Journal of Agricultural Extension and Rural Development

Volume 8 Number 6 June 2016

ISSN 2141-2170

Academic Journals

ABOUT JAERD

The Journal of Agricultural Extension and Rural Development (JAERD) is published monthly (one volume per year) by Academic Journals.

Journal of Agricultural Extension and Rural Development (JAERD) is an open access journal that provides rapid publication (monthly) of articles in all areas of the subject such as Impact monitoring and evaluation system for farmer field schools, Metals in bio solids-amended soils, Nitrogenous fertilizer influence on quantity and quality values of balm, Effect of irrigation on consumptive use, water use efficiency and crop coefficient of sesame etc.

The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in JAERD are peer-reviewed.

Contact Us

Editorial Office: jaerd@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: http://www.academicjournals.org/journal/JAERD

Submit manuscript online http://ms.academicjournals.me/

Editors

Editorial Board

Journal of Agricultural Extension and Rural Development

Table of Contents: Volume 8 Number 6 June, 2016

ARTICLES

academicJournals

Vol.8(6), pp. 89-98, June 2016
DOI: 10.5897/JAERD2016.0774
Articles Number: E685BD658747
ISSN 2141-2170

http://www.academicjournals.org/JAERD

Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Effect of extension and training on farmers' husbandry and management practices and field performance when using draught horses in ploughing

Elsamawal Khalil Makki*, Fatima Elbasheer Eltayeb and Osman Abdelkarim Badri

School of Rural Extension, Education and Development Ahfad University for Women P.O. Box 167 Omdurman, Sudan.

Received 13 February, 2016; Accepted 26 April, 2016

For draught animal technology to contribute to its full potential to farming, it needs to be backed up with suitable and relevant extension and training packages. This study investigated the effect of extension on farmers' husbandry and management practices and field performance of draught horses in EN-Nhoud locality, West Kordofan State, Sudan. The study followed the cross-sectional survey design on a sample of 80 farmers, selected following the systematic random sampling technique on geographical location. Data was collected using a formal questionnaire with the farmers in face to face interview and was analysed descriptively to produce frequency and percentage tables. Dependency between the selected variables was tested using chi square test. Additional data was collected through interviews with the director of the Administration of Agriculture in the locality and the senior staff as well as group discussions with the prominent farmers. The results showed that extension faces many constraints and problems; the most important of which are: Lack of funds, lack of experienced staff and lack of clear curricula and training content. This reflected on a weak role and impact on the farmers' side and their husbandry and management practices were less than optimal and consequently field performance was on the poor side. Animal feeding, harnessing and plough operation and care were poorly applied.

Key words: Draught animal technology, agricultural extension, draught horses, animal husbandry, animal management, field capacity and efficiency, harness, farming in Sudan.

INTRODUCTION

The role of draught animal technology (DAT) in agriculture and transport is well understood and documented in different parts of the world. The improved use of the technology is seen as the most appropriate and relevant form of strategy for small holder agriculture due to economical, technical and agro-ecological problems associated with mechanized agriculture. The technology has been qualified as an ecologically sustainable means of increasing agricultural production, reducing human drudgery and improving the quality of the rural life (Chanie et al., 2012).

The realization of the technology benefits in some parts

*Corresponding author. sammakki@hotmail.com

of Asia and Latin America lead the technology to be widely advocated in the Savannah areas of Africa. Nevertheless, the technology did not perform to its potential capacity due to many reasons; amongst which poor extension remains the most important. This is typical to the situation in Sudan where the technology was introduced few decades ago to many parts of the traditional rainfed farming system in an attempt to assist rural farmers achieving food security and reducing the drudgery of work. The objective was to reduce the drudgery of work and assist the farmers to expand horizontally in a traditional subsistence oriented farming system.

