Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol. 3, No.10, 2013

Does Conservation Agriculture Matters in Swazis' Economy? Evidence from Maize Producing Farmers in Ngwempisi Rural Development Area of Swaziland

Job Olatunji Oladeebo*[1, 2], Cebile S. Mkhonta[1]
1. Department of Agricultural Economics and Management, Faculty of Agriculture, Luyengo Campus, P.O. Luyengo, M205, Luyengo, University of Swaziland, Swaziland. Southern Africa.
2. Department of Agricultural Economics, Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, P.M.B 4000, Ogbomoso, Nigeria. Western Africa.
*E-mail of corresponding author: joladeebo@uniswa.sz

Abstract
The purpose of the study was to determine the economic impact of conservation agriculture on maize production in the Ngwempisi Rural Development Area of Swaziland. Data were obtained from maize farmers distributed equally among farmers practicing conservation agriculture and conventional agriculture. Data obtained were analyzed by the use of descriptive analysis as well as budgeting technique of analysis. Results showed that maize farmers operating under conservation agriculture obtained higher profit level with an average gross margin of about E 3609 compared with an average gross margin of about E161 obtained for maize farmers who operated under conventional agriculture. Majority of farmers practicing conservation agriculture were males with an average age of about 48 years. It was recommended that famers who are currently not practicing conservation agriculture should adopt the method.
Key words: Conservation agriculture, production, input costs, Swaziland

1. Introduction

Swaziland is a small, mountainous and landlocked country in Southern Africa with an economy based largely on agriculture and agro-forestry which contributes 13% to the country's Gross Domestic Product (Swaziland annual report, 2012). Food security is threatened by a number of factors including low rainfall, soil erosion, rising unemployment rates and increasing poverty. (Swaziland annual report, 2012) Swaziland also has one of the highest rates of HIV/AIDS in the world (which is estimated to be 26.1% of adults and over 50% of adults in their 20s), wide spread ill health and the ensuring loss of income have worsened the already severe impact of adverse weather.

Large populations (0.9%) of Swazis die each year due to hunger and unhealthy diets as a result of poverty and unemployment (FAO, 2007) and thus The United Nations Food and Agricultural Organization (FAO) is trying to deliver programmes that aim to enhance sustainable livelihoods for the most vulnerable households and conserve the environment at the same time. Swaziland is one of many countries affected by the global food crisis. The United Nations Food and Agricultural Organization (FAO) is helping poor farmers in Swaziland to boost their agricultural production through the introduction of conservation agriculture which could be used in soil conservation.

Soil conservation is a set of management strategies for prevention of soil being eroded from the earth's surface or becoming chemically altered by overuse or chemical soil contamination (FAO, 2007). Conservation Agriculture is one of the best strategies introduced as a method of soil conservation in Swaziland and which has left farmers happy with their yields and has minimized their costs FAO (2007).

Conservation Agriculture (CA) is a concept for resource-saving in crop production that strives to achieve optimum profits together with high and sustained production levels while concurrently conserving the environment, (FAO, 2007). Maize is the most grown crop in Swaziland because it is the most stable food item being consumed by almost all the citizens of Swaziland. CA has emerged as an alternative to conventional agriculture as a result of losses in soil productivity due to soil degradation (FAO, 2011). CA was introduced to solve the problems associated with conventional agriculture such as the problem of tillage which is responsible for natural resource and soil degradation. CA can also be defined as minimal soil disturbance (no-till) and permanent soil cover (mulch) combined with rotations, as a more sustainable cultivation system for the future.

According to Masimula (2009), a CA specialist in FAO office in Swaziland, CA is about regeneration of soil and restoration of land to its original functionality. In general, CA includes any practice that reduces changes or eliminates the soil tillage and avoids the burning of residue in order to maintain adequate surface cover throughout the year (FAO, 2001). CA has three key principles that producers (farmers) can use in order to be successful with CA. The three key principles includes minimum mechanical soil disturbance, managing the top soil to create a permanent organic soil cover and practicing crop rotation with more than two crop residues.

Since the adoption of CA in 2002 by the Cooperation for the Development of Emerging countries (COSPE) and Food and Agriculture Organization (FAO) there has been a change in the way people react towards the adoption of CA in the country.

