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Technical Efficiency of Smallholder Tobacco Farmers under Contract Farming in Makoni District of Manicaland Province, Zimbabwe: A Stochastic Frontier Analysis

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Abstract: This study assessed the technical efficiency of smallholder tobacco farmers in Makoni district of Zimbabwe and the impact of the impact of contract farming on technical efficiency using a sample of 98 randomly selected farmers comprising 78% contract farmers and 22% non-contract farmers. The study employed the stochastic frontier analysis to estimate the production function and technical efficiencies. The results show that contract farmers have a higher mean technical efficiency of 94% whilst non-contract farmers have a mean technical efficiency of 67%. The overall mean technical efficiency of the smallholder tobacco farmers in Makoni district is 73%. These results show that contract tobacco farmers are more efficient than non-contract tobacco farmers. The results also reveal that fertiliser and fixed costs are important inputs in smallholder tobacco production. More importantly, the study also found that contract farming significantly improves the technical efficiency of farmers. Non-contract farmers are 10.84 more inefficient than contract farmers and this result is significant at 5% level. Other determinants that significantly improve technical efficiency are education level of farmer, the total cropping area, gender of farmer whilst access to other loans apart from the contract farming credit reduces technical efficiency. Based on the findings the study recommends that government must promote increased access of contract farming arrangements particularly for women farmers as only 4.5% of the contract farmers are women as a measure to increasing overall productivity of tobacco farmers.
Keywords: Technical efficiency, Smallholder tobacco farmers, Contract farming, Zimbabwe, Stochastic frontier analysis

INTRODUCTION

Growth and development in the agricultural sector can be achieved if farmers strive to increase their resource utilization efficiency. Most policies that have been adopted in the past have tried to address growth through increasing use of agricultural inputs and expansion of agricultural enterprises by bringing more land under cultivation without really focusing on maximizing efficient utilization of the already available resources. In sub-Saharan Africa, development practitioners are now realizing that improving efficiency of agricultural production is a necessary strategy for economic growth and the alleviation of rural poverty [1].

Post-independence, the Zimbabwean agriculture sector has witnessed phenomenal structural and policy transformation which has seen a majority of smallholder farmers evolve from just being subsistence farmers to commercial farmers. This transformation is not only attributed to technological changes such as green revolution witnessed in the 1980s or the structural changes such as the fast-track land reform exercise of the 2000s, but also to institutional innovations in value chain development in regard to inputs and output marketing through the development of contract farming (CF). Contract farming has been adopted as a strategy for improving smallholder household incomes through improved access to agricultural finance, improved production inputs, specialized extension support, output markets and better output prices which in turn results in improved agricultural productivity, job creation and enhanced household sufficiency.

Contract farming is one strategy for improving the well-being of small scale producers as well as productivity. Given that a majority of these small scale producers are predominantly rural peasant farmers producing for large processing firms, contract farming is therefore a critical solution to increasing agricultural productivity and incomes and reducing rural poverty [2]. Olomola [3] also pointed out that contract farming can help solve some of the challenges facing small-scale farmers such as limited access to public extension services, market information and markets, credit, land, labour information and insurance markets. Contract farming has a higher potential in the Sub-Saharan including Zimbabwe where the smallholder marketing infrastructure and systems are still underdeveloped. Through contract farming arrangements, contractors

offer farmers credit, extension services, inputs, transport services and marketing facilities in return for land, labour and output from farmers. Economists should therefore be delighted that demand and supply are being matched up, and market imperfections are being resolved.

Given the size of individual smallholder farmers, the development of farmer organisations and contract farming presents opportunities for increasing smallholder access to agricultural finance and input and output markets with the subsequent effect of increasing productivity and reducing rural poverty [3] Contract farming has been widely accepted in Zimbabwe and generally across Africa because of its potential to addressing most challenges being faced by smallholder farmers. There is an emerging interest in linking up smallholder farmers with larger processing companies or business operations the scope being to produce and market certain agricultural commodities.

Zimbabwe is the largest producer of tobacco leaf in Africa and the world's fourth-largest producer of flue-cured tobacco, after China, Brazil and the United States of America [4]. The country exports 98 percent of all the tobacco production as it does not have a large tobacco manufacturing industry. Tobacco plays an important role to Zimbabwe's economy as it accounts for more than 50 percent of agricultural exports, 30 percent of total exports and nearly 12 percent of GDP [4, 5]. It also generates considerable rural employment and is also a major source of government revenue which is raised through levying both growers and buyers a fixed percent on the value of crop sales. Almost 80 percent of the country's tobacco output is produced under contract while in countries like Mozambique, Malawi and Zambia, cotton and tobacco are 100 percent on contract. Leading tobacco leaf producers like Turkey, the United States of America (USA), and China also use contract farming to finance farmers [6].

