Production Frontier of Small Scale Pearl Millet Farmers: A Comparison of Conservation and Traditional Agricultural Practices in the Northern Namibia

Mr. Bonolo, P. Montle
Post graduate (Honours) student, Department of Agriculture & Natural Resources Sciences, Namibian University of Science and Technology
Tel. +264816082873, E-mail: bpmontle@gmail.com

Dr. David, I. Uchezuba (Corresponding author)
Namibian University of Science and Technology, Department of Agriculture & Natural Resource Sciences, 13, Storch Street, Windhoek, Namibia. Tel +264810425716,
E-mail: stickydamap@gmail.com

Mr. Salomo Mbai.
Namibian University of science and Technology, Department of Agriculture & Natural Resource Sciences, 13, Storch Street, Windhoek, Namibia.Tel. +264813902376, E-mail: smbai@polytechnic.edu.na

Abstract

This study fits a stochastic Cobb-Douglas production frontier of the pearl millet smallholder farmers and examined their technical efficiency comparing Conservation and Traditional Agriculture practices. The data was collected using a structured questionnaire administrated to 100 randomly selected smallholder farmers in Omusati, Ohangwena, Oshikoto, Oshana and Kavango regions during the 2014-2015 planting season. The estimated parameter of the model shows that land availability, the level of fertilizer use and tractor power explains variations in the production of pearl millet. The efficiency analysis result shows there is no statistically significant difference in the technical efficiency of farmers who were exposed to conservation agriculture compared to their traditional method of agriculture. The inefficiency model indicates that farm experience, farm size, and farm training have significant positive effect on efficiency. In addition, the study examined farmers willingness to pay for extension services, the predicted probability of getting farmers who are willing to pay is 60%. Some socio-economic factors such as farm size, herd size, and membership of a cooperative were found to influence farmers' willingness to pay for extension service. The study recommends that Conservation Agriculture should be continued over a long period of time so that the impact can be felt. Capacity building, training, extension services, information on agronomic practices and farmer's education are factors that policy should address.
Keywords: technical efficiency, Conservation Agriculture, pearl millet, stochastic production frontier.

1 Introduction and background

The Namibian population at large has a large number of people that are rural dwellers. About 70 percent of these rural dwellers depend on agriculture for sustenance (UNEP, 2012). The agriculture sector is a major contributor to employment. It employs about twenty-seven percent of the country's workforce and fifty-eight per cent of the workforce live in the rural areas (UNEP, 2012). Nevertheless, there has been a declining trend in agricultural productivity and often the practice is seldom sustainable. In 2013, a report by the World Food Programme on food security indicated that crop production in Namibia was threatened by continued drought. Consequently, a significant drop in cereal output was recorded in 2015. Maize production declined by 73% from the above-average yield in 2014. Production of sorghum and millet also decreased by 60 and 65 percent respectively (Food and Agriculture Organisation (FAO), 2015). This resulted in food shortages, leading to about 30% of households adopting survival strategy of reducing the number of their food ration to one meal per day (FAO, 2015). This led to reduced availability and reduction in dietary diversity to about 46% among the households (Emergency Food Assessment in Communal and Resettlement Areas of Namibia (EFA), 2013). As a result, an estimated number of 330 925 people were found to be food insecure (EFA, 2013).

Due to the declining trend in food production, attention is now focussed on methods of improving agricultural productivity. This is because the improvement of agricultural productivity is an important tool towards increasing household food security and alleviating rural poverty (Owour, 2000). Despite the various past efforts, food security continues to be a challenge in Namibia as is the situation in a number of Sub-Saharan African countries. This is so because of low and stagnant agricultural productivity growth associated with major crops like pearl millet which are predominantly produced by smallholder farmers under rain-fed conditions (United Nation Partner Framework (UNPAF), 2014). More effort is required for total eradication of poverty and food insecurity. In this regard, the key area of interventions is to enhance efficiency and productivity growth, make land available to the poor through land reform and maximize the potential of available land through the use of improved soil fertility, and the adoption of technical innovations that enhance technical change (UNPAF, 2014). These landmarks are currently not achieved under the Traditional Agricultural (TA) system where few available lands are marginally utilized, resulting in soil degradation and a decline in productivity. In the wake of this situation, there is a need for a re-thinking about the best way of utilizing land potentially. As a result, an agricultural practice (conservation agriculture) that inculcates the principle of conservation has recently been introduced to the farmers in some parts of the Northern Namibia. This type of agricultural practice aims at improving efficiency and productivity by preventing loss or damage to the soil and soil components, thereby enhancing the preservation and careful management of the environment and of natural resources, such as land. As a pilot project, the conservation agricultural practice was introduced to the farmers (by a non-governmental organization NGO) who applied it alongside their Traditional Agricultural (TA) practice, that is, farmers were selected to utilize the two methods simultaneously.

