Journal of Agriculture and Sustainability
ISSN 2201-4357
Volume 4, Number 1, 2013, 115-140

Estimating Technical Efficiency of Cotton Production in Yendi Municipality, Northern Ghana

Adzawla, W. Fuseini, J. and Donkoh, S.A

Department of Agricultural & Resource Economics, Faculty of Agribusiness and Communication Sciences, University for Development Studies, P. O. Box TL 1882, Tamale-Ghana

Corresponding author: Donkoh, S.A, Department of Agricultural & Resource Economics, Faculty of Agribusiness and Communication Sciences, University for Development Studies, P. O. Box TL 1882, Tamale-Ghana

Abstract. Agriculture remains the kin pin of most African economies, including Ghana. In recent times the contribution of non-traditional export crops, including cotton, to foreign exchange earnings in Ghana has been quite significant. The aim of this study was to explore the social, economic and environmental factors influencing cotton production in Yendi Municipality in Northern Ghana. A multi-stage sampling technique was used to select 91 small holder cotton farmers in 8 communities in the Municipality. The data was collected during the 2011/12 cropping season and fitted into Translog stochastic frontier model. The one-stage maximum likelihood estimation was used to obtain the efficiency levels as well as the determinants of such efficiency levels. A SWOT analysis was carried out to assess the sustainability or otherwise of the cotton industry in the study area. Individual farm level technical efficiency ranged between 0.70 and 0.99 with a mean of 0.88. This was as a result of the agricultural intensification system made possible by the cotton company, Armajaro Ghana Ltd. However, in order to reap the full benefits of commercializing cotton production in the region, both farmers and the cotton companies must keep to their contractual agreement; while the latter should supply the inputs timely and pay the farmers promptly, the former should use the inputs for the intended purposes and pay back promptly. Above all, there should be land reforms to make land available for the expansion of cotton farms.

Keywords: Cotton, Northern Ghana, SWOT Analysis, Technical efficiency

INTRODUCTION

In June 2012, world leaders from across the globe gathered at the United Nations conference on sustainable development (Rio+ 200) to declare a common commitment to ensuring the promotion of an economically, socially and environmentally sustainable future for the earth's present and future generations (FAO, 2012). Similarly, Agriculture and hunger eradication have been high on the international agenda. During the conference the UN Secretary-General, Banki-Moon announced the Zero-Hunger challenge, calling for an end to world hunger. Agriculture is the engine of growth to many economies, including Ghana. Agriculture in Ghana, like in many African economies is in the hands of small-scale farmers who constitute about 92% of the farming population. These normally live in the rural areas and use rudimentary tools for the farming activities. Until the rebasing of the GDP, the agricultural sector provided the highest contribution, followed by the service sector and then the industrial sector. However, in 2010, the agricultural sector lost its lead- role to the service sector and contributed 30% to GDP, while the service and the industrial sectors respectively contributed 51% and 19%. Growth of the agricultural sector was 4.8% in 2010 compared to 7.6%in 2009 and well below the target of 6.0% (ISSER, 2010). However, while the share of non-traditional agricultural exports, including cotton, in total non-traditional exports has been falling since 2007, Ghana received US $164.96 million from non-traditional agricultural exports in 2010 compared to US$ 150.86 million in 2009 (ISSER, 2010).

Hussein (2010) observed that cotton has been at the heart of an agricultural revolution in cotton producing countries in Western and Central Africa (WCA), promoting access to technical and extension advice, technological innovation, intensification and increased used of inputs not only on farmers' cotton fields but also on other crops. He stressed that this synergy between cotton production and production of food crops had led to increased productivity for both category of crops since 1980s in WCA.

Cultivated cotton belongs to the genus *Gossypium*. It is a soft fiber shrub, native to tropical and sub-tropical region around the world including America, India and Africa. The largest volume of cotton production in the world is concentrated in countries like China, United State, India, Pakistan and Brazil. These countries produce more than three quarters of world output. However, low income countries also depend on cotton to earn foreign exchange (Anderson and Valenzuela, 2006). Anderson and Valenzuela (2006) also stated that exports of lint cotton in US, Australia, Uzbekistan and Brazil account for almost two-third of the world export. The well known lint cotton importing countries in the world are Pakistan, India, Egypt, United Arab Emirates, China, Korea and South Africa. Recent trends in the cotton production focuses on cost reduction by using less intensive input, for example, using genetically modified(GM) seed technology and organic methods of production(Baffes,2004).

Cotton is an important cash crop to a number of developing countries. Goreux (2003) stated that cotton has a strong poverty reduction impact because it is cultivated in small family farms in areas where opportunity for growing other crops are very limited and per capita income is very low. Although cotton production in Africa is not significant on a global scale, a large number of African countries remained heavily dependent on cotton. For instance, cotton accounts for 60% of foreign exchange earning in Benin. The West and Central African producers, which had a very marginal rank in the world market forty years ago (approximately 30, 000 tonnes), have also considerably increased their production capacity, and now account for more than one million tonnes, representing over 4% of the world production. Between 1990 and 2007, West African cotton yield per hectare was approximately 1.1tons (FAOSTAT, 2010).

Cotton production in Ghana however, is low compared with that of her neighbours. For instance, whereas cotton yield in Ghana was 0.8 tonnes/ha that of Benin and

Burkina Faso were 1.5tonnes/ha and 1.3 tonnes/ha respectively (FAOSTAT, 2010). This notwithstanding, Salifu (1999) observed that the potential area for Ghana's cotton production is about 500,000 hectares of which more than 80% lies in the Northern part of Ghana and is capable of producing 200,000 metric tonnes of lint cotton with market value of about US$200 million. The cultivation of cotton has the potential of becoming a major cash crop in northern Ghana as some put it, "the cocoa of the north" given the needed boost. Developing cotton as a major cash crop in northern Ghana offers increasing economic rewards and has a better potential of reducing poverty as it provides a source of employment as well as income security. Ghana's cotton production had a couple of good years in the early and late 1990's, with a record harvest of 45,000 tonnes of seed cotton, but for the last 10 years, the production appears to be stable around 20,000 tonnes per year. (FAOSTAT, 2010).