Oladeji et al. (2012) recommended that a well-designed extension based animal traction program should be put in place to arouse the interest of farmers in the technology to combat shortage of labour in the agricultural sector. They continued suggesting design of animal traction oriented program and use of appropriate extension organ to disseminate well packaged animal traction related information to propagate the use of the technology in Northern Nigeria.

Pearson et al. (1999) pointed that small scale farmers are not receiving the information they need, much of which is available; to improve the farming practice. Further, Chanie et al. (2012) emphasized that the absence of work to improve traits for work performance indicates least emphasis is given to promote draught animal power. Pearson (1998) added “research and extension activities have to be undertaken in an environment in which population is increasing, grazing land is diminishing and labour expectations are changing”.

In rural Sudan poor field performance a major concern for the success of draught animal technology programs. Few are reported on the effect of extension on DAT in the country; Therefore, this study was carried out to:

1. Identify the situation of extension and training on DAT En-Nhoud locality, West Kordofan State, Sudan.
2. Identify farmers’ perceptions on extension and training in DAT in the area.
3. Explore the effect of extension on farmers’ husbandry and management practices of draught horses in the area.
4. Explore the effect of extension on field performance.

MATERIALS AND METHODS

Study area

Field data was collected in EN-Nhoud locality to investigate the effect of extension on farmers’ husbandry and management practices of draught horses and field performance when ploughing. EN-Nhoud locality is located in the semi-arid savannah zone. The locality consists of five rural councils. Different tribes live in the area with the *Hamar* being dominant. Most of the population depends on crop production beside other activities like animal breeding and poultry production. The average land holding of the family is about 4.5 feddans (1 feddan = 0.42 ha), but only 60% of that area is annually cultivated (ENCCP, 1997).

The dominant system of agriculture in EN-Nhoud area is the traditional rainfed farming system which is known as a small holding farming system that is mainly characterized by being subsistence oriented. No systematic agricultural rotation is followed, and farmers always tend to the horizontal expansion to increase crop production (Dahab and Hamad, 2003). The land is flat to undulating and there are only a few seasonal water streams (*Khors*). However, the soil is mostly sandy to sandy loam, while clay soil (*Gardood*) covers the southern parts of the area. Groundnuts, hibiscus *"Karkade"*, sorghum, sesame and water melon are the main crops in the area. The area is famous for production of groundnuts as the main cash crop (ENCCP, 1997). The agricultural production of both food and cash crops depends mainly on family labour mostly in an agricultural sharing system. The area is well known for livestock production for milk and meat. All the farmers use the same size of animal drawn mouldboard plough (15 kg in weight, 25 cm wide and 20 cm maximum depth).

Sampling

This study was based on the cross-sectional survey design targeting farmers who operate on plots more than 1 ha. A sample of 80 farmers was selected from 10 villages (clusters) following the systematic random sampling technique based on geographical location. The first of every five farmers was chosen along a survey line drawn across the farming area in each cluster starting at the upper end until 8 farmers had been selected. Farmers are mostly illiterate or with low educational level attained at informal educational institutions and their age ranges between 30 and 65 years (76%).

Data collection and analysis

The main management parameters considered in this study were:

1. Animal health (veterinary care, vaccination and wounds management)
2. Animal feeding.
3. Animal harnessing (care for harness, padding and sores and wounds related to harness).
4. Plough condition (care measures and plough condition).

All these were tested against the checklists of the ideal practices presented by Makki and Pearson (2011) and Pearson et al. (2003). Further, field capacity and efficiency were determined as direct assessments of the management practices.

Data were collected using a formal survey questionnaire in a face to face interview for literacy reasons and by direct field measurements during land preparation. Some information was recorded as observations to avoid farmers’ bias on issues they can consider “sensitive”. Direct field measurements were concerned with determining field capacity and field efficiency in accordance with Gbadamosi and Magaji (2004) and Abubakar et al. (2009). Two stop watches and a tape measure were used to record the total and net times of operation and the land dimensions, respectively.