Although contract farming has been practiced for a long time for crops like tea, sugarcane and cotton, tobacco contract farming was introduced in Zimbabwe in 2004 to boost output which had tumbled in the wake of the fast-track land reform exercise that decimated agriculture production at the turn of the millennium [7]. The major challenge that was faced by new tobacco smallholder farmers prior to the introduction of contract farming was failure to access finance from commercial banks that traditionally financed the tobacco crop as most of them had no bankable collateral and limited expertise and experience in tobacco production. Information asymmetry problems also led to extensive credit rationing to the unbanked smallholder tobacco farmers [6]. These challenges saw the production of tobacco fell from a high of 237 000 kilograms in 2000 to just 48.7 thousand kilograms in 2008 [7, 8]. Although government, contractors, non-governmental organizations and development actors have been championing contract farming in Zimbabwe as a strategy promoting smallholder tobacco production there is limited empirical evidence on how contract farming has impacted productivity in the smallholder tobacco sector. Most of the evidence used to justify and promote contract farming is from studies carried out in other countries. There is therefore need for research to inform policy on the impact of contract farming on smallholder agricultural productivity in Zimbabwe.

The purpose of this paper is to estimate the technical efficiency of smallholder tobacco farmers in Zimbabwe employing stochastic production frontier and to determine the impact of contract farming on smallholder tobacco farmers' technical efficiency. This study also proposes some recommendations for improving smallholder tobacco productivity in Zimbabwe.

METHODOLOGY

Study Area and Sample

This study was conducted in Makoni district, Manicaland region where tobacco is the main cash crop with more than 75% of all farmers being regular tobacco growers. A total of 6.726 households are engaged in tobacco production and the total area under tobacco production is 3.200ha. Other main economic activities of the residents in the area are livestock husbandry, maize, groundnuts and horticulture farming.

Data was collected from a randomly selected sample of 98 farmers using a structured questionnaire between February and March 2016.

Analytical Framework

Through contract agreement, producers may learn more skills and knowledge relating to the efficient use of resources, methods of input using, record keeping, the significance of product quality and characteristics of different markets. These contribute to improve productivity of agricultural production [9]. This therefore implies that the impact of contract farming services on farm productivity can be measured through output gain due to elimination of technical inefficiency.

The effect of contract farming on farm productivity can be estimated using the stochastic frontier approach (SFA) whereby the frontier production function specifies what output can be achieved, if all decisions were taken according to their best practices. A smallholder farm's technical efficiency is a measure of their ability to produce relative to the smallholders' best-practice frontier, which is a measure of the maximum output possible from a given set of inputs and production technology [10, 11]. Technical inefficiency on the other hand is the deviation of an individual smallholder farm's production from the best practice frontier. The level of technical efficiency of a particular farm is based upon deviations of observed

output from the efficient production frontier [12]. If the actual production point lies on the frontier it is perfectly efficient. If it lies below the frontier then it is technically inefficient. The distance between the actual to the achievable optimum production from given inputs, indicates the level of production inefficiency of the individual firm [12].

A stochastic frontier production function is estimated to analyze differences in technical efficiency between contract participating and non-participating smallholder tobacco farmers in Makoni district. As in Battese and Coelli [13], the study follows a two-step estimation model. The first step involves the specification and estimation of the stochastic frontier production function and the prediction of the technical inefficiency effects, under the assumption that these inefficiency effects are identically distributed. The second step involves the specification of a regression model for the predicted technical inefficiency effects. The effect of participating or not participating in contract farming is captured by use of dummy variables.

The estimated stochastic production function was specified as follows:

$\ln BALESOLD = \alpha_0 + \alpha_1 \ln FERT + \alpha_2 \ln LAB + \alpha_3 \ln HRS_{processing} + \alpha_4 \ln Other\ Costs + \alpha_5 \ln FixedCosts + (\nu - \mu)$

Where:

$\alpha_0 - \alpha_5$ are the production function model parameters;

ln denotes the natural logarithm (base e);

BALESOLD denotes the total number of bales sold

$FERT_{TOT}$ is the total amount of fertilizer used by the i^{th} farmer;

LAB_{TOT} denotes the total of family labor and hired labor used in man-days;

$HRS_{processing}$ is total hours spent on tobacco curing and processing;