History of the Cotton Industry in Ghana

The history of cotton industry in Ghana dates back to the 17th century when the Bassel missionaries first introduced it into the country (Seini, 2002). However, we understand from Scholtes et al. (2011) that large scale production of the commodity began in 1968, with the establishment of the Cotton Development Board (CDB). The board was established with the mandate to stimulate the production of cotton, ensure adequate supply of raw materials to local industries and undertake research on improved seed varieties. The CDP was efficient in performing its functions until in 1977 when its production began to fall due to declining producer prices relative to that of food crops. Following a decline in the industry in the 1980s the board was privatized and re-constituted into the Ghana Cotton Company Ltd, with the Government of Ghana keeping 30% of the shares and the remaining70% sold to two textile companies. With time the government was able to increase its shares to 90% because it paid off the debts of one of the company's shareholders, namely, Agricultural Development Bank (ADB). The ADB was then state-owned and the payment of the debt was converted into equity for the government. The remaining 10% was shared among 16 private investors which included input providers and textile companies. Scholtes et al (2011) observed that the privatization did not do much in reversing the downward trend in productivity of the cotton industry. This was exacerbated by falling world prices, to the extent that by 2010, there were 5,000 hectares of cotton under cultivation, and the total ginning capacity of 86,000Mt (of which 61,000 Mt was in the hands of GCCL) produced that year only about 2,000 Mt. FOASTAT (2010) reported in Scholtes et al (2011) noted that Ghana has never produced much cotton in comparison with its neighbors. Yet the Government of Ghana considers that the revival of the cotton industry is important in alleviating poverty in the northern region, which remains one of the poorest in the country. Against this backdrop, among others, the government has brought on board three new cotton producing companies, namely Olam, Wienco and Armajaro. These have assumed the role of inputs-extension-tractor service providers for the farmers in their respective zones.

Northern Ghana comprises three regions; Northern, Upper East and Upper West. These regions are bordered by Togo to the East, Cote d'Ivoire to the West, Burkina Faso to the North and Brong-Ahafo and Volta regions to the south. As compared to the south the region is relatively dry with a single rainy season that begins in May and ends in October with an annual rainfall record varying between 750mm and 1050mm. The dry season starts in November and ends in March/April with maximum temperatures ranging between 40^0C - 43^0C occurring between March and April and minimum temperatures in December and January. The main vegetation of the region is the savannah grassland, interspersed with the guinea savannah woodland and characterised by drought-resistant trees such as baobab, acacia, dawadawa, shea, mango and neem. The harsh climatic conditions of the region are a limiting factor for the region to attract both material resources and human capital. As a consequence, industrial activity in the region is relatively low as compared to the southern part of Ghana, with the bulk of the population engaged in agriculture. In 2005/2006, households in the three northern regions derived more than 50% of their incomes from agricultural activities (Ghana Statistical Service, 2007).

The three northern regions are also among the poorest in the country. For example, The Ghana Statistical Service (2007) reveals that while the national poverty in 2005/2006 was 28.5% that of the northern, Upper East and Upper West were 52%, 70% and 88% respectively. Similarly, while the World Food Programmes (WFP) Comprehensive food security and vulnerability analysis for Ghana (WFP, 2009) identified only 5% of the population as poor or borderline food consumption, in rural areas of northern, Upper East and Upper West, this percentage increases to 10%, 15% and 34% respectively. Lastly, northern Ghana is viewed by many to be the main conflict zone of Ghana. With only one rainy season which lasts for about 5 out of the 12 months, most of the people are either under-employed or idle for the rest of the year. This has a lot of implications for conflicts. Over the years the population figures for all the three regions have been increasing and this means a higher demand on the limited resources, including land, making arable land sizes even smaller. Land issues have been a source of many a conflicts.

Against this backdrop, the development of the north has been a concern to both governmental and non-governmental organizations. The development strategies have mainly centred on improving the activities in which there is absolute/comparative cost advantage. The production of cotton is one of such economic activities and many analysts have argued that if efficiency is ensured in the industry, it would go a long way to lift a lot of the farming population from poverty. Ensuring efficiency calls for finding out, at the grassroot, the determinants of such efficiency as well as the strengths, weaknesses, opportunities and threats (SWOT) of the cotton industry. Thus, in this study, a combination of quantitative and qualitative methods has been employed to explore the determinants of technical efficiency as well as the SWOT of the cotton industry.

MATERIALS AND METHODS

Study area

The study was conducted in Yendi Municipality, located in the eastern corridor of the Northern region of the Republic of Ghana between latitude 9^0- 35^0 N and 0^0- 30^0 W and 0^0 - 15^0 E. The choice of Yendi was informed by its popularity in cotton production. Yendi is the second largest town in the northern region of Ghana, second to Tamale, the regional capital. In fact, it is the capital of the Dagbon Kingdom. As a northern town, it shares all the characteristics of northern Ghana outlined above, including the conflict which claimed the lives of the immediate past King Yaa-Naa Yakubu Andani II. Since cotton is the main cash crop in the area where a higher number of communities are involved in the cultivation of the crop, the zone is re-clustered into three for effective supervision by the cotton companies.

The operation of the cotton companies

Armajaro Company Ltd is one of the main cotton companies operating in the Northern region and for that matter Yendi. They have field agents in all the districts in northern Ghana who register potential cotton farmers during the dry season and provide them with production inputs such as tractor ploughing, cotton seed, fertilizer, weedicides and insecticides on credit. When the cotton is harvested, they value the cost of the cotton, deduct the total cost of production inputs advanced to the farmer and the remaining amount paid to the farmer as profit. The cotton farmers are organized into groups so that if a member of the group should default, the cost is borne by all the group members. The field agents regularly visit the farmers in their homes and farms during the cotton cultivation period to offer agricultural extension service until the cotton is harvested and sold to the company.

Sampling procedure and data collection

Cross-sectional data was collected from 91 farmers during the 2011/12 cropping season through questionnaire administration. Purposive sampling was employed in selecting eight communities in the Municipality based on their popularity in the cultivation of cotton. A simple random sampling technique was then used to select the final respondents.

Data analysis

Theoretical framework

Efficiency is the act of achieving good results with little waste of effort. A firm's efficiency can be defined in terms of its ability to produce the highest possible amount of output under a given technology. Shehu et al, (2010) indicated that efficiency is concerned with the performance of the 'processes' used in transforming a given set of inputs into outputs. The modern theory of efficiency dates back to the pioneering work of Farrel (1957). Farrel also proposed that the efficiency of a firm consist of two components: technical and allocative efficiency, and that the combination of these gives the economic efficiency. Allocative efficiency reflects the firm's ability to use the inputs to optimal proportions, given their respective prices and the production. It deals with the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost. Technical efficiency which is the main focus of this study is the ability to produce maximum output with a minimum use of resources. It indicates the potential gains in output without inefficiency.