Other parameters computed from the field performance data were; working speed (km/h), effective field capacity (ha/h) and field efficiency (%), expressed as:

Working speed = distance of run (km) / overall time taken (h)

Then the effective field capacity (ha/h) was taken as the product of dividing the area worked (ha) by the total time (h) as follows:

Effective field capacity (F.C) = Area (ha)/Total time (h)

And the field efficiency = Net productive time/Total time of operation

Survey data were entered into an SPSS computer programme (SPSS 14.0) and analysed to produce frequency tables and the different parameters were assessed using the *chi* square test.

Additional information on extension service providers was collected through interviews with the director-general of the Administration of Agriculture and the departments' directors along with participation in the daily activities over a period of one month. Prominent farmers were also included in group discussions.

RESULTS AND DISCUSSION

Background and situation of extension service

The administration of Agriculture, EN-Nhoud locality is the official body responsible for all the agricultural strategies, policies, decisions and programs. It is formed of different departments and is headed by a director-general. The administration follows the Ministry of Agriculture at the State level and implements its policies with some freedom at the local decisions level. The Administration is characterized by:

1. Lack of clear well designed policies and plans for extension and training programs in the field of DAT.
2. Training is delivered by junior unexperienced staff with little knowledge on DAT.
3. Extension and training programs are less frequent and occasional; they do not target the right beneficiaries (some farmers attended the same packages repeatedly looking to collect the daily allowance paid for attending these programs).
4. In the mandate of the Administration DAT is not a priority and receives less attention; priorities are decided at the State level.
5. The Administration is understaffed and lacks experienced staff with good or even acceptable knowledge in DAT.
6. Most of the junior staff is fresh graduates with low or no experience in DAT. This leads to lack of trust and accountability from the farmers' side.
7. Lack of funds and resources to finance the training and extension programs. The administration turned to rely on donations and endorsement of NGOs and other donors to finance DAT activities.
8. Lack of coordination between the different departments relating to DAT (that is, veterinary service, animal production and agricultural mechanization).
9. All the training and extension packages in DAT focused on labour reduction, timeliness, harness and implements use which are of less concern to the farmers compared with animal husbandry and management practices, production and productivity which farmers consider of utmost importance.
10. It is difficult if not impossible to cover all the spatially scattered villages in the locality with the available staff and budgets.

These characteristics clearly show that extension and training in DAT lags way behind being optimal and is constrained by many difficulties that hinder it from delivering usable formulated messages. Training is provided to farmers in demonstration sessions at the Department of Agriculture buildings. There are no clear criteria for farmers selection nor there is enough training material or illustration material given to the farmers as hand-outs. Further, extension is considered as part of this training. Field extension is very scanty if not completely absent.

Chanie et al. (2012) pointed that the absence of works to improve traits for work performance indicates that least emphasis is given to promote draught animal power. Further, Abubakar and Ahmad (2010) suggested that utilization of animal traction would be increased significantly if more funds are injected in animal traction technology by the State and local government. The only available DAT service, training and extension center which is stationed in the locality capital city fails to serve the users in remote villages; instead of establishing new training centers the Administration of Agriculture opted to train farmers as trainers to other farmers and were considered as 'model' farmers who are basically seen as extension aids. This policy might not achieve good impact if farmers lack confidence in the 'model' ones and will necessarily depend on the capacity and experience of the latter. In a similar farming system Abubakar and Ahmad (2010) presented the problems of inadequate funding, poor infrastructure, undefined curricula and poor staffing as the main limiting factors to farmers training, while Oladeji et al. (2012) recommended that animal traction training centers should be established at suitable or strategic location to demonstrate the use and benefits of animal in the zone.

Staff capacity and skills are very important in designing/tailoring and identifying the local needs for training and extension. All the junior staff who practically shoulder the field work and participate in policymaking are not trained in DAT. It is necessary that workers and extension agents in the field of DAT receive in-service training in animal traction and related technology to enable them to adequately meet the needs of the farmers they serve. It is envisaged that for training programs to be fully effective they need to be backed by animal traction resource centers. The situation in the study area is way far from Abubakar and Ahmad (2010) who pointed that in order to meet the huge needs of the small scale farmers for animal traction training, extension and on farm research, it is believed that the use of mobile animal traction and research units would be an effective way to rapidly address such needs.