Other Costs denotes the total amount of other tobacco production costs in dollars;

Fixed Costs is the total amount of tobacco production fixed costs in dollars. Quantity of fertilizer per hectare used;

The investigation of factors influencing the inefficiencies of extension participant and non-participant farmers is carried out by estimating the following model:

$E = ß_0 + ß_1\ FARMERTYPE + ß_2 FEDUC + ß_3 TENURE + ß_4 CROPAREA + ß_5 GENDER + ß_6\ OTHERLOAN + \mu$

Where E is technical inefficiency effects and ßs are inefficiency model parameters. The variable definitions are presented in Table 1**.** The *a priori* or hypothesized impact of the independent variables on the dependent variable is also shown. A (+) means the independent variable is expected to have a positive impact on the dependent variable while a (-) means the independent variable is expected to have a negative impact on the dependent variable.

Table 1: Independent Variable Definition and Measurement for Inefficiency Function

Variable	Description	Variable Measurement	Hypothesis
INDEPENDENT / EXPLANATORY VARIABLES			
FARMERTYPE	Whether farmer participates in contract farming	Dummy: 1= Non-contract farmer 0= Contract farmer	+
FEDUC	Education level of farmer at least secondary education	Dummy: 1= yes, 0= otherwise	-
TENURE	Whether farmer has individual tenure or not	Dummy: 1= yes, 0= otherwise	-
CROPAREA	Total cropped area	hectares	+
GENDER	Gender of farmer	Dummy: 1= male, 0= otherwise	-
OTHERLOAN	Access to other loans other than contract farming credit	Dummy: 1= yes, 0= otherwise	+

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Sample Farmers

Seventy-eight percent of the sample farmers were contract farmers compared to 22% who were non-contract farmers (Figure 1).

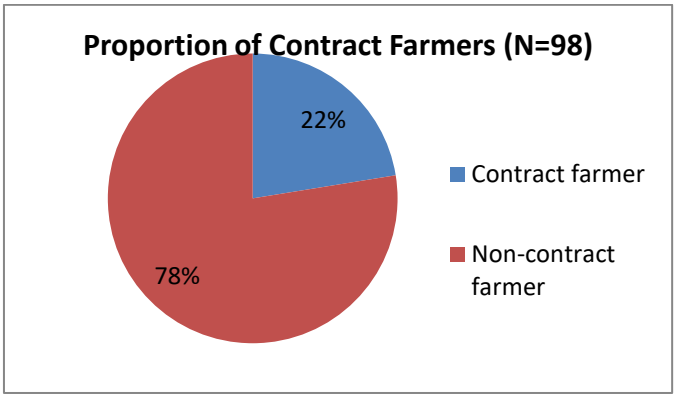

Figure 1: Proportion of contract farmers

The average age for both contract farmers and independent farmers was 48 years. None of the contract farmers were aged more than 70 years (Figure 2).