The term frontier involves the concept of maximality in which the function sets a limit to the range of possible observations (Forsund et al., 1980). The frontier represents an efficient technology, and a deviation from the frontier is regarded as inefficient (Okon et al., 2010). The stochastic frontier model is theoretically defined as:

$$Y_i = f(X_i'; \beta) - U_i + V_i, i = 1,2 \dots n \quad (1)$$

Where Y_i is output of the ithhousehold

X_i is a $(1 \times k)$ vector of farm inputs(in natural logarithm)

β is a $(k \times 1)$ vector of parameters to be estimated

V_i measures the random variation in output (Y_i) due to factors outside the control of the farm firm such as weather and natural disasters ; u_i on the other hand measures the factors (within the control of the firm) responsible for that firm's inefficiency such as mismanagement. V_i is assumed to be identically and independently distributed as $N(0,\sigma_v^2)$ random variables, independent of U_i which is distributed as a truncated normal (at zero) of the $N(0,\sigma_v^2)$ distributions. U_i is independently, but not identically distributed. In general, ε_i=$V_i - U_i$is the composed error term. The technical efficiency of a given firm (at a given time period) is defined by Battese and Coelli (1992) as the ratio of its mean production (conditional on its level of factor inputs and farm-effects) to the corresponding mean production if the firm utilizes its levels of inputs most efficiently.

Formally,

$$TE = \frac{Y_i}{Y_{i*}} = \frac{f(X_i;\beta)exp(V_i - U_i)}{f(X_i;\beta)expV_i} = exp(U_i) \quad (2)$$

Where the numerator is the output of the i^{th} firm and the denominator is the potential output or the average output of all the efficient firms in the same industry as the i^{th} firm.

$$Y_i^* = \exp(Y_i) \quad (3)$$

and TE_i will take a value between zero and one.

Equation 1 may take the form

$$In(y_i) = f(x_i;\beta) + v_i - u_i \quad (4a)$$

$$u_i = w_i\delta + e_i \quad (4b)$$

Where;

$w_i$is a vector of independent socio economic variables

$\delta$is a vector of parameters to be estimated and e_i is a two sided error term with $N(0,\sigma_e^2)$. The other variables are as defined above.

Empirical model

Data gathered was analysed using the stochastic frontier approach as it provides estimates of the efficiency level of each farmer and the various variables associated with the farmer's efficiency. The Translog stochastic production frontier approach was used to estimate the production function, considering its flexibility as opposed to the Cobb-Douglas specification. Following from equations 4a and 4b the empirical model is defined by equations 5a and 5b as follows:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 (\ln X_1)^2 + \beta_6 (\ln X_2)^2 + \beta_7 (\ln X_3)^2 + \beta_8 (\ln X_4)^2 + \beta_9 \ln X_1 \ln X_2 + \beta_{10} \ln X_1 \ln X_3 + \beta_{11} \ln X_1 \ln X_4 + \beta_{12} \ln X_2 \ln X_3 + \beta_{13} \ln X_2 \ln X_4 + \beta_{14} \ln X_3 \ln X_4 + V_1 \qquad \text{5a}$$

Where X_1 is farm size(acres), X_2 is labour(number of workers),X_3 is quantity of fertilizer (kilograms) and X_4 is quantity of insecticides(liters), β_s are the parameters to be estimated and v_i measures the random variation in output due to factors beyond the control of the farm.

The model formulated to estimate the factors contributing to the efficiency of cotton farmers that was jointly estimated in a single stage with equation 5a above is expressed as;

$$u_i = +\delta_1(Age) + \delta_2(Educ.) + \delta_3(Exp) + \delta_4(Extension) + \delta_5(Farmsize) + v_2 \qquad (5b)$$

Where U represents technical efficiency, δs are the parameters to be estimated. Age is measured in number of years, education in number of years in formal education, experience in number of years a farmer is into cotton cultivation, extension contact in number of times and farm size in acres v_2 is the two sided error term. The β and δ were estimated by Maximum Likelihood using the computer program, Frontier version 4.1c (Coeli 1996)

SWOT analysis was used to evaluate the internal and external environmental factors that affect the production of cotton in the area. This is done to provide further insights into the sustainability or otherwise of the cotton industry.

RESULTS

Descriptive statistics of respondents

The descriptive statistics of the sampled farmers is presented in Table 1. On the average, a typical cotton farmer in the Yendi Municipality is 36 years old, with virtually no formal education. There is a wide range (25) in the number of members of the farmers' family given an average household of 12. This is far above the average household of 7.4 in the Northern region. Cotton farmers in the area cultivated the crop for approximately 5 years with a land holding of 1.22 acres in the 2011/12 cropping season. This farm size produces an average output of 344kg of cotton lint using 5.3kg of seeds, 156.03kg of fertilizer, and 2.55 litres of insecticides as well as 9 persons as work force. Finally, on average the farmers were visited five times during the farming season.

Table 1: Descriptive Statistics of Farmers

Variable/ Characteristic	Minimum	Maximum	Mean	Mode	Standard Deviation	Variance
Age	18	70	36.12	35	9.73	94.62
Education	0	12	0.92	0	2.82	7.94
Household size	4	29	11.98	7	5.84	34.11
Experience	1	20	4.56	5	3.23	10.45
Extension visit	1	10	4.51	5	1.14	1.30
Farm size	1	2	1.22	1	0.42	0.17
Labour	1	27	8.51	4	4.87	23.70
Seed	1	20	5.31	5	3.36	11.26
Fertilizer	50	300	156.04	150	37.89	1.44
Insecticides	0	7	2.55	2	1.37	1.86
Output	107	664	344.03	360	122.22	1.49

Test of hypotheses

Three main hypotheses were tested in the study. The first was that there were no inefficiency effects in the model. In other words the model is an average response model, which implies that all the inefficiencies were due to factors outside the control of the farmers. This was rejected since the estimated X^2 statistic was significantly different from zero at 1%. This implies that the ordinary average response function is not a suitable specification of cotton production in the area. Thus, factors outside the control of farmers were also responsible for the inefficiencies. The second hypothesis was that the Cobb-Douglas specification is an adequate representation of the stochastic frontier model. This was also rejected considering the fact that the test statistic is significantly different from zero. Thus, the translog production function better fits the stochastic frontier model used to estimate the technical efficiency of the cotton farmers. The third test was conducted with the null hypothesis that, the explanatory variables in the technical efficiency model have a zero coefficient (i.e. $\delta = 0$). That is to say that the socio economic variables do not influence technical efficiency of the cotton farmers. This was also rejected and the alternate hypothesis accepted that the explanatory variables contribute significantly to the variation in the efficiency of cotton production.