The introduction of Conservation Agriculture in Swaziland began in 2002 and was intended to alleviate food shortages and ensure food security among the less privileged rural households. This move was a response to the frequent drought, crop failures and land degradation especially in areas with poor soils. A preliminary survey by Mlipha (2007) showed low levels of crop productivity in Shewula due to soil erosion, mono-cropping with maize and vulnerability to draught. Shewula was therefore selected to be one of the pilot sites for Conservation Agriculture (Mlipha, 2010). Over the years FAO continued expanding and up scaling the promotion of CA on Swazi Nation Land. One of the beneficiaries of the CA up scaling programme was the Ngwempisi Rural Development Area (RDA). CA was introduced in Ngwempisi RDA in the year 2007.

1.1 Statement of the problem

Swaziland is one of the countries that is greatly affected by soil erosion which is the removal of top soil due to heavy rainfall on land that is not protected by a layer of mulch (FAO, 2001). Tilling of the soil is a practice done in conventional agriculture greatly promoting soil erosion and crusting of soils because it loosens the soil making it vulnerable to soil erosion thus promoting soil degradation and a decrease in soil fertility. Soil tillage is also responsible for destroying organic matter that is provided within the soil cover, mineral loss and water loss within the soil.

Tillage of the ground in preparation of maize plantation in Swaziland requires more money from the farmer due to the fact of fuel for tractors or feed for animals pulling the plough in order to till the ground. A lot of labour is also needed to carry out and manage the tilling activity. Majority of farmers in Swaziland mainly from the rural areas lack the adequate funds for soil preparation thus leading to a reduction in maize production and an increase in hunger and poverty. Maize production ends up being expensive for majority of Swazi farmers thus leading them not to produce to their utmost capabilities. No study has been conducted on maize production and conservation agriculture in Swaziland, hence the necessity for this study. Thus, the study was guided by the following research questions:

1. What are the socioeconomic characteristics of farmers practicing conservation agriculture and those who are not?
2. Are the farmers currently practicing conservation agriculture in maize production experiencing an increase in profits due to a decrease in costs of production?
3. Does practicing conservation agriculture increase the production of maize?

1.2 Objectives of the Study

The main objective was to determine the economic impact of conservation agriculture on maize production in Swaziland, while the specific objectives of the study were:

- To identify and discuss the socioeconomic characteristics of farmers practicing conservation agriculture and those who are not practicing conservation agriculture.
- To determine if practicing conservation agriculture increases profits due to reduced costs of maize production.
- To determine if farmers currently practicing conservation agriculture on maize production are experiencing an increase in production.

1.3 Hypothesis

It was null hypothesized that: there was no significant difference between the total output of farmers practicing CA and those who are not.

1.4 Research justification/rationale

Swaziland is a country with a majority of poor people who are mostly affected by poverty and hunger (FAO, 2005). Swazi farmers could not afford all the costs that are associated with growing maize from buying seeds, tools, fertilizer and up to hiring of tractors. Thus, this study was conducted to confirm if conservation agriculture is a cheaper method of farming and at the same time conserves the soil while increasing the productivity of maize. Swazi soil is also greatly affected by soil erosion and crusting of the soil due to soil tillage thus leading to soil degradation (FAO, 2007). Tillage erosion is a huge problem in Swaziland due to lack of knowledge of safer ways of farming (FAO, 2007).

2.0 Conceptual framework

Lu *et al* (2000) states that soil conservation is a set of management strategies for prevention of soil being eroded from the earth's surface or becoming chemically altered by overuse, acidification, salinization or other chemical soil contamination. Soil conservation is mainly about solving the problems of land degradation, conservation agriculture is a form of soil conservation, (Green *et al*, 2005).

2.1 Conservation agriculture (CA)

Conservation Agriculture is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment (FAO, 2007). CA can also be defined as minimal soil disturbance (no-till) and permanent soil cover (mulch) combined with rotations, as a more sustainable cultivation system for the future. CA promotes the concept of optimizing yields and profits while ensuring provision of local and global environmental benefits and services.