A major concern in the extension and training programs is the lack/absence of emphasis on participatory research needs as highlighted by Starkey (2000) who mentioned that 'top-down' approaches to extension and development of improved technologies have greatly failed. This situation shows one of the reasons for extension/training inefficiency which is in accordance with Pearson et al. (1999) who reported that small scale farmers are not receiving the information they need, much of which is available; to improve the farming practice.

Farmers perceptions on extension service and training

The group discussions with the farmers revealed the following:

1. Farmers are not satisfied with the quality of extension and training provided to them.
2. They believe they know more/better than the staff of the Administration of Agriculture.
3. The content of extension and training packages is not what they anticipate; they demanded more information about the proper husbandry practices and work strategies, while the staff of the Administration of Agriculture insists on harnessing and implement side.
4. Farmers mostly learn about DAT from their peers and experienced farmers.
5. They prefer training their animals by themselves because they suspect the *'employees'* experience in proper animal training or selection.
6. Extension agents seldom reach the remote villages and farmers have to come to the locality center to get the service.
7. The selection of the 'model' farmers and trainers is highly biased and model farmers are not necessarily the more experienced ones.
8. Some farmers cannot afford the transportation cost or are not willing to spend money on transportation. Therefore, unless the training providers/organizers have enough funds to pay farmers, they will not participate or attend.

This situation is far from being convenient/satisfactory and resulted in less capacity and skills on the farmers' side as will be presented in the survey results. Abubakar and Ahmad (2010) presented comparable trends among farmers in Nigeria. Pearson (1998) pointed that farmers learn more from family members on draught animals than from institutions or organizations; and Madama et al. (2008) added that farmers learn about animals handling from family members. Further, Abubakar and Ahmad (2010) reported that farmers in Nigeria –an almost similar to the study area- mentioned poor extension as one of the constraints to the successful use of DAT. Mulanda et al. (2000) added that more than 80% of DA training has been educated by the farmers themselves using their own resources.

Field survey

Animal health care

Table 1 shows the distribution of work horses by animal health care parameters and extension service. Most (85%) of the farmers claimed that they vaccinate their animals, while the rest of them do not. Within this group, the majority (69%) received extension service in different aspects of DAT. On the other hand, farmers who do not vaccinate their animals distributed equally between those who received extension and those who did not (6 farmers in each group). No significant differences were indicated between the two groups (P = 0.96 using chi square) and this shows that extension service did not improve farmers' practice in this regard. Farmers in the study area even confuse vaccination and any other injection given to their animals as reported by Makki and Musa (2011). Furthermore, the majority of the farmers (52.2%) take their animals regularly to the veterinary center which is stationed in the locality center. Most of whom received extension service (76.2%); but the determinant factor here is not the awareness of the importance of regular veterinary care inspection of the animal, it is rather the vicinity of farmers' villages to the locality center. Transportation is a major constraint here in an area where it is unavailable and/or unaffordable. This compels the majority (53.8%) of the farmers to opt/resort to local remedies or buying medicines directly from the veterinary pharmacy in the locality center rather than shouldering the cost of transportation. The use of local remedies is common especially in the far villages where the service is geographically inaccessible.

The poor effect of extension service on animal health care parameters is evident in farmers' response to the appropriate measures that they take to keep their animals in a good health condition. Most of them (87.5%) focused on feeding concentrates and food additives, while few (12.5%) of them mentioned veterinary care in their response. Differences between both groups were statistically similar (P = 0.83 using chi square test).