Therefore, the aim of this study is to compare the production frontier of the two practices to determine the response of agricultural output to the inputs under both practices and in addition, measure the farmers' efficiency of production. The measurement of farm efficiency is an important factor for productivity growth and it will be a viable option in the developing countries such as Namibia where resources are scarce (Kibaara, 2005). As mentioned previously, the administration of this pilot project is facilitated by an NGO whose services are currently offered without cost to the farmers. However, it is envisaged that in the future, the farmers might be required to pay for the services. Therefore, the study also assesses the farmers' willingness to Pay (WTP) for such services in the future. In agriculture, WTP studies have been used to evaluate demand and cost curves for extension services delivery through commercial agents (Oladele, 2008). A similar approach will be adopted in this study because the extent to which the farmers are willing to pay for extension services has not been conducted in this field of study in Namibia. The study is important because the outcome will aid policy makers and stakeholders towards the generation of a pool of knowledge about farm practice that is optimal and can maximize land use. This will form important anecdote to the mandate of the national development plans (Mushunje, 2005).

2 Materials and Methods

2.1 Data and Sampling

The study was conducted in five administrative regions of Northen Namibia namely; Oshana, Omusati, Oshikoto, Ohangwena, and Kavango region. The selected regions are well suited for this study because their inhabitants derive their sustenance mainly from crop production especially pearl millet which is their major staple. Also, information regarding conservation agricultural (CA) practices in these regions is not known and has not been investigated before. Primary data was collected in a farm-level survey using structured questionnaire administered to 100 randomly selected household heads in the study area during the 2014-2015 cropping season. The data consist of production information, farmer's support, and farmers' socio – economic characteristics.

2.2 Empirical Model

2.2.1 Technical efficiency

According to Alene and Hassan (2003), production frontier is specified to represent the maximum output from a given set of inputs and existing production technology. Failure to attain the frontier output implies the existence of technical inefficiency. Both production frontier and technical inefficiency models were fit. The frontier model specification was developed by Battese and Coelli (1995) who proposed a stochastic frontier model where technical inefficiencies can be expressed as a function of explanatory variables and a random error (Battese and Coelli, 1995). The Cobb-Douglas stochastic frontier production function was specified as follows:

$$\text{Ln } Y_i = \beta_{0i} + \beta_1 \text{Ln}X_{1i} + \beta_2 \text{Ln}X_{2i} + \beta_3 \text{Ln}X_{3i} + \beta_4 \text{Ln}X_4 + V_i + U_i \ldots\ldots \quad (1)$$

Where:
Output (Y) is yield of pearl millet in kg;
X_1 is planted land size (ha)
X_2 is the fertilizer application (kg)
X_3 is the seed quantity (kg)
X_4 is the total labour (man days)
X_5 is tractor power

The technical inefficiency model was used to identify factors that influence the efficiency among pearl millet farmers in the study area, and the model was estimated as follows;

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i} \ldots\ldots\ldots\ldots \quad (2)$$

Where:
Z_1= farm experience; Z_2 = education level; Z_3= extension services; Z_4 = off farm income; Z_5 = farm size; Z_6 = Cooperative membership, Z_7= household income less than 2000, Z_8= household size, Z_9 = household status, Z_{10} = farm training, Z_{11}= farm credit (loan).