CA is much more than just zero tillage because that alone will not restore and conserve the soil. True CA practices not only conserve the soil, but also the soil moisture. They capture carbon and are entirely compatible with the axioms of Sustainable Land Management. CA has been shown to work with a wide range of food and cash crops. It can also be used for plantation crops, agro-forestry being only one example.

Conservation agriculture is comprised of a number of technologies that, when used together, can limit, arrest, or reverse the effects of unsustainable agricultural practices, especially soil erosion, soil organic matter decline, and physical degradation of the soil, while at the same time reducing excessive pesticide and fuel use. Conservation agriculture aims to produce stable crop yields while reducing production costs, maintaining soil fertility, and conserving water. Practicing conservation agriculture may at first seem daunting; however, once farmers take up the challenge they will find that the benefits are very rewarding.

Conservation agriculture (CA) aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production. It can also be referred to as resource efficient or resource effective agriculture, (FAO, 2001).

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. The soil micro-organisms and soil fauna take over the tillage function and soil nutrient balancing. Mechanical tillage disturbs this process. Therefore, zero or minimum tillage and direct seeding are important elements of CA. A varied crop rotation is also important to avoid disease and pest problems (FAO, 2001).

Conservation agriculture does not just mean not tilling the soil and then doing everything else the same. It is a holistic system with interactions among households, crops, and livestock since rotations and residues have many uses within household; the result is a sustainable agriculture system that meets the needs of farmers. CA can be done on the flat or on raised beds; in both cases the three pillars of CA are followed (Sayre and Hobbs, 2004).

2.2 Key principles

The Food and Agricultural Organization of the United Nations (FAO) has determined that Conservation Agriculture has three key principles that producers (farmers) can use in order to do the process of Conservation Agriculture successfully. These three principles outline what conservationists and producers believe can be done to conserve what we use for a longer period of time.

- The first key principle in CA is practicing minimum mechanical soil disturbance which is essential to maintaining minerals within the soil, stopping erosion, and preventing water loss from occurring within the soil (FAO, 2007).
- The second key principle in Conservation Agriculture is the principle of managing the top soil to create a permanent organic soil cover can allow for growth of organisms within the soil structure (Hobbs *et al*, 2008; FAO, 2007).
- The third principle is the practice of crop rotation with more than two crop species. Crop rotation can be used best as a disease control against other preferred crops (Hobbs *et al,* 2008).

3.0 Research Methodology

3.1 Study area

The study was conducted at the Ngwempisi Rural Development Area, an area under the Manzini region of Swaziland. The Ngwempisi RDA is under the Highveld region, a good climatic region for maize production. The Ngwempisi RDA is easily accessible since it is near to the Mankayane town.

3.2 Sample size and sampling technique

This study made use of 50 farmers from which information for the analysis were sought. 25 farmers among the 28 farmers practicing CA were simple randomly selected and 25 farmers among other farmers who were not practicing CA were also simple randomly selected in order to determine the amount of maize the farmers would be producing and the costs they would be incurring if they were not practicing CA.

3.3 Source and type of data

The study made use of primary data which were elicited from both maize farmers who practiced CA and those who did not in the study area.

3.3.1 Technique of data collection

Structured questionnaire was used to obtain the primary data from the maize famers in the study area. Clear short questions were used for the questionnaire in order to acquire the necessary information from the farmers, the way to answer the questions was clearly explained to the farmers prior to them filling the questionnaire.

3.3.2 Technique of data analysis

1. *Descriptive statistics*

The first and third objective were analysed by the use of descriptive statistics such as tables, frequency counts, percentages, pie charts, bar charts and averages. Descriptive statistics provide simple summaries about the sample and the measures. Together with simple graphics analysis, they form the basis of quantitative analysis of data.

2. *Gross margin analysis*

The second objective was analyzed using the gross margin analysis. This is the analysis of the income above variable cost for each enterprise needed to be considered in the farm plan. It is the measure of the difference between total revenue and total variable costs incurred in production.

4.0 Results and Discussion

4.1 Socioeconomic characteristics of farmers

It could be seen from tables 1 and 2 that farmers who are currently practicing conservation agriculture (CA) are mostly below 50 years. A larger proportion (60%) of the population was below 50 years while 40% of the population was above 50 years but below 80 years. This is so because practicing CA requires energy. Older people do not have such energy and they at the same time are more reluctant than younger people to adopt new technologies. The minimum age of this category of farmers was 21 years, while the maximum age was 73 years. The mean age stood at about 48 years, while the standard deviation was about 12 years. From the mean age, it could be seen that farmers who practiced CA are mostly growing old.

