

From table 4.1, 54.4% of the respondents stated that minimum tillage had a little effect on maize production in their farms whereas 24.2% and 12.1% said that they had experienced some great extent and very great extent respectively. The small holder farmer respondents stated that minimum tillage had brought some positive change in maize production in their fields. Minimum tillage advocates for less soil disturbance hence the soil fertility remains intact and the moisture content in the soil assists the maize in the germination process. Samia sub county experiences high temperatures by virtue of it being in close proximity to Lake Victoria, the high temperatures are not very conducive to maize germination and hence minimum tillage helps in conserving soil moisture which is vital in the germination process of maize. Rathore, Pal and Sahu (1998),confirm that minimum tillage enhances soil moisture conservation and moisture availability during crop growth. As a consequence, crops planted get enough water to assist in the germination process.

Table 4.2:

| **Extent to which minimum tillage has increased maize production in your Farm** | | | |
|---|---|---|---|
| | Frequency | Percent | Cumulative Percent |
| No extent | 5 | 2.0 | 2.0 |
| Little extent | 135 | 54.4 | 63.7 |
| Undecided | 18 | 7.3 | 9.3 |
| Great extent | 60 | 24.2 | 87.9 |
| very great extent | 30 | 12.1 | 100.0 |
| Total | 248 | 100.0 | |

Table 4.2 shows that 54.4% experienced a little increase in their maize production when they embraced minimum tillage. 24.2% and 12.1% of the respondents experienced a great extent and very great extent respectively. Most farmers recorded between 3-4 (80Kgs bag) bags of maize per acre under minimum tillage unlike under conventional agriculture where they would get 1 bag or less per acre. This shows that by the farmers switching to minimum tillage as a conservation agriculture practice they were able to increase their harvests compared to when they were practising conventional agriculture. According to the farmers conservation agriculture had helped reduce the wilting of maize at germination stage due to less moisture content in the soil.

The results from the above table affirm Derpsch et al (2010) and findings that minimum tillage unlike the unsustainable intensive tillage practices is superior in terms of higher maize production. Lal (1976) also affirms this when he asserts that no tillage farms in Nigeria produced higher crop yields.

Table 4.3:

**Extent to which use of cover crops has affected maize production in your farm**

| | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| No extent | 6 | 2.4 | 2.4 |
| Little extent | 58 | 23.4 | 29.8 |
| Undecided | 10 | 4.0 | 6.5 |
| Great extent | 166 | 66.9 | 96.8 |
| Very great extent | 8 | 3.2 | 100.0 |
| Total | 248 | 100.0 | |

Table 4.3 shows that 66.9% of the respondents use cover crops in their farms having a great effect on their maize production. A further 23.4% of the respondents said that they experienced some little effect on their maize production. 4% of the respondents were undecided on whether cover crops had any effect on maize production since they practiced it just as a means of adding to their cereal output and not as a conservation agriculture strategy. A small percentage (2.4%) of the respondents stated that use of cover crops had no impact at all on maize production. Most of

the farmers falling under the undecided category and those in the little extent category stated that the use of cover crops brings about weed and pest infestation. This assumption has been disputed by scholars like Abdin et al (2000) who categorically state that weeds are best controlled by use of cover crops in maize fields. Fisk et al(2001), from their research in Michigan also found that use of cover crops helps suppress weeds and thus production.

From the table 4.3, it shows that use of cover crops in maize production as a conservation agriculture practice adds great value to the production process as compared to those who do not subscribe to the use of cover crops. This affirms Hartwig and Ammon (2002) research on the use of cover crops and its benefits toother plants through increase in nitrogen in the soils, thus in turn increasing production.

Table 4.4:

**Extent to which use of cover crops has increased maize production in your farm**

| | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| No extent | 6 | 2.4 | 2.4 |
| Little extent | 58 | 23.4 | 29.8 |
| Undecided | 10 | 4.0 | 6.5 |
| Great extent | 166 | 66.9 | 96.8 |
| Very great extent | 8 | 3.2 | 100.0 |
| Total | 248 | 100.0 | |

From table 4.4, 2.4% of the respondents said that use of cover crops had no impact at all on the increase maize production in their farms whereas 3.2% said that it had a very great impact. A further 23.4% of the respondents stated that maize production had increased to some little extent due to adoption of cover crops whereas 66.9% of the respondents stated that cover crops had increased maize production to a great extent. Most farmers recorded between 5-6 (80Kgs bag) bags of maize per acre through use of cover crops unlike under conventional agriculture where they would get 2 bag or less per acre. The table depicts that maize produced under use of cover crops is higher compared to maize produced under conventional agricultural methods. 4% of the

respondents were undecided as to whether use of cover crops increase maize production or not. This could be due to them combining several conservation agriculture practices hence they cannot tell which strategy is more effective.

Table 4.5:

**Extent to which use of mulch has affected maize production in your farm**

| | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| No extent | 77 | 31.0 | 31.0 |
| Little extent | 12 | 4.8 | 81.0 |
| Undecided | 112 | 45.2 | 76.2 |
| great extent | 36 | 14.5 | 95.6 |
| very great extent | 11 | 4.4 | 100.0 |
| Total | 248 | 100.0 | |

Table 4.5, 31% of the respondents stated that mulching had no effect at all on maize production whereas 45.2% of the respondents said there was no extent. According to Bu et al (2013),maize is usually sensitive to high temperatures at the seedling stage. For production to be increased, mulching is used to help in lowering the surface temperatures of the soil. From the above table it shows that the most respondents either do not understand the importance of mulching, or for fear of their maize being ravaged by foraging animals they prefer not to embrace mulching.