2.2.2 Willingness to pay for extension services
Probit regression model was fit to assess the factors that may be associated with willingness to pay (WTP) for the extension services. The independent variables are, farm experience, age, education level, extension services, off-farm income, farm size, cooperative membership, household income, and household size. The dependent variable WTP is a dichotomous variable which takes the value of one if a farmer is willing to pay otherwise, zero. The main issue is to identify the individual household characteristics that influenced the farmers' WTP. Following Nagler (2002), the probit model takes the form:

$$\Pr(Y_1 = 1) = f(\beta_i X_i) + e_i \ldots\ldots\ldots\ldots \quad (3)$$

Where, Y is a dichotomous dependent variable which can assume the value of 0 or 1. It measured the farmer's willingness to pay for extension services. X_i = n x k matrix of explanatory variables (farm experience, age, education level, extension services, off farm income, farm size, cooperative membership, household income, household status). β_i =k x 1 vector of parameters to be estimated and e_i is the error term.

3 Results and Discussion
3.1 Descriptive statistics
The descriptive statistics of the variables included in the models are presented in Table 1. The existence of multicollinearity was tested which was detected as some variables correlated with others. The autocorrelation was corrected by allowing for correlated errors in the variance-covariance matrix (VCE) estimation.

Table 1: Summary descriptive statistics

Variable	Mean	Standard. Deviation	Min	Max
Wtp520	0.6	0.4923	0	1
Farmexp	31.07	12.4634	2	61
Age	61.16	13.3088	22	100
Edu	0.76	0.4292	0	1
Extserv	0.44	0.4988	0	1
NFI	0.66	0.4760	0	1
Farmsize	6.464	4.4041	1	25
HHsize	9.46	5.2308	1	28
Memcop	0.43	0.4975	0	1
Income < 2000	0.66	0.4760	0	1
HHstatus	0.76	0.4292	0	1

From the results, it can be deduced that the average farmer is more than sixty years old. The average farming experience is about 31 years, which means that most of the farmers have farmed for the most part of their life. This is an indication that pearl millet production has been in existence for a number of years as the majority of the small-scale farmers have been in pearl millet production for more than 31 years. The age of the farmer is an important factor of production as older people tend to be too stereotyped always sticking to what they are used to (that is, they prefer to use old methods of planting than adopt new technology). It is assumed that older farmers are more experienced in farming activities and are in a better position to assess the risks involved in farming than younger farmers. The household size plays an important role in pearl millet production because most farmers depend on family labour. The data shows that the average household size is 9. Invariably, the large family size means that more labour will be available for farming. The average farm size for the farmers is 6.4 hectares. This indicates that the land capacity of the sampled farmers is small, however; the aim of the study is to determine how efficient they are given their farm size and the introduction of conservation agriculture.

3.2 Maximum likelihood estimates of production frontier parameters

Table 2 presents the results of the Cobb-Douglas production function for both methods (Conservation and traditional agriculture). In the case of conservation agriculture, the estimated production function parameters indicated that the area planted, fertiliser and the use of animal plough significantly affect the pearl millet yield. Labour and seed were found to be insignificant. In traditional agriculture, fertiliser and the use of animal plough were shown to significantly affect yield while seed, area planted and labour was insignificant. These results are consistent with findings by Baloyi (2011), Musaba and Bwacha (2014) in a study carried out in South Africa and Zambia respectively. The insignificant effect of seed quantity could imply that farmers in the study area do not use improved seeds hence; they resort to the indigenous varieties and the use of inappropriate seed rate. The insignificant effect of labour with a negative sign is consistent with Musaba *et al* (2014), this could imply that there is abundant household labour in the study area and any increase in this labour will lead to diminishing returns. The positive and significant coefficient for fertiliser indicates that pearl millet output increases with a unit increase in fertiliser input. The higher significance level under CA implies that farmers were advised well on the application of both basal and top dressing and application was also done in rows in close accessibility to a plant. While on TA, farmers mostly applied basal dressing fertilisers through the broadcasting method which makes this result acceptable. This is in agreement with a study by Tchale and Sauer (2007) which emphasised the essence of obtaining efficiency in more fertile areas. For CA, the area planted was significant at 5% while on TA it was insignificant. The result shows that access to land is important in explaining the differences in yield of the farmers. This finding is supported by Kimhi (2003) who found a positive relationship between maize yield and plot size, indicating that economies of scale are dominant throughout the plot size distribution.