Almost all the farmers (98.75%) claimed inspection of their animals' hoofs regularly. The majority of them (65.8%) received extension service. This suggests that farmers do this by tradition rather than as a result of awareness raising through extension. Few farmers get advice on decisions regarding wounds management from health officers or veterinarians. The same concerns and situation was reported by Krecek (1999) in North-west Province, South Africa. However, differences between both groups were statistically similar. The same trend is observed with grooming as 95% of the farmers groomed their horses, of whom 67% received extension. All these results suggest that health measures are practiced by tradition rather than awareness raising through extension.

As suggested by Makki ad Pearson (2011) animals' teeth and tongue should be checked/examined regularly

Table 1. Frequency distribution and (percentage) of the farmers by animal health care measures and extension service.

Categories	Extension service		Total
	Extension received	Extension not received	
Animal Vaccination			
Yes	47 (69.1)	21 (30.9)	68
No	6 (50)	6 (50.0)	12
Regular veterinary care of animals			
Yes	32 (76.2)	10 (23.8)	42
No	21 (55.3)	17 (44.7)	38
Procedure followed when the animal is sick			
Take it to the veterinary care	27 (73.0)	10 (27.0)	37
Buy medication from pharmacy	17 (56.7)	13 (43.3)	30
traditional treatment	9 69.2)	4 (30.8)	13
The appropriate measures to keep animals in a good health condition			
Giving it concentrates and food additives	44 (65.7)	23 (34.3)	67
Take to veterinary care regularly	4 (100.0)	0 (0.0)	4
Veterinary care and food additives	2 (33.3)	4 (66.7)	6
Wounds care	3 (100)	0 (0.0)	3
Inspection of animal hoofs			
Yes	52 (65.8)	27 (34.2)	79
No	1 (100)	0 (0.0)	1
Animals grooming			
Yes	51 (67.1)	25 (32.9)	76
No	2 (50)	2 (50.0)	4
Regular examination of animals teeth and tongue			
Yes	47 (68.1)	22 (31.9)	69
No	6 (54.5)	5 (45.5)	11

as they affect the feeding ability of the animals and consequently its live weight and body condition which both decide animals' power output. Most of the farmers in both groups (86.3%) claimed regular inspection of animals' teeth and tongue. Differences between the two groups were statistically similar. Although farmers who received extension were more than those who did not receive the service.

Animal feeding

Extension is not expected to influence the types of feed offered to the work animals as feed types are dictated by the availability of diversified feed types in the area and the prevalent environmental conditions. Extension is more likely to affect feeding practices and programs followed by the farmers since their knowledge is the key factor here. In a semi-arid farming system dry feed remains the only option available to the farmers especially after the end of the short rainy season. Open grazing is not a choice for the farmers in the study area. It is more observed with bovines rather than equids. Table 2 shows animal feeding parameters. In both groups almost all the farmers (97.5%) fed their animals on dry feed and cereals referred to as concentrated feed. Farmers who mentioned green fodder do not mean fresh one. Further, the same percentage of the farmers (97.5%) offered feed to their animals in a container rather than on the ground. Interestingly all farmers with no access to extension fed their animals in containers instead of on the ground which shows that the same animals' feeding and husbandry practices are performed by tradition and not a result of receiving proper instructions.

Pearson (1998) suggested that work animals should be fed differently before the beginning of the season so that the animals will be in a good shape with enough fat reserves to work efficiently, there is little conclusive evidence to show that animals in good body condition

Table 2. Frequency distribution and (percentage) of the farmers by animal feeding practices and extension service.