Table 2: Tests of hypotheses

Null hypothesis	**Log likelihood**	**X^2 statistics**	**Critical region**	**Decision**
1.Ho: $\gamma = 0$	69.45	75.78	19.54***	Rejected
2.Ho: $\beta_5+\ldots+\beta_{14} = 0$	97.65	19.38	15.32**	Rejected
3.Ho: $\delta_1+\ldots+\delta_5 = 0$	99.72	15.24	6.64***	Rejected

Technical efficiency levels of farmers

One of the main objectives of the study was to find out the efficiency levels of the cotton farmers in the study area. From Table 3, we observe that the average technical efficiency level is 0.88, ranging from 0.70 and 0.99. This is comparable to that of many studies (Mohammed-Yusuf, 2005; Tsimpo, 2010; Neba et al, 2010). The wide difference in technical efficiency among the least practice and best practice farmer indicates an opportunity for efficiency improvement. The mean efficiency of the farmers implies that, on the average, 88% of output was obtained from the given mix of production inputs by the farmers. This is an indication that cotton output have fallen by 12%, otherwise, there is a potential of increasing output by 12% through the adoption of efficient farming practices. However, it can be seen from Table 3 that as high as 82.4% of respondents had efficiency score of at least 80%.

Table3: Technical efficiency levels of farmers

Efficiency level	**Frequency of farmer**	**Percentage of farmers**
70-79	16	17.6
80-89	30	33.0
90-99	45	49.4
Total	91	100
Minimum efficiency	0.70	
Maximum efficiency	0.99	
Mean efficiency	0.88	

The determinants of output

In Table 4 the maximum likelihood estimation results of the stochastic frontier model are presented. It can be observed that the estimated coefficients of all the first order terms, except insecticides, were significant. Also, while labour and fertilizer had the expected positive sign, farm size had a negative sign. In the case of the squared variables, we notice an opposite scenario where farm size squared had a positive sign but labour and fertilizer had a negative sign. In general, the squared terms indicate the relationship between the variables with output on their continuous usage. Thus, in the case of farm size it can be said that at the initial stages of its use, less of it must be employed if output is to be increased. However, with time, more of it should be employed if output is to be increased. The opposite is the case for labour and fertilizer; at the initial stages more of them must be used if output is to be increased. However, with time, if more of them are employed output would fall. The interaction terms indicate the substitutability or complementarity of the inputs. In general, a significant positive coefficient of an interaction term means that the two inputs are complements, while substitutes would have a negative term. From the table, the interaction term between farm size and labour is significant and positive, which means that both inputs must be increased if output is to be increased. On the other hand the interaction term between farm size and fertilizer is negative, which suggests that while one must be increased, the other must be decreased if output is to be increased. The same explanation goes for the interaction term between labour and fertilizer.

Socio-economic determinants of technical efficiency

It should be noted that the socio-economic variables used in the technical efficiency model are the determinants of inefficiency and not efficiency. This implies that the variables with negative coefficients have negative relation with inefficiency but positive relation with efficiency and *vice versa*.

The coefficient of farmers' experience (number of years in cotton production) was negative and significant at 5% implying that farmers cultivating cotton for longer years were less technically inefficient. This was perhaps due to their ability to draw on past experiences to suit their farming conditions. Neba et al (2010) also found experience to positively influence technical efficiency and stressed that technical know-how obtained through experience increases technical efficiency. Farm size was also significant at 5% with a negative coefficient indicating that, farmers tended to be less inefficient as their farm sizes increased. Thus, farmers with larger farms were more technically efficient than their counterparts with smaller farms. This is in contrast with the findings of Tsimpo (2010) and Gal et al (2009), who found technical efficiency to be higher for small farms. In our present study, age, education and extension variables were insignificant. However, in the studies by Neba et al (2010), Gal et al (2009) and Kouser et al (2010), the age variable had a negative significant effect on technical efficiency. Similarly, while education had a negative significant impact on technical efficiency in Gal et al (2009), it positively influenced technical efficiency in Kouser et al (2010).

Table4: Maximum likelihood estimates of the stochastic frontier model

Variable	Parameter	Coefficients	Standard error	t-ratio
Production factors				
Constant	β_0	-3.947	0.549	-7.191***
Farm size	β_1	-13.727	0.901	-15.232***
Labour	β_2	3.409	0.736	4.630***
Fertilizer	β_3	4.129	0.650	6.352***
Insecticides	β_4	0.275	0.883	0.311
Farm size squared	β_5	53.416	0.991	53.876***
Labour squared	β_6	-0.294	0.098	-3.017***
Fertilizer squared	β_7	-0.609	0.216	-2.816***
Insecticides squared	β_8	-0.076	0.173	-0.439
Farm size* Labour	β_9	0.673	0.368	1.826*
Farm size* Fertilizer	β_{10}	-1.344	0.387	-3.470***
Farm size* Insecticides	β_{11}	-0.353	0.342	-1.033
Labour* Fertilizer	β_{12}	-1.330	0.339	-3.921***
Labour* Insecticides	β_{13}	-0.192	0.123	-1.571
Fertilizer* Insecticides	β_{14}	-0.019	0.405	-0.047
Efficiency factors				
Constant	δ_0	0.3355	0.066	5.11
Age	δ_1	-0.001	0.002	-0.609
Education	δ_2	-0.008	0.007	-1.247
Experience	δ_3	-0.004	0.002	-2.551**
Extension contact	δ_4	-0.994	0.011	-0.939
Farm size	δ_5	-0.116	0.048	-2.431**
Variance parameters				
sigma-squared(σ^2)		0.012	0.001	9.005
Gamma(γ)		0.100	0.00008	11753.969
log likelihood function		107.338		
total number of observations		91		

The figures (1-6) provided further explanation of the relationship between average efficiency and the socio-economic variables characterizing the farmers.
As one progresses along the educational ladder, the average efficiency continues to increase. This is evident in fig.1 as farmers with secondary education had a higher efficiency than those with primary education, and they also had a higher efficiency than those with no formal education. However, as seen earlier, the education variable in the econometric model was not significant.

Apart from farmers under 20 years of age, efficiency seemed to be quite stable among the age groups, as there was relatively insignificant difference in their average efficiencies (see fig 2). From Figure 2, while the average efficiency of farmers under 20 years was 0.79, farmers above age 20 years had efficiency ranging from 0.88 to 0.89, suggesting that older farmers were more efficient. However, like the education variable, age was not significant in the estimated model.