Table 4.6:

**Extent to which use of mulch has increased maize production in your farm**

| | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| No extent | 77 | 31.0 | 31.0 |
| Little extent | 12 | 4.8 | 81.0 |
| Undecided | 112 | 45.2 | 76.2 |
| great extent | 36 | 14.5 | 95.6 |
| very great extent | 11 | 4.4 | 100.0 |
| Total | 248 | 100.0 | |

Table 4.16 shows that 31% of the respondents said that mulching had no effect at all on increase of maize production whereas 45.2 % of the respondents said it had no effect. Of the total respondents only 14.5% and 4.4 % said that mulching had increased maize production in their farms. The high percentage of respondents who stated the mulching had no effect on maize production confirmed that they use plant remains as fodder for their domestic animals as opposed to mulch. Farmers recorded between 1-2 (80Kgs bag) bags of maize per acre under mulching due to constant intrusion into their farms by foraging animals. But the 4.4% who had protected their farms stated that through mulching, they were able to increase their maize production to over 7 bags per acreage.

The challenges facing small holder farmers practising minimum tillage are weed control which usually attack the maize crop since minimum tillage advocates for little or no soil disturbance. The findings of this study support Grichar and Boswell (1987) study that stated that minimum tillage though being cost effective, poses a challenge in weed control hence reduced production if not well managed.

Another study by Wall (2007), stated that minimum tillage involves a change of mind set by the farmer. The above table shows that 11.3% of the respondents said that they had a formed opinion on minimum tillage as opposed to conventional agriculture.

Challenges associated with use of cover crops as a conservation agriculture strategy was pest and animal control. Out of 248 farmer respondents, 177 (71.4%) stated that cover crops such as beans easily attract animals in to the maize fields hence the maize gets trampled on and fails to germinate. Some of the animals also forage on the germinating maize hence interfering with the yields in the long run.

Lack of cover crop variety was also sighted as a challenge on use of cover crops by 28.6% of the farmer respondents. Most of the farmers easily access beans as a cover crop though it attracts pests and animals into their maize fields. The other variety which is the lablab bean though being the best is not readily available in the markets and is rather expensive for the farmers.

That foraging animals were a biggest challenge to mulching. This has dissuaded the respondents into shying away from practising mulching. This shows that most farms are not fenced and hence easily attract animal.

Pest infestation on maize fields covered with mulch was also sighted as a problem with 18.1% of the farmer respondents stating that the mulch attracts many pests into their farms hence they suffer losses on their maize crop. This shows that most of the 18.1% farmer respondents practising mulching do not spray their farms with pesticides and hence the maize get vulnerable to pest hence reduced maize yields.

**Conclusion**

From the study, majority of the respondents from all categories agreed that both minimum tillage and use of cover crops are best suited to increase maize production as opposed to conventional agricultural methods. This implies that with the continuous embracing and spreading of minimum tillage and cover crops as conservation agriculture strategies, Samia Sub County can be food sufficient. The implication here is that the farmers can be able to produce maize in surplus while at the same time conserving their environment. Some of the farmers who practice minimum tillage combine it with use of cover crops so as to reap the maximum benefits of conservation agriculture.

Use of mulch as a conservation agriculture strategy has not been fully embraced by the farmers since most of their fields are not fenced and hence other locals easily graze their cattle in the open fields after post-harvest. The cattle feed on the plant remnants that would have been used as mulch during the new planting season thus leaving the fields with no mulch.

According to Kassam et al 2009, conservation agriculture requires a deeper understanding of its ecological underpinnings in order to manage its various elements for sustainable intensification, where the aim is to optimize resource use and protect or enhance ecosystem processes in space and time over the long term. It is knowledge-intensiveand brings a fundamental change in production system thinking.

For minimum tillage to effectively be adopted by many small holder farmers, they need to form vibrant groups that will enable them easily access information and training from both the agricultural officer and the community facilitators. Through this they can assist each other to carry out weed control; attitude changes on minimum tillage and its benefits. The County government and Kalro should endeavor to have a minimum tillage adopted by all farmers so as to ensure increase in maize production both in Samia-Busia County and in Kenya.

The introduction of a special kind of grass by ICIPE which attracts the pests and is also safe for animal consumption will go a long way in tackling some of the challenges that come with adoption of use of cover crops. The 'mlato' grass is planted around the edges of the field so as to 'pull' the pests away from the maize and cover crop in the field. This push pull technology as advocated by Khan et al (2011) is the best and simplest way of protecting planted maize in the fields. The technology is highly appropriate for smallholder farmers who do not purchase seasonal inputs. This has been known to increase maize yields for these farmers. According to Amudavi et al (2008), planting of Napier grass on the edges of the farm acts as a deterrent from striga weed. Napier grass (pull), is planted as a border crop around this intercrop. Gravid stem borer females are repelled from the main crop and are simultaneously attracted to the trap crop
According to FAO (2017), it is important to choose the precise moment at which the vegetative cover is controlled, because most of the species used can regenerate if their growth is interrupted prematurely. Alternatively, seeds of the cover crop can germinate if the plants are allowed to mature, as may happen with oats, rye, chickpea, and vetches and forage radish. There are, however, species and rotations where cover crops are purposely brought to maturity to establish a seed bank which will allow the cover crop to grow automatically once the cash crop is harvested. Through its agricultural agencies, both the national and county governments should ensure that maize farmers adopt the push pull technology so as to reduce pest infestation on maize crops and thus increase production.

The small holder farmers had stated that use of mulch exposes them to foraging animals and hence their crops are affected. For this problem to be tackled effectively, there is need to fence their pieces of land with barbed wire fence or with live fences. The animals could also be tethered to prevent them from straying into the farms and thus enabling the farmers to effectively

practice mulching. The option would be for farmers to set aside part of their land specifically for grazing their cattle hence reducing the chances of the animals venturing into their crops.

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