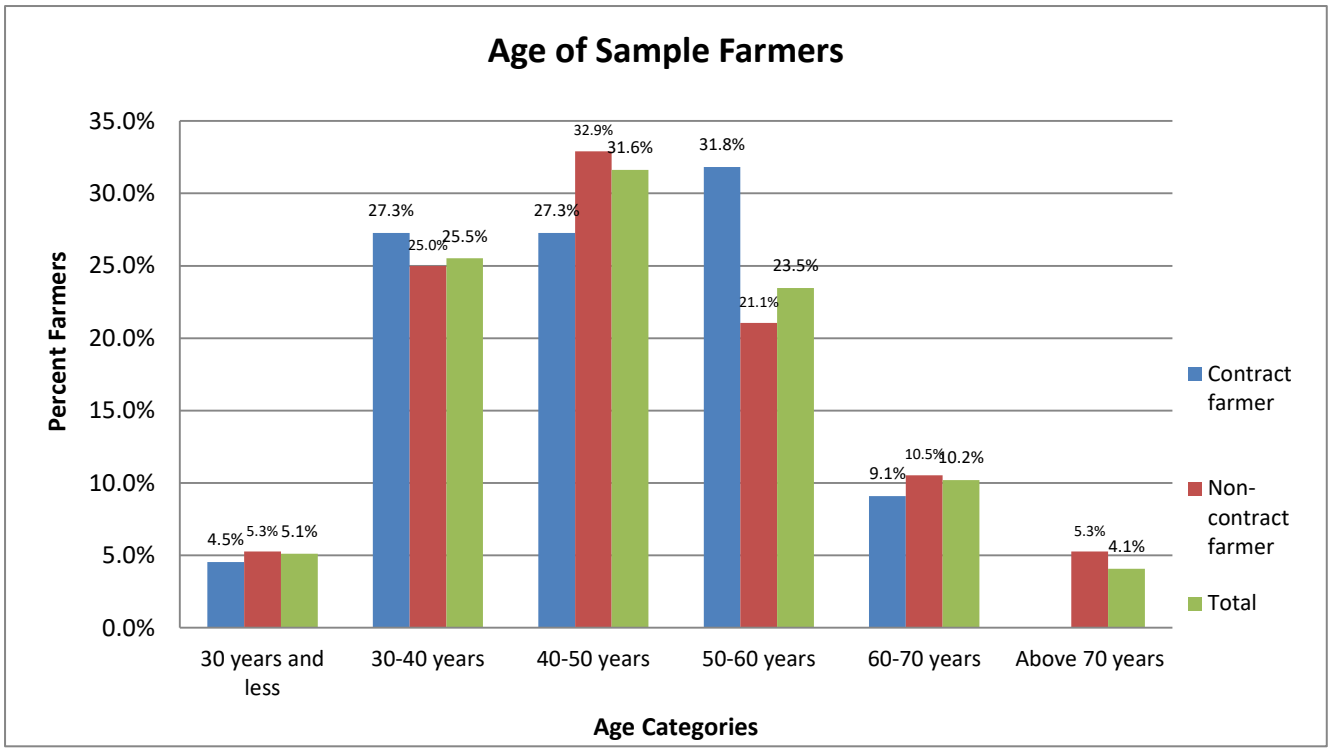

Fig-2: Age distribution of sampled farmers

In terms of gender distribution, tobacco is a men's crop as depicted by Figure 3 where men constitute 95% of the contract farmers and 74% of the independent farmers respectively. The very low proportion of women contract farmers may be an indication of contractual arrangements and tools that still discriminate against women participation and access. In most patriarch societies like Zimbabwe, women still require the approval of men when borrowing money and this therefore tends to limit women's participation and access to contract farming.

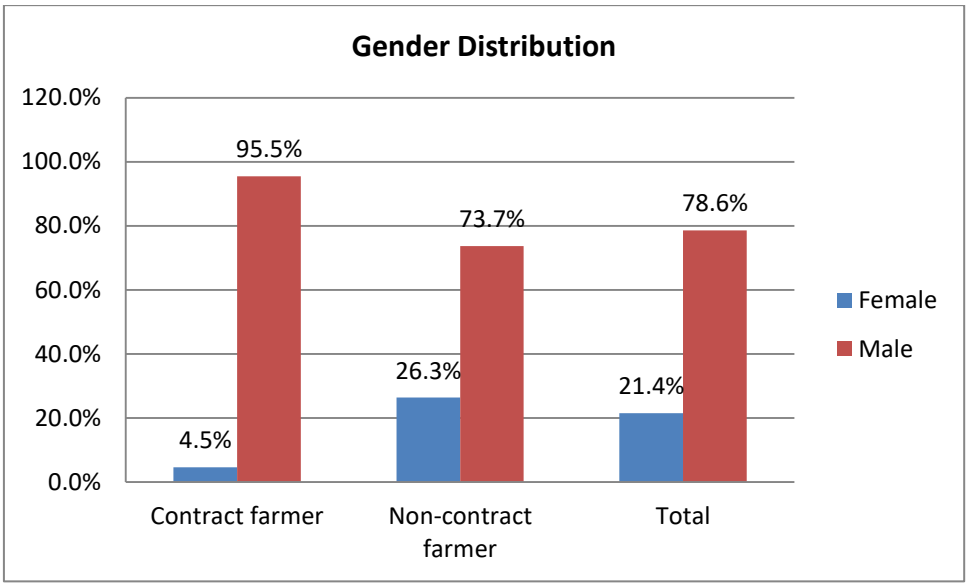

Fig-3: Gender distribution

Eight-two percent of the contract farmers had attained at least secondary education compared to 67% of the non-contract farmers (Figure 4). This clearly shows that a majority of the farmers had attained a good level of education to enable them to have a better understanding of how contractual arrangements work.