The estimated coefficients for production frontier parameters have the expected positive signs except labour, suggesting that labour had less influence in the production of millet. This is consistent with the study by Ogundele & Okoruwa (2006). This scenario is expected as the level of pearl millet production depends largely on a number of factors including climate and not only limited to production inputs. However, all other variables for both technologies were positive, implying that the pearl millet in the study area is positively influenced by these factors. The seed quantity being insignificant is quite unexpected but given that farmers in the study area do not know the correct amount of seeds to be used in a unit area, the result is acceptable. With regards to land preparation, both in TA and CA the variable was significant but the sign was not as expected.

Table 2: Maximum Likelihood Estimation of the Cobb-Douglas stochastic production frontier for the comparison of Conservation Agriculture vs Traditional Agriculture

	Conservation Agriculture (CA)	Traditional Agriculture (TA)
Variable	**Coefficients**	**Coefficients**
Total labour	-0.0458 (0.5180)	-0.1279 (0.5290)
Land	0.1846** (0.0570)	0.1171 (0.2620)
Fertilizer	0.0592*** (0.0080)	-0.0551** (0.0120)
Seed	0.0410 (0.4020)	0.0253 (0.6250)
Tractor power	-0.2229** (0.0140)	-0.2309** (-0.0260)
Constant	6.5761*** (0.000)	0.1228 (0.6660)
$Ln\sigma_v^2$	-3.8945 (0.0000)	-3.6696 (0.0000)
$Ln\sigma_u^2$	-0.7741 (0.0000)	-0.7922 (-0.00060)
σ_v	0.1427 (-0.0370)	0.1596 (-0.0662)
σ_u	0.6791 (-0.0810)	0.6729 (-0.0973)
Wald Test: Joint Significance:		
Wald Chi-square(11)	20.030	15.650
Prob > Chi-square	0.001	0.008
LR Test: Sigma_u = 0	29.46 (0.0000)	7.02 (0.004)

Note: Figures in parenthesis are the p-values. The notation ***, **, and * denote statistical significance at the 1%, 5% and 10% level of significance.

3.3 Constant returns to scale (CRS)

For constant return to scale, the sum of the technical coefficients β must be equal to one, for an increasing return to scale, it should be greater than one, and for decreasing return to scale it should be less than one. For the case of this study, the constant return to scale hypothesis was rejected indicating that the sum of the technical coefficients is not equal to one. This is an indication that the hypothesis is not supported by the data. Reasons attributed to this are that of a shorter period of trials to examine the impact of CA, and that the labour input is not efficiently utilised by the farmers due to the communal nature of their farming. Therefore, the output cannot double if inputs levels are doubled.

3.4 Hypothesis testing

The standard deviation of the two error components σ_v and σ_u, and their log likelihood estimates $Ln\sigma_v^2$ and Ln_u^2 for the two models are respectively given in the post estimation Table 2. The result shows that they are all statistically significant. To test the presence of technically inefficiency effects, the log-likelihood-ratio (LR) test was adopted. The null hypothesis of no technical inefficiency effects in pearl millet production was strongly rejected indicating that the production frontiers of the farmers are characterized by technical inefficiency effects (Table 2). The Wald test statistics for joint significance of the variables in the two models are 20.03 and 15.65. The null hypothesis of joint zero coefficients was rejected. Based on the result of the two tests, it can be concluded that the included variable contribute to explain production frontier and that technical inefficiency effects are present in the model thus confirming the need to fit inefficiency model.

3.5 Technical inefficiency scores

This section discusses the technical efficiency estimates obtained from the stochastic frontier model. Table 3 presents summary statistics of the technical inefficiency scores based on two farming methods as well as by region.