Services	Extension Service		Total
	Extension received	Extension not received	
Basic type of feed during the year			
Concentrated feed and dry feed	52 (66.7)	26 (33.3)	78
Concentrated feed and green fodder	1 (50.0)	1 (50.0)	2
Animals feeding place			
On the ground	2 (100.0)	0 (0.0)	2
In a container	51 (65.4)	27 (34.6)	78
Time before work when animals are fed			
Less than 2 h	37 (66.0)	18 (34.0)	55
2 h and more	16 (64.0)	9 (36.0)	25
Number of concentrated feed types offered to the animals			
One type	53 (67.0)	26 (33.0)	79
2 types	0 (0.0)	1 (100.0)	1
Offering water to the animal during the work			
Yes	3 (75.0)	1 (25.0)	4
No	50 (65.8)	26 (34.2)	76
Animals watering			
Before and after eating	26 (65.0)	14 (35.0)	40
After eating	21 (77.8)	6 (22.2)	27
Before eating	4 (40.0)	6 (60.0)	10
All day	2 (75.0)	1 (25.0)	3

work faster and/or longer than those in poor condition at the start of the working season when they are required to do most of the work. This was not followed by the surveyed farmers and all of them fed their animals differently at the beginning of the season. In this case animals are not expected to benefit from this practice to generate the required energy.

A close look to the time before work when animals are fed shows that the majority of the farmers (68.7%) fed their animals less than 2 h before work starts, while the rest (31.3%) fed their animals 2 or more hours before work. The latter is the optimal practice according to Pearson (1998). Between the two groups the feeding time of those who received extension is less optimal; which questions the effectiveness and/or usefulness of extension programs.

The less optimal feeding practices included the number of concentrated feeds offered to the animal. All the farmers except for one (98.8%) relied on one type of cereals/oil seed cake offered to the animal. Evidently extension played no role here as all those who received extension offered only one type of cereals, while the optimal practice is to offer a mix of two or three types cereals (Makki and Pearson, 2011). Further, farmers did not mostly (95%) offer water to the horses during work and only a marginal percentage of both groups did that. The group discussion with the farmers revealed their misconception that water during work causes gases and hernia to the animal and results in slow work. Contrary to this offering water to the animals helps in reducing the heat stress animals undergo in a semi-arid environment. This suggests that the practice is by intuition and tradition and not on recommendation or any scientific grounds.

Animal watering is not an exception and one half of the farmers claimed watering their horses before and after eating, while the recommendation is to offer water to the horse before eating. One third of the farmers (33.8%) offered water to their horses after eating, while only 12.5% followed the optimal practice by offering water to the horses before eating. All these less acceptable practices are a direct result of the lack of organization and coordination between the different departments of the Administration of Agriculture since each department organizes its own packages without appreciating or acknowledging the multi-disciplinary nature of draught animal technology.

Animal harnessing

All the farmers in both groups harnessed their horses with collars which is common in the study area (Table 3).

Table 3. Frequency distribution and (percentage) of the farmers by harnessing and extension service.

Categories	Extension Service		Total
	Extension received	Extension not received	
Harness padding			
Yes	20 (77.0)	6 (23.0)	26
No	33 (61.0)	21 (39.0)	54
Does the harness fit the animal			
Suitable	52 (66.7)	26 (33.3)	78
Large	1 (50.0)	1 (50.0)	2
Rate of harness cleaning			
Not at all	51 (67.0)	25 (33.0)	76
every now and then	0 (0.0)	1 (100.0)	1
During the season	1 (50.0)	1 (50.0)	2
Everyday	1 (100.0)	0 (0.0)	1
State of harness cleanliness			
Dirty and dusty	6 (43.0)	8 (57.0)	14
Clean	47 (71.2)	19 (28.8)	66

Farmers did not care much for harness padding (67.5%) although padding is imperative for a comfortable work of the horse and reduces susceptibility to any bruises and/or injuries resulting from the harness rubbing on the horse skin. Extension role in this aspect is on the weak side keeping in mind that extension packages in the area mainly focus on harnessing and implement work. The majority of the farmers who received extension did not pad the collar of their horses; this certainly questions the effectiveness of extension packages and messages and the trust and reliability/accountability from the farmers' side on the service providers.