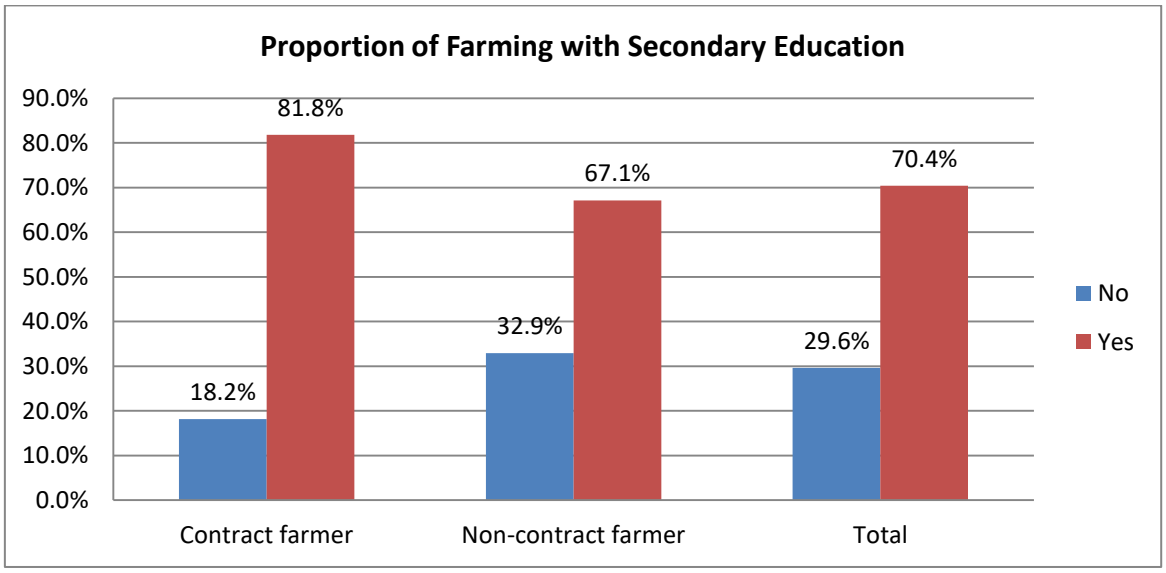

Fig-4: Education level

Fifty-nine percent of the contract farmers had individual land title compared to 37% of the non-contract farmers (Figure 5). Land tenure status still play a critical role in accessing credit in Zimbabwe where a majority of financial institutions still prefer land as collateral.

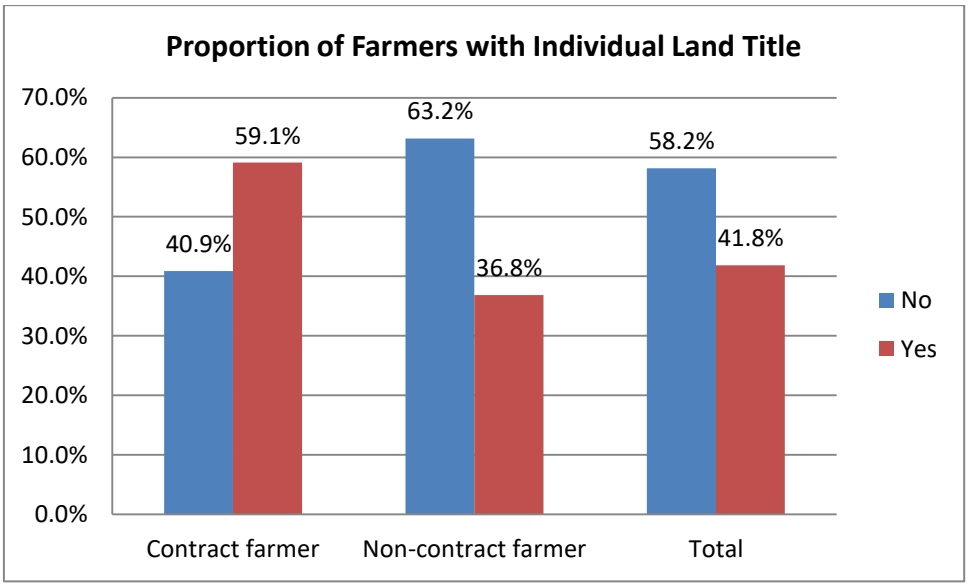

Fig-5: Land tenure

Both contract farmers and non-contract farmers had a mean crop area holding of 4 hectares (Figure 6). The crop area distribution is almost similar between contact farmers and non-contract farmers although 59% of the contract farmers have a cropping area above 3 hectares compared to just 50% for non-contract farmers.