From Figure 3 efficiency was highest among farmers with between 11 and 15 years of cotton production experience (0.91), followed by those with between 6 and 10 years of experience (0.90), and then those with between 16 and 20 years (0.89). The farmers with the lowest efficiency (0.88) were in the category of 1 and 5 years of experience.

As depicted in Figure 4 technical efficiency was also highest for farmers who received between 5 and 6 extension visits during the cropping season (0.91), followed by those who received between 3 and 4 visits (0.90), and those who received between 9 and 10 (0.89). Farmers who received the least extension visits of between 1 and 2, understandably had the lowest average technical efficiency (0.88). However, as seen earlier the extension visits variable was not significant.

Figure 5 confirms the estimation results that farmers who had relatively large farms (2 acres) had greater efficiency (0.93) than those who had smaller farms (1 acre); the average technical efficiency of the latter being 0.87.

Lastly, Figure 6 shows that generally, technical efficiency reduced with increasing household size. Farmers with family size of between 1 and 5 had the highest technical efficiency of 0.93, followed by those with between 16 and 20 (0.90) and then those with size between 6 and 10 (0.89).

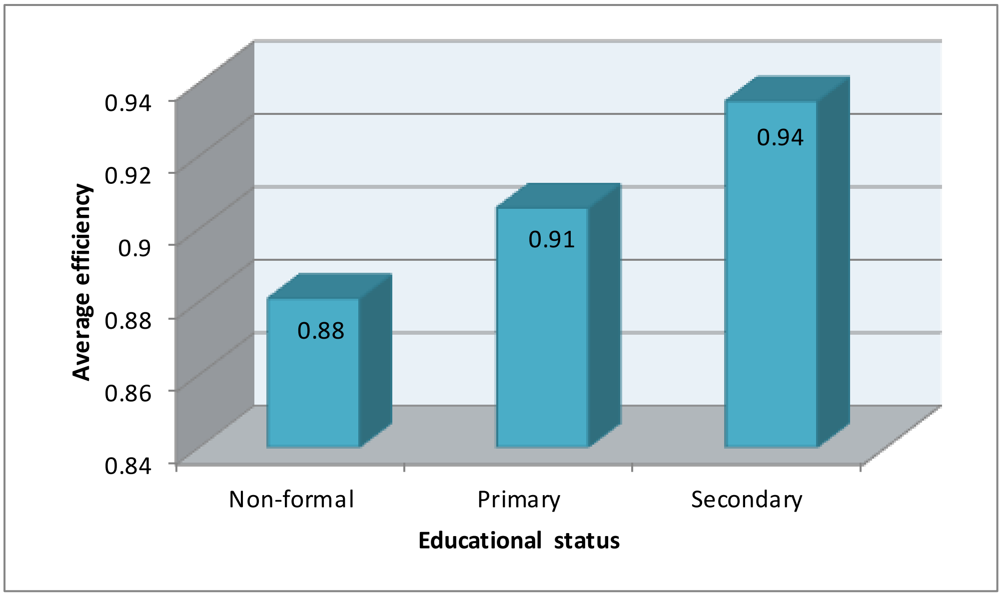

Fig 1: Average efficiency and educational status of farmers

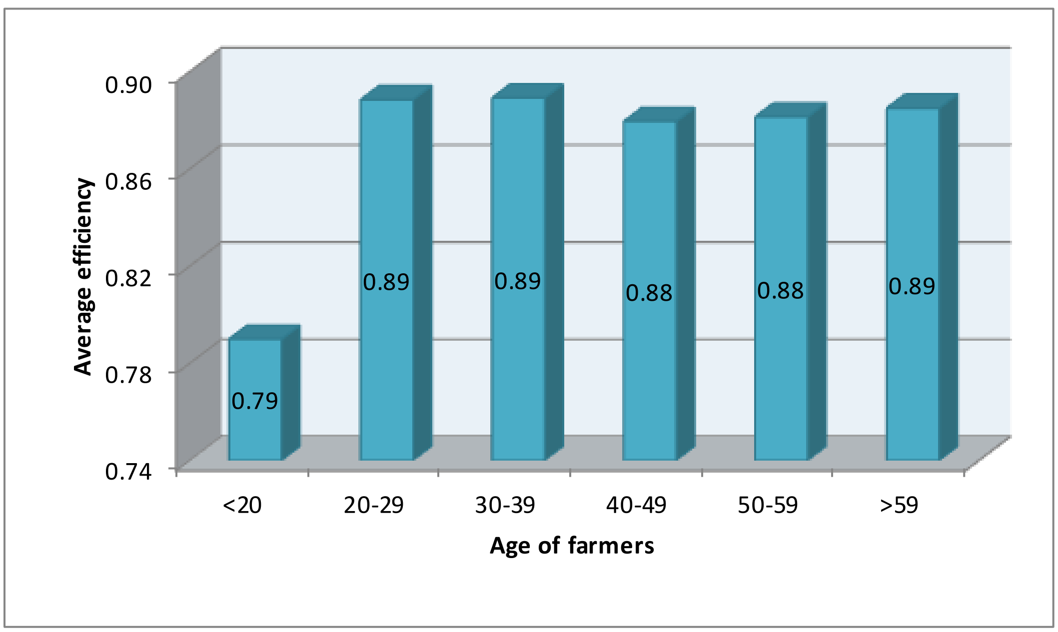

Fig 2: Average efficiency and age of farmers

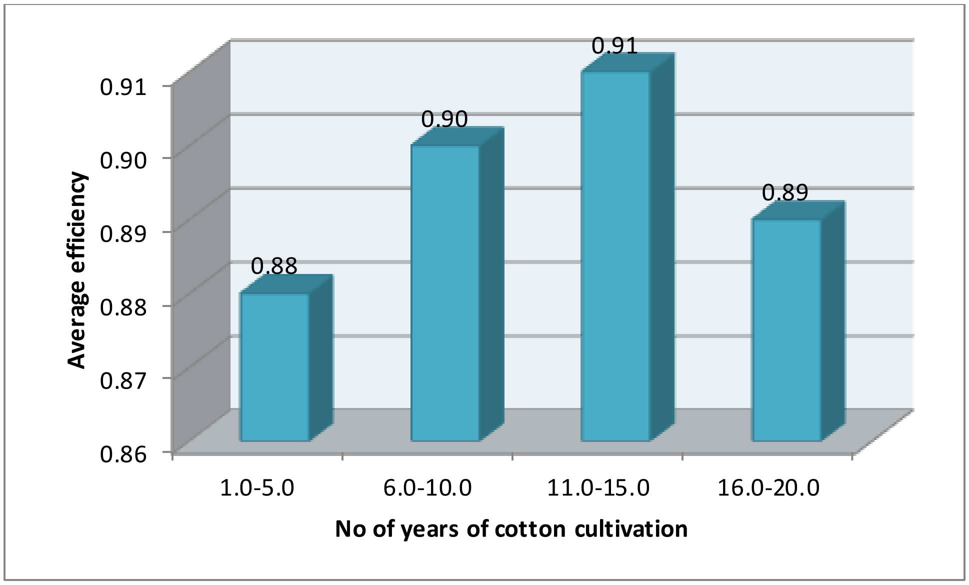

Fig 3: Average efficiency and experience level

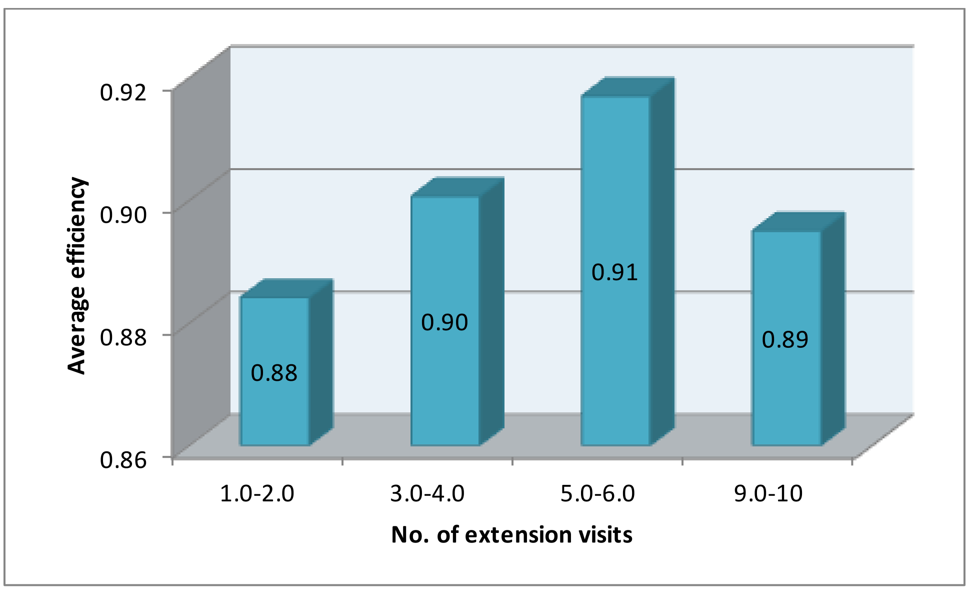

Fig 4: Average efficiency and extension contacts

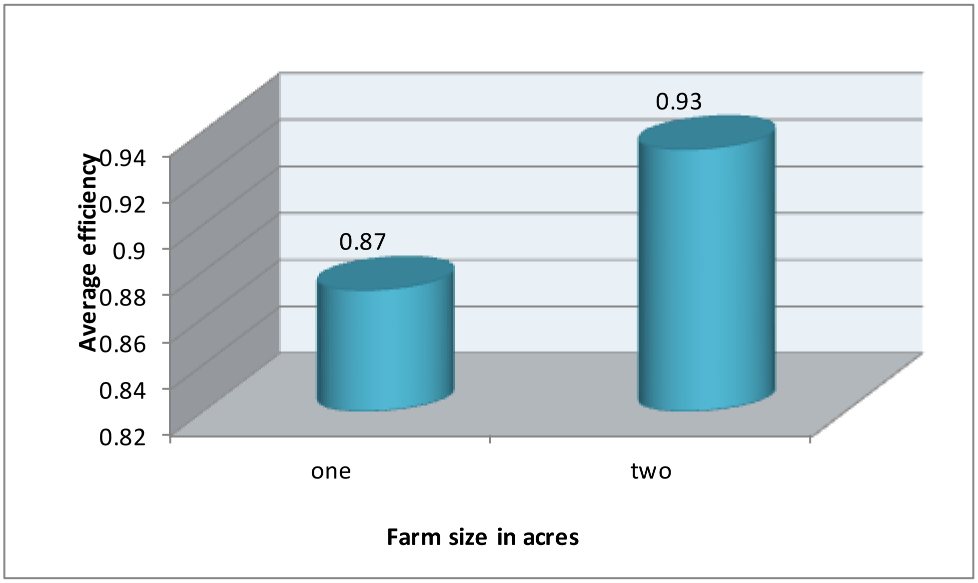

Fig 5: Average efficiency and farm size of farmers

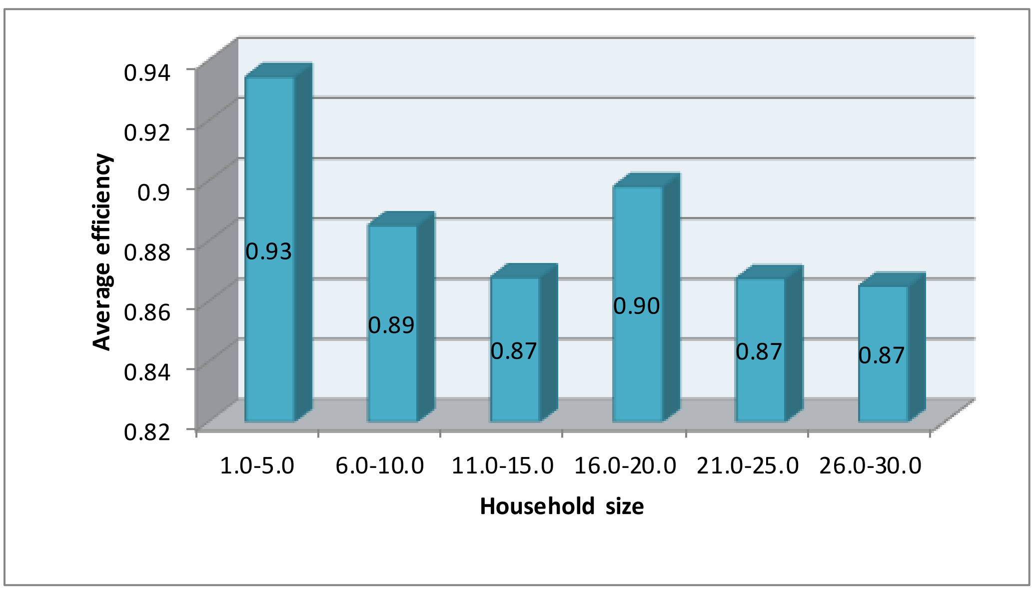

Fig 6: Average efficiency and household size

SWOT analysis of cotton production in Yendi Municipality

As indicated earlier, a SWOT analysis was conducted to assess farmers' perceptions on the internal and external environmental factors that affect cotton production in the study area. The responses were as follows:

Strengths

All the respondents (100%) indicated that the soils in the area were fertile and favourable for the crop. They explained that this implied cutting down on the use of fertilizer and hence cost of production. This had further boosted their efficiency in the cotton industry. The farmers (88%) also opined that family labour was readily available and was far cheaper than hired labour. Similarly, both men and women were involved in the production from sowing to harvesting of the crop. Furthermore, the youth had great interest in cotton farming as it provided them cash security. However, only 33% indicated that there was enough land for the cultivation of cotton in the area.

Weaknesses

It was indicated by 78% of the respondents that there were high losses in cotton yield in the area. This reduced the income they derived from the production, and consequently their interests, considering the amount of resources, energy and time spent in production. The inadequacy of spraying equipment (indicated by 51% of the farmers) makes the control of pest, especially bollworm very difficult. This affected the performance of the crop which often led to reduction in yield. The cultivation of cotton in the area is based on contract farming where inputs are credited to farmers preferably, in groups. Therefore, the group becomes responsible for the loan in case there is a default in the payment. The farmers disclosed that the behaviour of defaulting members discourages potential group members from forming groups or joining existing ones. The net effect is that they lose their bargaining power.

Opportunities

All sampled farmers (100%) did indicate that, there was ready market for lint cotton. This is as a result of the contractual arrangement made with them by Armajaro Ghana Ltd. Sixty three percent of the farmers mentioned that the produce buying company provides them with inorganic fertilizer, seeds, pesticides and tractor service on credit, payable at the time of crop harvest. Similarly, 51% of the respondents noted that the extension services provided by the extension agents helped them to gain more knowledge, which further helped in the adoption of the appropriate farm management practices.

Threats

However, 57% of the farmers indicated that the delay in the supply of inputs caused a serious threat to the production of cotton, as the late arrival of inputs meant that such inputs could not be used for the intended purposes. Equally threatening was the late payment of income from the sale of cotton lint, mentioned by 25% of the respondents. The farmers stressed that when payments are delayed it put a lot of pressure on them as they do not have alternative sources of income. However, in terms of the price at which cotton lint are bought, only 21% indicated that it was low, the majority did not have problems with it.

DISCUSSION

In a conflict-prone district where majority of the people live in the rural areas and have agriculture as their main source of livelihood, it is an understatement to argue that agricultural commercialization is the way to get the people out of poverty. Fortunately, cotton is a cash crop which would not face competition from direct household consumption like some staples such as maize, rice and yam. Cotton would necessarily be sold once it has been harvested. But this is not the only good thing. From the findings of this study, there is relative technical efficiency in cotton production in Yendi, made possible by a number of social, economic and environmental factors. The first is agricultural intensification made possible by the contractual agreement between the farmers and the cotton company in the area. As indicated earlier, the company provides the farmers with inputs such as fertilizers, seeds, pesticides and tractor service on credit, payable at the time of crop harvest. In addition, the company offers them extension advices through their extension agents which they have hired. The fact that they buy the cotton lint from the farmers after harvest is also a big relief to the farmers, who otherwise would have searched for their own markets like their counterparts producing food crops. The efficiency of the farmers was also as a result of their long years of experience in cotton production. Lastly, as it emerged from the SWOT analysis, the farmers' efficiency was as a result of the relatively good soils they had. Inhibiting factors however, included the sizes of their plots, lack of spraying equipment; delay in input supply as well as in payments for the sale of their produce, and loan default on the part of some of the farmers which goes a long way to discourage group formation.

For the maximum social, economic and environmental impact on the commercialization of cotton production in the study area, the cotton company must work at supplying the input timely so as to avoid misapplication. There are a lot of instances where the late arrival of inputs has resulted in such inputs sold or diverted to the production of other crops which may not require early cultivation. Once the inputs are sold and the money spent on direct consumption, at least, three problems may arise; first, the farmers' cotton farm suffers, secondly, s/he is not able to pay back the loan, and thirdly, the group suffers, leading to its collapse and the consequent discouragement of potential members. Every effort must be made to procure and supply farm inputs timely if agricultural commercialization is to thrive! Equally important, is for the cotton company to keep to their contractual agreement of paying the farmers on time after buying their produce."Money delayed", they say, "is money devalued." But that is not even the real issue; with limited or no diversified sources of income, farmers sometimes face urgent financial needs, such as paying their wards' school fees/medical bills or if they have to renovate their houses because they have been destroyed by rainstorm. It is also important that farmers are assisted to buy spraying machines (for instance through hire purchase) so that they can spray their farms to avert pesticide infestation. Otherwise, the cotton company can do the spraying for them (on credit) instead of just supplying them with the pesticides. While the cotton company abides by the contractual agreement, the farmers must do same. Farmers must do their best not to misapply loans given them. When inputs come late, it may be advisable to give them back if they realize you cannot use them on your cotton farm. In this case, they avoid the risk of misapplication and the consequent default. But even when the inputs have been misapplied, it is important that they make every effort to pay back for the sake of your group and posterity. Lastly, the fact that technical efficiency increases with larger farms implies that more land should be brought under the cultivation of the crop if maximum yield is to be realized. The 2 acres maximum farm size does not augur well for the commercialization of cotton production. "In Ghana, complex and uncertain land tenure arrangements have tended to hamper private investments (Nankani, 2007). It is sad to note that land issues are one of the causes of conflicts in the study area, and as long as they are not addressed commercialization of agriculture will be hampered. As Donkoh and Awuni (2011) recommends, there is the need for government to speed up the land reformation process and ensure that the implementing strategy is designed and followed. Nankani (2007) observed that land reforms, and for that matter, markets have been pivotal in the green revolution in many countries, including China and Vietnam.