However, farmers who are currently not practicing CA are mostly above 50 years, this is so because older people are more reluctant to adopt to new technologies than younger people. A larger proportion (56%) of the population was above 50 years while 44% of the population was below 50 years. The minimum age was 26 years, while the maximum age was 75 years. The mean age stood at about 52 years, while the standard deviation was about 14 years.

Figure 1 shows the distribution of the farmers by gender. A larger proportion (56%) of farmers that are practicing CA were males and just 44% were found to be females. This was so because practicing CA requires a lot of energy. Practicing CA is also time consuming and females in the Swazi set up usually have a lot of chores to do. On the other hand, out of the farmers that were not practicing conservation agriculture, 44% were found to be males and 56% were found to be females. Females tend to prefer convectional agriculture because it is not time consuming and does not require a lot of energy.

4.2 Analysis of the profitability level of maize production under conservation agriculture and conventional agriculture.

Tables 3 and 4 show the average costs and returns for farmers practicing CA and conventional agriculture respectively. It is clearly shown that CA was more profitable (PI of 4.96) than conventional agriculture (PI of 1.05). CA lowers the total variable costs as well as an increase the amount of gross revenue which led to its being more profitable than conventional agriculture. Farmers practicing CA had average gross revenue of E4 520 while those who were not practicing CA had average gross revenue of E3 320. This shows a difference of E1 200 which means that farmers who are currently practicing CA show a higher amount of returns than farmers who are not practicing CA. It should be noted that the two categories of farmers were exposed to the same inputs and outputs market conditions.

Farmers producing maize with the use of CA experienced lower average costs because lesser amounts of the inputs were used in CA. The total average variable costs for those who are practicing CA was E911.20 while for those who are not practicing CA was E3 158.80. Practicing conservation agriculture does not require the use of tractors thus no tractor costs were incurred while those who are not practicing CA required the use of tractor and incur average cost of E625.60. A larger percentage costs of those who are not using conservation agriculture comes from fertilizer costs. Large quantities of fertilizer were used thus resulting in higher costs. The average costs of fertilizer for those farmers operating under conventional agriculture was E1 604.00 while those who are practicing conservation agriculture only incur an average cost of E542.40. The average cost of seeds is another great expense to farmers who are not practicing conservation agriculture, with an average cost of E809.20 while those who are practicing CA incurring an average of E204.00. This shows that a smaller quantity of seeds is used in CA and it results in lower costs.

The calculations of the profitability index also prove that CA is more profitable than conventional agriculture. This is so because CA's profitability index is 4.96 while conventional agriculture's profitability index is 1.05.

This means that CA results in an increase in the profitability of maize production.
Table 5 shows the statistics of the output levels of maize production for the two categories of farmers. Practicing conservation agriculture was shown to have a minimum production level of 450 kg of maize per hectare while on the other hand practicing conventional agriculture shows a minimum level of 150 kg. This shows that some farmers that were practicing conventional agriculture were getting low yield of 150kg which is lower than the minimum (450kg) of conservation agriculture. Farmers practicing conservation agriculture obtained up to a maximum of 1800kg output of maize while conventional farmers had only a maximum output of 1250 kg of maize. CA records higher output levels than conventional agriculture. This shows that CA produced more output of maize than conventional agriculture.
The mean output level for CA was 1130 kg while the mean output level of conventional agriculture was 830 kg. The output levels of the two methods had a difference of 300 kg, indicating that CA results in higher output yields by 300 kg compared to conventional agriculture.