The mean technical efficiency of 32% under conservation agriculture indicates that on average the respondents are able to obtain over 30% of potential output from a given mix of production inputs. The result is consistent with Diiro (2013) and Kibaara (2005). This implies that, in the longer term, there is a potential for pearl millet producers to increase their efficiency by about 68% by utilising existing farm resources better and following the appropriate principles of conservation agriculture so as to be on the optimal production frontier. While under TA, the mean technical efficiency of 33% indicate that on average there is a potential for pearl millet producers to increase their efficiency by about 67% utilising existing farm resources better and adopting improved technology and techniques. The regional analysis (Table 4) shows that Kavango region was the most efficient region in both technologies as evidenced by the farmers' inefficiency scores. The most inefficient were Oshikoto and Ohangwena regions for both methods of farming. The differences in efficiency levels between regions could be attributed to factors such as climate, soil fertility, availability of planting materials such as seeds, poverty prevalence, management and socio-economic factors. The intra-region differences between CA and TA are also very small an indication that the effects of the CA cannot be realized in the short-run. Generally, the result indicates that there is a need to practice CA over a longer period of time in order to observe the desired impact.

Table 3: The summary statistics of Technical Inefficiency scores of sampled farmers

Farming method	Obs	Mean	Std. Dev	Min	Max
CA	100	0.6791	0.6285	0.0619	2.8432
TA	100	0.6729	0.5547	0.0641	2.7142

Table 4: Mean technical inefficiency scores by regions

	Oshikoto	Omusati	Oshana	Kavango	Ohangwena
CA	1.2171	0.5741	0.6439	0.2563	0.7038
TA	0.8824	0.5943	0.7511	0.3234	0.8136

3.6 Determinants of technical efficiency

The analysis of the estimated coefficients of the inefficiency model explains the contribution of the variables to technical efficiency in the study area. Using the SFA model, the sources of inefficiency were examined using the identified determinants of inefficiency effects. Table 5 shows the results for both conservation and traditional agriculture technical inefficiency model. The negative sign on the estimated parameters in the technical inefficiency model implies that the associated variable reduces inefficiency, meaning it has a positive effect on technical efficiency; as a result, it increases productivity level. A positive sign indicates that the associated variables increase inefficiency or have a negative effect on technical efficiency.

In the case of conservation agriculture, household size, cooperative membership, income>2000, farming experience are significant at 5% and 10%. Although these variables are significant, they have positive signs except farming experience which implies that they have a negative effect on efficiency. This finding is consistent with studies carried out by Kibaara (2005), Mango, Makate, Lundy (2015) and Diiro (2013). The coefficient sign for farming experience is negative and significant; suggesting that this variable reduces technical inefficiency. This further entail that experienced farmers tend to be more efficient because of good managerial skills which they have learnt over time, and more efficient than younger ones. This result is supported by Khairo and Battese (2005) who found that the farming experience coefficient was negative and significant which means that farmers tend to decrease their technical inefficiencies as they become more experienced. The estimated positive coefficient of the household size which is significance at 5% implies that smaller families are efficient compared to larger ones because large family size exerts pressure on the limited resources a farmer has (Mango et al, 2015).

The insignificant level for extension service and training is not as expected, however; this could be attributed to slow rate of adoption and understanding of the intervention by first time participants' farmers (Mkhabela, 2005). The positive coefficient sign for Income<2000 indicate that farmers who have a household income less than 2000 are inefficient compared to the ones earning more than this amount. This is because farmers with income<2000 will not have the financial resources to purchase necessary inputs for farming that may increase their technical efficiency; this result is consistent with Oladimeji and Abdulsalam (2013).

Table 5: Determinants of technical efficiency for Conservation Agriculure vs Traditional Agriculture

	Conservation Agriculture (CA)	**Traditional Agriculture (TA)**
Variable	**Coefficients**	**Coefficients**
Farmexp	-0.0105*	-0.0122***
	(0.0952)	(0.0180)
Edu	-0.0845	0.0437
	(0.623)	(0.7730)
Extserv	-0.0029	0.1071
	(0.623)	(0.3390)
Nfi	-0.1512	-0.1537
	(0.381)	(0.2440)
Farmsize	-0.0128	-0.0210*
	(0.29)	(0.0700)
Hhsize	0.0319**	0.0263**
	(0.026)	(0.0230)
Memcop	0.2454*	0.1784
	(0.072)	(0.1470)
Income<2000	0.3508***	0.2207
	(0.016)	(0.1430)
Hhstatus	0.1802	0.1573
	(0.246)	(0.2140)
Training	-0.1789	-0.3505***
	(0.225)	(0.0140)
Loan	0.1783	0.3828**
	(0.357)	(0.0230)
Constant	0.4859	0.7711
	(0.266)	(0.0510)
F (12, 87)	5.88	6.84
Prob > F	0.000	0.000
R - Squared	0.139	0.1942
Root MSE	0.6219	0.5312