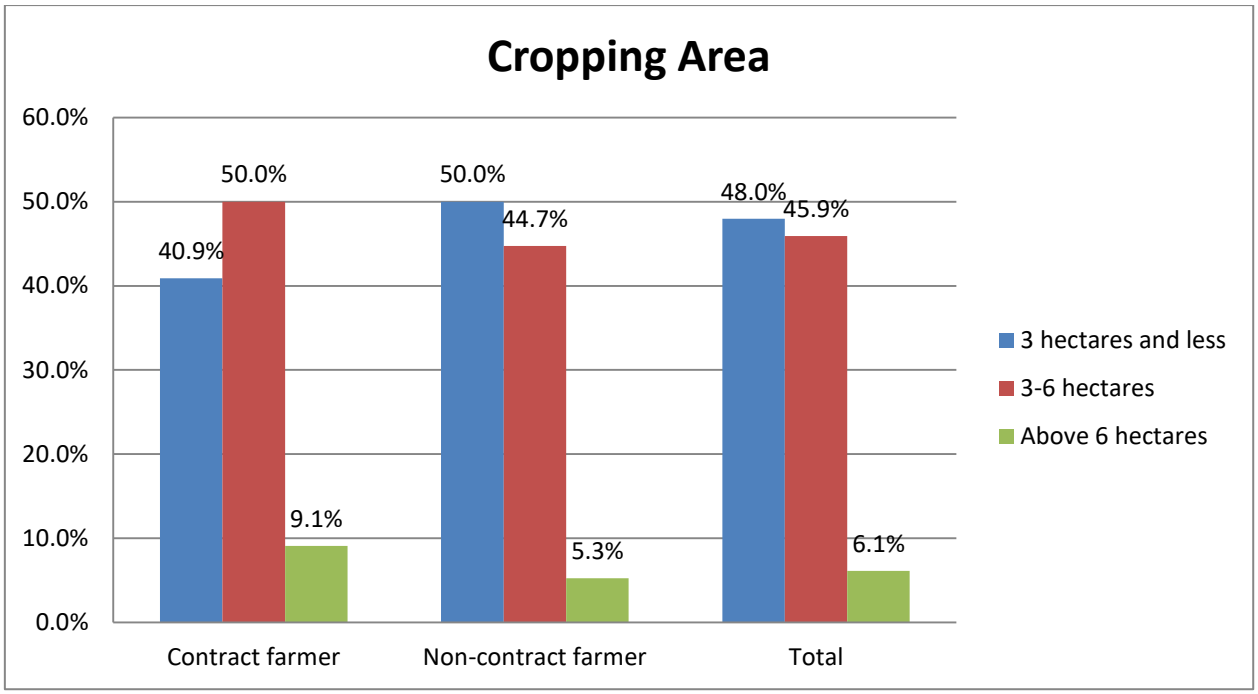

Fig-6: Cropping area distribution

Overall, the mean number of bales of tobacco sold during the 2015/2016 season was 19 with contract farmers selling 26 bales compared to just 16 bales for non-contract farmers. Given that on average, both contract farmers and non-contract farmers have a similar cropping area holding, this result shows that contract farmers are more productivity when compared to non-contract farmers. Twenty-seven percent of the contract farmers sold more than 30 bales compared to only 3% of the non-contract farmers whereas only 5% of contract farmers sold not more than 10 bales compared to 23% for non-contract farmers (Figure 7).