4.3 Test of hypothesis

The results of the hypothesis tested are presented in tables 6 and 7. The paired t-test statistics was used to test the hypothesis which is to asses if farmers currently practicing conservation agriculture on maize production are experiencing an increase in production. Two samples were used, of which one sample was of farmers currently practicing CA and the other was of those who are not. 25 farmers per sample were used to determine whether there is a significant difference in the level of output. The two means of outputs were compared using the paired samples T- test statistics from which it is shown in tables 6 and 7 that there is a significant difference between the two means. The mean for those who are currently practicing CA is 1 130 kilograms and the mean for those who are not is 830 kilograms per hectare. It is shown in table 7 that the difference between the two means is 300 kilograms of maize per hectare. This means that farmers that are currently practicing conservation agriculture have a greater output than those who do not by 300 kg of maize.
The calculated value of t is 3.238 while the tabulated value of t is 2.064, implying that the calculated value of t is greater than the tabulated value. Since the calculated value is greater it means that this test falls under the reject region and the null hypothesis is rejected. The alternative hypothesis which states that $\mu 1 \neq \mu 2$ is accepted, this means that there is a significant difference of 300kg between the 2 means and practicing CA results in a greater output.
The p value also supports the same notion, since $\alpha = 0.05$ and the p value is 0.004. It is clear that the p value falls under the reject region because it is smaller than α which implies that the null hypothesis was rejected and the alternative hypothesis was accepted.

5.0 Conclusion

The study aimed at confirming if the CA matters in Swazi economy, specifically maize production in Swaziland by CA. This is because a majority of farmers in Swaziland mainly from the rural areas lack the adequate funds for input costs thus leading to a reduction in maize production and an increase in hunger and poverty. Maize production ends up being expensive for the majority of Swazi farmers thus leading them not to produce to their utmost capabilities.
The results of the study show that CA matters for Swazi farmers because it was found that CA increases the output of maize production. The average maize output obtained by those farmers practicing conservation agriculture was increased by 300kg per hectare compared to those farmers who were not practicing conservation agriculture.
Conservation agriculture was more profitable than conventional agriculture in the study area. A gross margin of about E3609 was obtained by farmers practicing CA as compared to the paltry gross margin of about E161 obtained by famers practicing conventional agriculture. This shows that CA matters for Swazi farmers, all other things being equal, because it requires less costs and yet resulting in higher yields with subsequent higher profit level compared to other methods of farming.
It is therefore recommended that famers who are currently not practicing CA should adopt the method because;

- Farmers who are using conservation agriculture are experiencing an increase in yields with subsequent higher profit level.
- Farmers using this method have seen CA to result in lower input costs.

References

Food and Agriculture Organization Annual Report (2001), Agriculture and Consumer Protection Department. Rome, Italy http://www.fao.org/ag/ca/
Food and Agriculture Organization (2005), Conservation Agriculture Holds Promise for Food Production in Africa. http://news.mongabay.com/2005/1004-fao.html 05/03/2012
Food and Agriculture Organization annual report (FAO) (2007), Agriculture and Consumer Protection

Department. Rome, Italy http://www.fao.org/ag/ca/
Food and Agriculture Organization Annual Report (2011)
Green, R.E, S.J Cornell, J.P.W. Scharlemann and A. Balmford (2005). "Farming and the Fate of the Wild Nature" *Science*, **307**(5709): 550-555
Hobbs, P.R., K. Sayre and R. Gupta (2008), "The Role of Conservation Agriculture in Sustainable Agriculture". *Philosophical Transactions of the Royal Society for Biological Sciences* **363** (149): 543-555
Lu Y.C, Watkins K.B, Teasdale, J.R, and A.A. Abdul-Baki (2000). "Cover Crops in Sustainable Food Production". *Food Reviews International* **16** (2): 121-157
Masimula Ndumiso. Food and Agriculture Organization employee, personal interview on the 31st of October 2009
Mlipha, M. (2007). A Study of the Factors Guiding the Selection of Crops, Cropping Patterns and Purposes of Cultivation of Crops among Subsistence Farmers of Shewula. *Unpublished B.Sc. Thesis*, Luyengo: University of Swaziland.
Mlipha, M. (2010). *The Introduction and Practice of Conservation Agriculture in Swaziland.* University of Swaziland, Pp. 225-241.
Swaziland annual report (2012) http://swaziland.sz 06/07/2011

Table 1: Frequency distribution of age of farmers

Age in years	**Conservation agriculture**		**Conventional agriculture**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
20-29	1	4.0	0	0.0
30-39	7	28.0	2	8.0
40-49	7	28.0	2	8.0
50-59	6	24.0	7	28.0
60-69	3	12.0	10	40.0
70-79	1	4.0	4	16.0
Total	**25**	**100**	**25**	**100**