Most of the farmers (98.5%) believe that the collars they use are suitable to their horses; of whom 67% received extension while the rest did not. Knowledge on harness cleaning is alarming as most of the farmers (82.5%) never clean the collars of their horses, 67.5% of them claimed receiving extension. This practice does not comply with the harness care checklist (Pearson et al., 2003). The rest of the farmers cleaned the harness less frequently. Lack of harness cleaning subjects the horses to cuts and bruises resulting from collar rubbing on its' skin. This resulted in poor (dusty and dirty) collars for most of the studied farmers (98.5%); most of whom (71.2%) received extension. Differences between the two groups were statistically similar (P = 0.76). Despite the no or less frequent cleaning, most of the collars (92.5%) were in a good condition without torn parts. Further all the farmers in both groups toss the harness on the ground by the animal keeping/tethering place exposing it to different hazards to both the harness and the animal (Pearson et al., 2003).

Plough operation and care

Although plough operation and care is one of the main components of extension and training packages, farmers' practices in this regard are mostly less optimal (Table 4). All the farmers use the same type of mouldboard plough (15 kg in weight 25 com wide and 20 cm maximum depth). They mostly (62.5%) did not follow the proper procedure for plough checking/inspection before work starts. It is evident from this that either the packages did not provide information on plough care measures, or the farmers do not trust the information provided to them. This extended to include procedure of plough care after work as only 30% of the total sample followed the proper procedure. Among the farmers who received extension only 26.4% followed the proper procedure, while the rest did not.

The situation is even acute when plough care procedure at the end of the season is considered. Only 22.5% followed the proper procedure; and among the farmers who received extension only 24.5% followed the proper procedure.

Consideration of work continuation in the field is the only optimal practice regarding plough operation and care. Most (85%) of the farmers kept nuts, bolts and nut-drivers to tighten or replace any broken nuts. This is because farming site is distant from any service area and any breakdown can lead to delays in operation and potential yield losses.

Almost one third of the tested ploughs (31.3%) were rusty; most of them (80%) were operated by farmers who received extension. Further, among the farmers who

Table 4. Frequency distribution and (percentage) of the farmers by plough condition and care parameters and extension service.

Categories	Extension service		Total
	Extension received	Extension not received	
Procedure followed to check the plough before work			
Proper	21 (70.0)	9 (30.0)	30
Improper	32 (64.0)	18 (36.0)	50
Procedure followed to check the plough after work			
Proper	14 (58.3)	10 (41.7)	24
Improper	39 (69.6)	12 (30.4)	56
Procedure followed to check the plough at the end of the season			
Proper	13 (72.2)	5 (27.8)	18
Improper	40 (64.5)	22 (35.5)	62
Signs of rust on the tool			
Yes	20 (80.0)	5 (20.0)	25
No	33 (60.0)	22 (40.0)	55
Keeping any type of nuts drivers or wrenches			
Yes	44 (64.7)	9 (30)	68
No	9 (75.0)	3 (25.0)	12

received extension nearly two fifths (37.7%) received extension. The same question on the usefulness of extension and training packages holds valid again.

Field performance

Field performance is affected by a list of factors that vary from soil, animal weight and body condition, harness to farmers experience in work and plough/implement condition. Nevertheless, it was considered as an indicator to the effectiveness of extension programs since extension relates from its side to the aforementioned factors. Table 5 shows farmers distribution by forward speed, field capacity and efficiency and extension service. Forward speed was mostly (72.5%) on the moderate to high range (2.6-4.0 and 4.1-5.0 km/h, respectively). Most of the farmers who received extension worked in these ranges, but the difference between the two groups is statistically similar.

Work speed ranges reflected on field capacity and collectively the highest percentage of the farmers (46.3%) worked at low field capacity (less than 0.14 ha/h), while slightly more than one third (35%) worked at moderate field capacity (015-0.17 ha/h). Those who worked at high field capacity were only 18.7% of the total sample. Among farmers who received extension the highest percentage worked at low field capacity followed by those who worked at moderate capacity. The same trend was observed with those who did not receive extension. The result confirms that extension did not reflect on farmers' field performance (P = 0.69).