Note: Figures in parenthesis are the p-values. The notation ***, **, and * denote statistical significance at the 1%, 5% and 10% level of significance.

The result for the cooperative membership shows that farmers who are non-cooperative members were more efficient than the ones who are members. This result is not expected because; being a member of the cooperative gives the farmers opportunities for training, information, collective bargaining power and credit sales. This could be due to the fact that most of the farm cooperative does not offer these services hence; members do not have much leverage over non-members.

In traditional agriculture, the estimated coefficient sign of the variables from the inefficiency model shows that only farmers' training, farm experience, and farm size are statistically significant with the correct signs. This indicates that these variables have a positive influence on technical efficiency. With regards to training, the finding implies that farmers who have access to training classes are more efficient than the ones who do not. The training sessions farmers have received over time by the Ministry officials on production related information tend to increase their efficiency levels. This result is consistent with Mango *et al* (2015). Moreover, a negative sign for farm size implies that farmers with large arable land tend to be more efficient than smallholder farms as they are able to diversify their activities i.e. practice crop rotation and other integrated farming systems that eventually increase their income and improve their efficiency. This same result was found by Mango *et al* (2015). Although the household size and financial credit are significant, their coefficients are positive which implies they have a negative influence on technical efficiency. Larger and poor households are more likely to default in honouring their financial obligation, more credit, in this case, mean more liability; therefore, credit-strapped farmers are more likely to be inefficient because increase credit gets them more entangled in debts. Debt financing strips them of the available cash flow.

3.7 Factors influencing farmer's willingness to pay (WTP) for extension services

To identify determinants of willingness to pay for agricultural extension services, probit model was estimated. The result shows that farm size, household income (Income < 2000), cooperative membership and household size have a significant relationship with farmer's willingness to pay. The predicted probability of getting farmers who are willing to pay for extension services is 60 %, (Table 6). The probability is high, an indication of the likelihood that future CA practices will be adopted by the majority of the farmers.

Table 6: Marginal effects test

	Delta method					
	Margin	Std. Err	z	P>|z|	[95% Conf. Interval]	
_cons	0.6008	0.0312	19.21	0.000	0.5395	0.6621

Table 7: Maximum likelihood estimates of the probit model

wtp520	Coef.	Robust Std. Err	z	P>|z|	[95% Confidence Interval]	
Farmexp	0.0185	0.0255	0.72	0.469	-0.0315	0.0685
Age	0.0050	0.0283	0.18	0.858	-0.0504	0.0605
Edu	0.4847	0.4044	1.2	0.231	-0.3080	1.2774
Extserv	-0.1653	0.3410	-0.48	0.628	-0.8337	0.5030
Nfi	0.5880	0.4284	1.37	0.17	-0.2516	1.4277
Farmsize	-0.0929	0.0430	-2.16	0.031	-0.1773	-0.0084
Hhsize	-0.1106	0.0378	-2.92	0.003	-0.1849	-0.0364
memcop	-2.5604	0.3419	-7.49	0.000	-3.2307	-1.8901
Inc<2000	-2.0064	1.0036	-2.00	0.046	-3.9736	-0.0393
hhstatus	0.1146	0.4137	0.28	0.782	-0.6963	0.9255
_cons	3.0895	1.6845	1.83	0.067	-0.2121	6.3911

Farm size was found to be statistically significant at 5% level with the willingness to pay for an extension. Negative sign implies that farmers with small farm size are more likely to pay than those with larger farms. This could be attributed to the fact that the farmers are in a communal leasehold farming system with small land capacity. If farm size increases they will pay more premium as the payment for extension is made per hectare. Household size was significant at 1% level and has negative signs. The result is in agreement with the a priori expected sign because if household size increases, the cost of living increases and the purchasing power of the farmer decline. This finding is supported by Tolera *et al* (2014) who revealed that negative sign implies that small size households were likely to pay more than larger households.