Source: Field Survey Data, 2012

Table 2: Statistics of age of farmers

	N	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Conservation agriculture	25	21	73	47.68	11.85229
Conventional agriculture	25	26	75	52.36	13.69574

Source: Field Survey Data, 2012

Table 3: Average costs and returns of maize production in conservation agriculture per hectare

Items	**Value (E)***	**Cost components as % of total cost**
Gross Revenue (GR)	**4 520.00**	
Variable costs		
Seeds	204.00	22.4
Fertilizer	542.40	59.5
Herbicides	136.00	14.9
Pesticides	28.80	3.2
Tractor hire	0.00	0.0
Total variable costs (TVC)	**911.20**	
Gross margin (GR-TVC)	**3 608.80**	
Profitability index = GR/TVC	**4.96**	

Source: Field Survey Data, 2012
*Exchange rate: US$1=E8.13

Table 4: Average costs and returns of maize production in conventional agriculture per hectare

Items	Value	Cost components as % of total cost
Gross Revenue (GR)	**3 320.00**	
Variable costs		
Seeds	809.20	25.6
Fertilizer	1 604.00	50.8
Herbicides	76.80	2.4
Pesticides	43.20	1.4
Tractor hire	625.60	19.8
Total variable costs (TVC)	**3 158.80**	
Gross margin (GR-TVC)	**161.20**	
Profitability index = GR/TVC	**1.05**	

Source: Field Survey Data, 2012
*Exchange rate: US$1=E8.13

Table 5: Statistics of output levels of maize production

	N	Minimum	Maximum	Mean	Standard Deviation
Conservation agriculture	25	450	1800	1130	295.099
Conventional agriculture	25	150	1250	830	299.653

Source: Field Survey Data, 2012

Table 6: Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Conservation Agriculture	1130	25	295.099	59.020
Conventional Agriculture	830	25	299.65258	59.93052

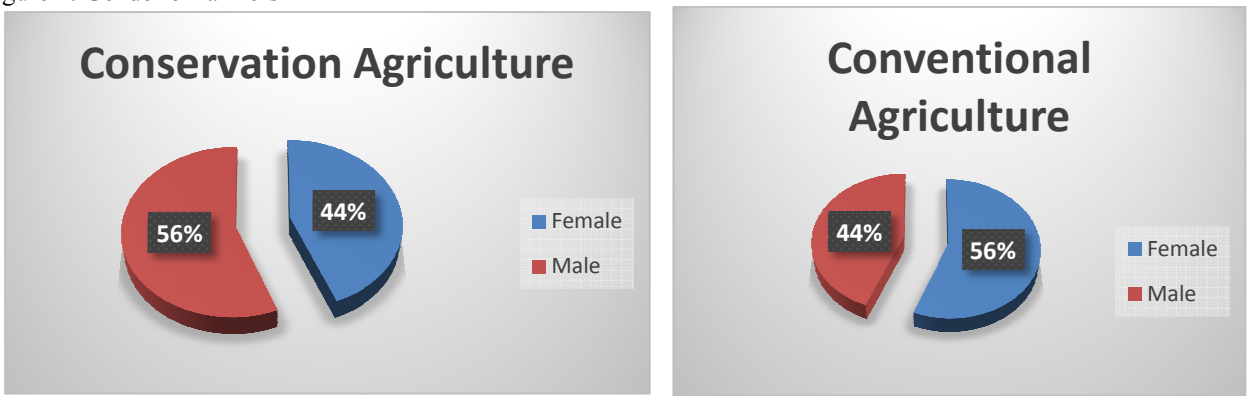
Source: Survey Data Analysis, 2012

Table 7: Paired samples test

	Mean	Std. deviation	Std. Error mean	t	df	Sig. (2-tailed)
Pair 1 Conservation agriculture Conventional agriculture	300.00	463.23140	92.64628	3.238	24	0.004

$\alpha = 0.05$ table value of t = 2.06
Source: Survey Data Analysis, 2012

Figure 1: Gender of farmers



Source: Field Survey Data, 2012