CONCLUSION

Northern Ghana, and for that matter Yendi Municipality, is disadvantaged in so many opportunities compared with southern Ghana. However, in terms of cotton production, social, economic and environmental factors combine to give the region absolute and comparative cost advantages over the other regions. For instance, the cotton companies are playing a vital role in not only supplying inputs on credit to the farmers, but also offering ready market to the farmers' produce. However, in order to reap the full benefits of commercializing cotton production in the region, both farmers and the cotton companies must keep to their contractual agreement; while the latter should supply the inputs timely and pay the farmers promptly, the former should use the inputs for the intended purposes and pay back promptly. Above all there should be land reforms to make land available for the expansion of cotton farms.

References

[1] Anderson, K. and E. Valenzuela, (2006). The World Trade Organization's Doha Cotton Initiative: A Tale of Two Issues. World Bank Policy Research Working Paper 3918. May, 2006. Washington DC.

[2] Baffes, J., (2004). Cotton Market Setting, Trade Policies, and Issue. World Bank Policy Research Working Paper 3218. February 2004, Washington DC. [Online] Available from: http://www.wds.worldbank.org/ser/elt/WDScontentserver/pdf.

[3] Coelli, T.J. (1995). Recent Development in Frontier Estimation and Efficiency Measurement. Australia Jounal of Agric. Economics, 39:219-245.

[4] Donkoh, S. A. and Awuni. J.A. G. (2011, July) Adoption of farm management practices in lowland rice production in northern Ghana. Journal of Agriculture and Biological sciences.Vol.2,4.pp.084-093

[5] FAOSTAT. (2010). Database http://faostat.fao.org/site/570/default.aspx

[6] FAO (2012) The state of food and agriculturewww.fao.org/docrep/017/i3028e/i3028e.pdf

[7] Farrel M. J. (1957). The Measurement of Production Efficiency. Journal of Royal Stat Soc Series A, 120: 253-281

[8] Forsund, F.R, Lovel C.A.K. and Schmidt P. (1980). A survey of frontier production functions and their relationships to efficiency measurement. Journal of econometrics 13 (1).

[9] Ghana Statistical Service (2007) Poverty trends in Ghana, Accra, Ghana

[10] Goreux, L. (2003) Prejudice Caused by Industrialised Countries Subsidies to Cotton Sectors in Western and Central Africa: Background Document to the Submission Made by Benin, Burkina Faso, Chad and Mali to the WTO." TN/AG/GEN/4, Geneva: World Trade Organization

[11] Gul, M., Koc, B., Dagistan, E, GokselAkpinar, M and Parlakay, O (2009) Determination of technical efficiency in cotton growing farms in Turkey: A case study of Cukurova. African journal of Agricultural research, Vol. 4 (10)

[12] Husseini, K. (2010) Cotton in West and Central Africa: Role in the regional economy & livelihoods and potential to add value. Proceedings of the symposium on Natural fibres

[13] ftp://ftp.fao.org/docrep/fao/011/i0709e/i0709e05.pdf

[14] ISSER (2010). The Institute of Statistical, Social and Economic Research. The State of the Ghanaian Economy in 2010. University of Ghana, legon.

[15] Qamar-ul-Haq, Tanvir Ali, Munir Ahmad and FarhanaNosheen*(2008).Role of age, education and landholding on cotton producing community: A case study of district multan

[16] Lundbaek, J. (2002). Privatization of the Cotton Sub-sector in Uganda: Market Failures and Institutional Mechanisms to Overcome these. Masters Thesis in Agricultural Economics, The Royal Veterinary and Agricultural University

[17] Mohammad-Yusuf, T. (2005) The effects of market reform on cotton production efficiency. The case of Tajkistan. Asian Pacific school of Economics and Government working paper 05-8

[18] https://crawford.anu.edu.au/degrees/idec/working_papers/IDEC05-8.pdf

[19] Neba, C. Ngassam, S. and Nzomo, J. (2010) The determinants of the technical efficiency of cotton farmers in northern Cameroon. MPRA Paper No. 24814

[20] http:// mpra.ub.uni-muenchen.de/24814/

[21] Nawaz, S. (2001). A study of the role and professional field (A case study of district Faisalabad). M.Sc. Rural Sociology. Thesis, Univ. of Agri., Faisalabad.

[22] Okon,U.E., Enete A.A. and Bassey N.E. (2010*)*. Technical efficiency and its determinants in garden gg (*SolanumSpp*) production in UyoMetroplis, AkwaIbom State, Nigeria. Department of AgricltureEconomis University of Nigeria,Nsukka, Enugu State, Nigeri. http:// www.factsreports.org.

[23] Salifu.A.BClottey, V.A. and Chamba, E.B. (1999). A proposal for agricultural sector investment project. Cotton research at SARI, AFFS_CSIR, Accra.

[24] Seini A. Wayo. (2002). Agricultural growth and competitiveness under policy reform in Ghana. Technical Publication No. 61, ISSER, University of Ghana, Legon, 33 pp.

[25] Serunjogi, L.K. Elobu, P., Epieru, G., Okoth, V.A.O, Sekamatte, M.B., Takan, J.P. and Orokot, J.O.E (2001): "Cotton (*Gossypium Sp.*)" In *Agriculture In Uganda* Volume II: Crops ed. Mukiibi J.K. Fountain Publishers Ltd./CTA/NARO

[26] ShahzadKouser, A., Mushtag, K. and Mazhar, M. (2006) Role of credit to enhance cotton production in Punjab, Pakistan.Pak. J. Agri. Sc. Vol 43 (3-4)

[27] Scholtes, P., Bokanga, M., and Sundin, K.(2011) Revitalizing the Ghanaian cotton sector Background paper for discussion 3ADI.

[28] http://www.3adi.org/tl_files/3ADIDocuments/Country%20information/Ghana/3ADI%20Ghana%20Background%20paper%20Cotton%20October%202011x.pdf

[29] Tiffin, R. &Irz, X. (2006). Is agriculture the engine of growth? *Agricultural Economics*, 35, 1, 79-89.

[30] Tsimpo, C. N. (2010~~1~~) Tehcnical efficiency and optimal farm size in the Jajik's cotton sector. MPRA Pper No. 35192

[31] http://mpra.ub.uni-muechen.de/35192

[32] WalusimbiRhona (2002). Farm Level Cotton Production Constraints in Uganda. A Contribution to the Strategic Criteria for Rural Investments in Productivity (SCRIP) Program of the USAID Uganda Mission. *The International Food Policy Research Institute (IFPRI)* 2033 K Street, N.W. Washington, D.C. 20006

[33] WFP (2009) Comprehensive Food security and vulnerability analysis for Ghana. World Food Programme, Accra, Ghana