Cooperative membership was significant at 1% level. A negative sign implies that farmers who are non-cooperative members are more likely to pay than unionized farmers. The finding is consistent with results by Oladele (2008). Cooperative member who gets services and other benefits from cooperatives are less likely to pay because they would rely on the cooperative assistance than pay additional money to other service providers. Household income (< NAD 2000) is statistically significant but has negative signs. The result shows that resource-poor farmers with income less than N$ 2000 would still not pay even if income increases beyond N$

2000. This implies that payment for extension services does not depend on income but on the need to understand the importance of the services rendered which most farmers find difficult to comprehend.

Table 8: Marginal effects of the covariates

Variable	dy/dx	Std.Err.	z	P>|z|	[95% Confidence Interval]	
Farmexp	0.0066	0.0091	0.72	0.469	-0.0113	0.0245
Age	0.0018	0.0101	0.18	0.858	-0.0180	0.0217
Edu	0.1737	0.1450	1.20	0.231	-0.1106	0.4580
Extserv	-0.0592	0.1216	-0.49	0.626	-0.2976	0.1791
Nfi	0.2107	0.1525	1.38	0.167	-0.0882	0.5097
Farmsize	-0.0333	0.0152	-2.18	0.029	-0.0632	-0.0033
Hhsize	-0.0396	0.0131	-3.02	0.002	-0.0653	-0.0139
Memcop	-0.9175	0.1323	-6.93	0.000	-1.1770	-0.6580
Inc>2000	-0.7190	0.3616	-1.99	0.047	-1.4278	-0.0102
Hhstatus	0.0410	0.1481	0.28	0.782	-0.2492	0.3314

Since the extension service will be based on cost per hectare serviced, farmers with larger farms will pay more than smaller farms. The result shows that an increase in one unit of farm size will lead to a decrease in the willingness to pay for extension services by 3%. Household size was also found to have similar effects. An increase in household size by one person decreases the farmer's willingness to pay by 4%. As the household enlarges, the farmer will have a huge responsibility of catering for a large family and may not have extra resources to pay for extension services. If a farmer belongs to a cooperative, the likelihood that they will pay is lower by 91% compared to when they are not a member. This is because the farmer will expect the cooperative to subsidise and cater for a larger percentage of their extension service needs. Farmers with an income less than 2000 are less likely to pay for extension services than those that have higher.

4. Conclusion and recommendations

The result of the production frontier under conservation agriculture shows that the area planted, tractor power and fertiliser application significantly affect the pearl millet yield. On the other hand, fertilizer and tractor power influenced production under traditional agriculture method. No statistically significant effect was observed for seed and labour used for both methods. The insignificant labour coefficient can be attributed to low labour productivity among low-skill workers in sub-Saharan Africa. Optimal labour use cannot be identified due to the use of family labour thus; output may be affected if additional labour is employed. Similar effects can be observed with regards to seed application. Non-optimal use of seed may result in negative effects on output. In addition, the use of the wrong seed variety that has low germination rate may affect output. The results show that there is a technical efficiency of 32% under conservation agriculture indicating that on average the respondents are able to obtain over 30% of potential output from a given mix of production inputs. While under traditional agriculture, the mean technical efficiency of 33% was calculated, indicating that on average there is a 67% allowance for efficiency improvement by addressing important constraints that affect farmers' levels of technical efficiency and productivity in the study area. The results show that variables such as farm size, cooperative membership, household size and household income were statistically significant but have unexpected signs.

This study recommends that conservation agriculture should be practised over a long period of time so that its impact can be felt. Skill development should be considered by policy-makers or institutions with the responsibility of designing programs towards pearl millet farming improvement in the study area. It is recommended that farmers' financial and social capacity be improved through the provision of hi-tech planting materials such as fertilizers, seeds, and increased extension training.