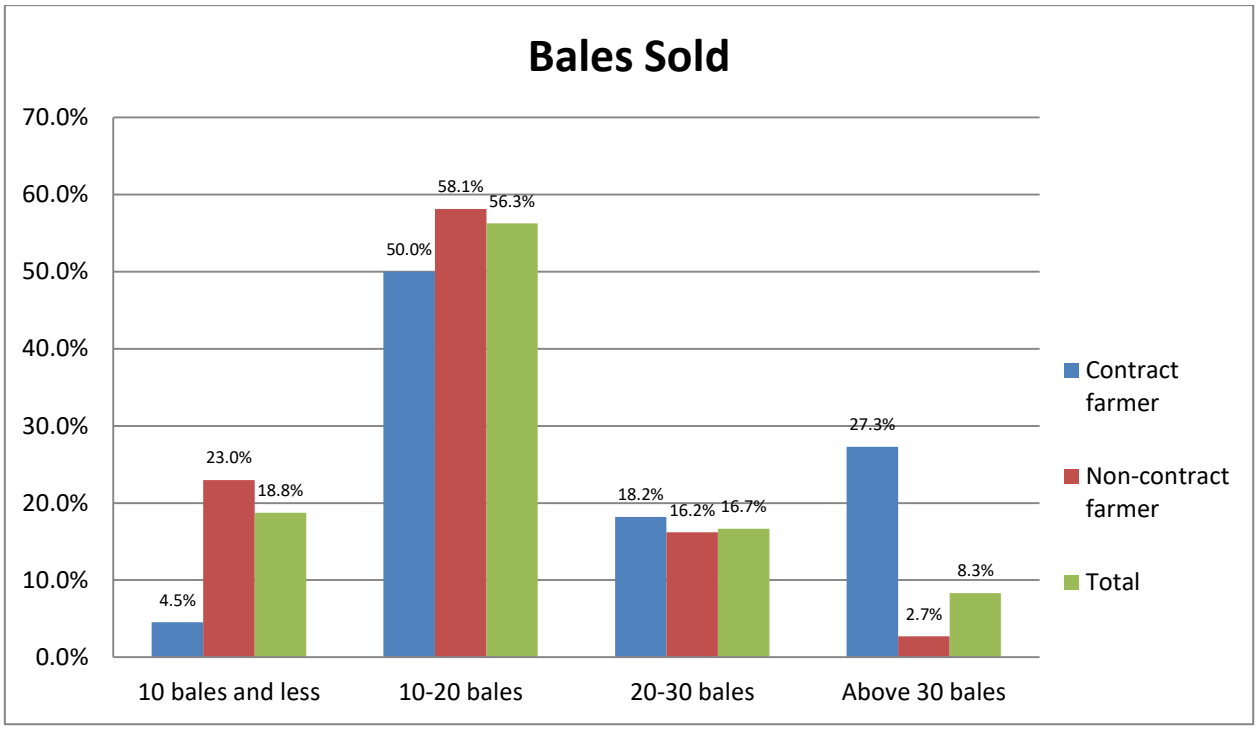

Fig-7: Bales sold

Technical Efficiency of the Farmers

The mean technical efficiency for contract farmers is 94% compared to 67% for non-contract farmers (Table 3). The overall mean technical efficiency for the sample is 73%. Therefore, contracted farmers were more technically efficient as compared to the non-contracted farmers and these results support earlier studies which argue that productivity of farmers can be increased by using contract farming [3, 14-16]. Contract farming is seen as a tool for creating new market opportunities as well as for providing credit and training, leading to increased productivity of smallholder farmers [17-19]. The results also further indicate that almost 96% of contract farmers have technical efficiencies above 80 percent compared to just 43% of non-contract farmers.

Table 3: Percentage distribution of tobacco production technical efficiency

Technical Efficiency Category	Contracted farmer	Non-contracted farmer	Total
0 – 20%	-	13.5%	10.4%
21 – 40%	4.5%	6.8%	6.2%
41 – 60%	-	17.6%	13.5%
61 – 80%	-	18.9%	14.6%
>80%	95.5%	43.2%	55.2%
Mean Efficiency	**93.73%**	**66.88%**	**73.04%**

Stochastic Frontier Estimates of the Production Frontier and Inefficiency Function

The results of the estimated production function and the analysis of the impact of contract farming on tobacco productivity are presented in Table 4. The Wald statistic of 140.6 and is highly significant at the 1% level and this indicates that the model fit is good. The results show that fertilizer and total fixed costs are the significant inputs in tobacco production and both inputs are significant at 1 percent level of significance (Table 4). A unit increase in fertiliser application results in a more than proportionate increase in output indicating that there is potential for farmers to increase output by a wider margin if they strive to apply more fertilizer.

The inefficiency function (Table 4) reveals that except for the tenure status of the farmer, the factors that significantly affect tobacco productivity are whether a farmer is producing under contract or not (FARMERTYPE), education level of farmer (FEDUC), the total cropping area (CROPAREA) gender of farmers (GENDER) and whether a farmer has access to other loans apart from the contract farming credit (OTHERLOAN).

Table 4: Stochastic Frontier estimates for bales sold

Variable	Coef.	Std error	Z	P> |z|
BALESOLD				
$HRS_{processing}$	0.0147967	0.0125529	1.18	0.238
$FERT_{TOT}$	1.232769	0.1713569	7.19	0.000
LAB_{TOT}	0.0201684	0.0275413	0.73	0.464
Other Costs	0.0122558	0.0087136	1.41	0.160
Fixed Costs	0.006775	0.0019269	3.52	0.000
Cons	-5.892972	3.529501	-1.67	0.095
Insig2u				
FARMERTYPE	10.83747	4.49346	2.41	0.016
FEDUC	-3.671906	2.109177	-1.74	0.082
TENURE	-0.5143992	1.163323	-0.44	0.658
CROPAREA	-0.9028926	0.5143819	-1.76	0.079
GENDER	5.874412	2.10853	2.79	0.005
OTHERLOAN	9.346182	3.956292	2.36	0.018
Cons	-9.713574	5.714765	-1.70	0.089
Insig2v_cons	3.962997	0.1687043	23.49	0.000
Sigma_v	7.253604	0.6118572		
Log likelihood	-253.40243			
Number of obs	74			
Wald chi2(5)	140.55			
Prob>chi2	0.0000			