References

Alene, A.D., and Hassan, R.M. 2003, "The determinants of farm-level technical Efficiency among adopters of improved maize production technology in Western Ethiopia." *Agrekon, Vol 42, No 1 (March 2003).*

Baloyi, R. 2011, "Technical Efficiency in Maize Production By Small Scale Farmers in South Africa: Case study from Gamothiba, Limpopo Provience".

Battese, G. E., and Coelli T. J. 1995, "A Model for technical inefficiency effect in a stochastic frontier production function for panel data". Empirical Economics, 20: 325-32.

Diiro G.M. 2013, "Impact of Off-farm Income on Agricultural Technology Adoption Intensity and Productivity-Evidence from Rural Maize Farmers in Uganda." Uganda Strategic program-IFPRI: Working Paper 11 -January 2013.

Emergency Food Assessment in Communal and Resettlement Areas of Namibia (EFA). 2013, World Food Programme on Food Security in Namibia.

FAO. 2015, "Global information and early warning of food agriculture. Country brief for Namibia Kimhi A. (2003). Plot Size and maize productivity in Zambia; the inverse relationship re-examined. Discussion paper No.10.*13*. Hebrew University of Jerusalem.

Kibaara, B.W. 2005, "Technical Efficiency in Kenyan's Maize Production: An Application of the Stochastic Frontier Approach". Unpublished M.Sc. Department of Agricultural and Resource Economics, Colorado State University, Fort Collins. Colorado.

Mango, N., Makate, C., Mlambo, B., Siziba, S., & Lundy, M. 2015, "A Stochastic Frontier Analysis of Technical Efficiency in Smallholder Maize production in Zimbabwe: The post-fast-track land reform outlook.

Mkhabela, T. 2005, "Technical efficiency in a vegetable based mixed-cropping sector in Tugela Ferry, Msinga District, KwaZulu-Natal". *Agrekon*, 44, (2):187-200.

Musaba E and Bwacha, I. 2014, "Technical Efficiency of Small Scale Maize Production in Masaiti District, Zambia": A Stochastic Frontier Approach: Journal of Economics and Sustainable Development: Vol.5, No.4, 2014. ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online).

Mushunje A. 2005, "Farm efficiency and land reform in Zimbabwe." PhD thesis: Department of agricultural economics and extension, University of fort hare, Alice, South Africa.

Nagler, J. 2002, "Interpreting probit analysis". New York University.
Webpage: www.nyu.edu/classes/nagler/quant1/probit1_post.pdf. Accessed 18 March, 2016.

Oladele, O.I. 2008, "Factors determining farmers willingness to pay for extension services in
Oyo State, Nigeria". Agricultural Tropica Et Subtropica 41: (4)165- 169

Oladimeji, Y.U. and Abdulsalam, Z. 2013, "Analysis of Technical Efficiency and its Determinants among Small Scale Rice Farmers in Patigi LGA of Kwara State, Nigeria". IQSR Journal of Agriculture and Veterinary Science. 3(3) Pp 34-39.

Ogundele O. O and Okoruwa, O.V. 2006, "Technical efficiency differential in rice production technologies in Nigeria", Africa Research Consortium, Research paper 154.

Owuor, S.O. and Foeken, D. 2000, "Urban farmers in Nakuru, Kenya. International Symposium. Berlin, German, July 7-9.

Tchale, H. and Sauer, J. 2007, "The efficiency of maize farming in Malawi: A bootstrapped translog frontier. Faculty of Social Sciences, Kent Business School". *Agri-Environment Economics*. Cahiers d'economie et Sociologie Rurales.82-83:34- 56.

Tolera, T., Temesgen, D. and Rajan, S. 2014, "Factors Affecting Farmers Willingness to Pay for Extension services in Haramaya District of Ethiopia". International Journal of Agricultural Science Research. Vol 3(12), pp. 268-277.

United Nations Environment Programme (UNEP) 2012, "Green Economy Sectoral Study: BioTrade – A catalyst for transitioning to a green economy in Namibia"

United Nation Partner Framework (UNPAF). 2014, "United Nations Development Programme in Namibia".