Contract farmers are more a technical efficient when compared to non-contract farmers and this result is significant at 5% level (Table 4). The results show a non-contract farmers are 10.84 more inefficient. Farmers who are contracted attain higher technical efficiency because as part of their contract farming arrangements, the contractor provides extension support and specialized agronomic training that is meant to improve their productivity. This finding is consistent with the findings of Warning and Key in 2002 [20], Ramaswami *et al.;* in 2006 [21], Ruben and Sáenz-Segura in 2008 [22], Chakraborty in 2009 [23] and Rao *et al.;* in 2012 [24].

Farmers with at least secondary education level are more technical efficient in tobacco production when compared to their counterparts without and the result is significant at 10% level. The results show that a farmer with at who has secondary education is 3.67 less inefficient when compared to a farmer with no secondary education. Better educated farmers find it easier to learn new technical skills which they can apply in tobacco production resulting in higher productivity. This result is consistent with the findings of Pius and Odjuvwuederhie in 2006 [25]; Shehu *et al.;* in 2010 [26]; Osawe *et al.;* in 2008 [27]; Theophilus and Taiwo in 2014 [28]; and Alene and Hassan in 2003 [29]. Education increases information access and assimilation and together with long-term experience leads to higher production efficiency [30-33]. Singh in 2009 [34] further argues that inaccessibility to new efficiency enhancing techniques/technology may be caused by low income, low education level and/or traditional mindset (conservative, risk averse, etc.) of farmers.

The results also show that men and women operate at different levels of technical efficiency. Contrary to expectations, male farmers are 5.87 less efficient than female farmers and the results are significant at the 1% level. This result supports the findings of Okeye *et al.;* in 2016 [35], Koirala *et al.;* in 2015 [36], Dadzie and Dasmani in 2010 [37] but refutes the findings of Yiadom-Boakye *et al.;* in 2013 [38] and Muoh *et al.;* in 2015 [39]. It has been observed that female farmers can be as efficient as male farmers once individual characteristics and input levels are controlled [37]. This is supported by Akinwuni and Djato in 1997 [40] who argue that female farmers are less efficient mainly because they face a number of constraints which disproportionately affect them.

Technical efficiency was also found to decrease with an increase in cropping area and the result is significant at 10% level. A unit increase in total cropping area reduces inefficiency by 0.9. This result is consistent with the findings of Dube and Guveya in 2014 [41], Sibiko *et al.;* in 2013 [42], Idris *et al.;* in 2013 [43] and Sarwar *et al.;* in 2012 [44]. The efficiencies being derived realized by farmers with larger cropping areas may be coming from economies of scale.

Farmers with other sources of loan finance other than contract farming are 9.3% less efficient when

compared to farmers with no alternative loan source. This could have resulted from the lack of concentration on the part of the farmer to fulfill the obligations of contract farming when the farmer has multiple sources of finance. Farmers with multiple sources of finance can borrow to repay back the contract farming loan and hence they do not put maximum concentration in making efficient use of the contract farming loan.

CONCLUSION AND RECOMMENDATIONS

This study sought to estimate the technical efficiency of smallholder tobacco farmers and to determine the impact of contract farming on smallholder tobacco farmers' technical efficiency. It is argued that contract farming improves farmers' productivity as it helps to facilitate coordination between farmers and other actors in terms of production, processing and marketing of agricultural products [17, 19]. Contract farming arrangements address the problem of liquidity and enhance access and better use of agricultural inputs in production. The study found that on during the 2015/2016 tobacco production season, the mean tobacco bales sold by contract farmers was 26 bales compared to just 16 bales for non-contract farmers. Contract tobacco farmers were also found to be more technically efficient with a mean technical efficiency of 94% compared to 67% for non-contract farmers. The results further show that contract farming significantly improves efficiency in tobacco farming. Non-contract farmers are 10.84 more inefficient when compared to contract farmers and the result is significant at 5% level. These results are in support of Desai and Mellor in 1993 [45] and Nwagbo *et al.*; in 1989 [46] who argued that farm level credit when properly extended encourages diversified agriculture which stabilizes and perhaps increases resource productivity and agricultural production.

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