Field efficiency is more indicative of farmers' experience and knowledge as it is determined from the net productive time to the total time of field operations. The highest percentage of the total sample (40%) worked at high efficiency (>80%), these were followed by 32.5% who worked at low efficiency (<70%). Nearly one half of the farmers who received extension (47.2%) worked at high efficiencies. Differences between the two groups were statistically similar. The ranges of field performance reported in this study are comparable to those reported by Geza (1999) in the neighbouring Ethiopia. Nengomasha (1999) reported similar low capacities for heavy male donkeys harnessed to the same type of plough used in the study area.

Conclusion

Extension activities in the study area are constrained by lack of funds, lack of experienced staff, mistrust from the farmers and lack of clear curricula and training content. This reflected on a weak role and impact on the farmers' husbandry and management practices of draught horses which were less than optimal and consequently field performance was on the poor side. Farmers' knowledge on animal harnessing, plough operation and care and

Table 5. Frequency distribution and (percentage) of the farmers by field performance and extension service.

Categories	Extension service		Total
	Extension received	Extension not received	
	Frequency	Frequency	
Forward speed categories (km/h)			
101 to 105	4 (100.0)	0 (0.0)	4
1.6 tp 2.5	10 (55.6)	8 (44.4)	18
2.6 to 4.0	28 (66.7)	14 (33.3)	42
More than 4	11 (68.7)	5 (31.3)	11
Field efficiency categories (%)			
≤50	2 (66.7)	1 (33.3)	3
51 to 60	6 (66.7)	3 (33.3)	9
61 to 70	6 (43.0)	8 (57.0)	14
71 to 80	14 (63.6)	8 (36.4)	22
81 to 90	16 (76.2)	5 (23.8)	21
≥91%	9 (81.8)	2 (18.2)	11
Field capacity (ha/h)			
≤0.11	13 (72.2)	5 (27.8)	18
0.12 - 0.14	10 (52.6)	9 (47.4)	19
0.15 - 0.17	19 (68.0)	9 (32.1)	28
0.18 - 0.23	7 (63.6)	4 (36.4)	11
≥0.24	4 (100)	0 (0.0)	4

feeding is poor. The results suggest that extension programs will not be efficient unless tailored upon needs assessment based on the priorities set by the farmers themselves. Further, training on site in a multidisciplinary form involving all the actors in DAT is imperative. The study recommends baseline surveys for needs assessment for the development of DAT projects, extension and training programs.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES

Abubakar MS, Ahmad D (2010). Utilization and Constraints on Animal Traction in Jigawa State, Nigeria. Aust. J. Basic Appl. Sci. 4(6):1152-1156.

Abubakar MS, Tekwa IJ, Ahmed MM (2009). Effects of Soil Physico-mechanical properties on field performance efficiency of ox-drawn mouldboard plough in Yola, Adamawa State. Agricultural Engineering International: CIGR Ejournal. XI, 1369-2137-1.

Chanie M, Fentahun T, Mitiku T, Behran M (2012). Strategies for Improvement of Draft Animal Power Supply for Cultivation in Ethiopia: A Review. Eur. J. Biol. Sci. 4(3):96-104.

Dahab MH, Hamad SF (2003). Comparative of weeding by animal-drawn cultivator and manual hoe in En-nohoud area, Sudan. Agric. Mechan. Asia Afr. Latin Am. 34(3):27-30.

ENCCP (1997). EN-Nhoud Cooperative Credit Project. Annual report.

Gbadamosi L, Magaji AS (2004). Field study on animal draught power for farmers in Zuguma village of Niger State; Proceedings of 5th International conference and 26th Annual General meeting of Nigeria Institution of Agricultural Engineers (NIAE). 26:84-85.

Geza M (1999). Harnessing techniques and work performance of draft horse in Ethiopia. In: Meeting the Challenges of Animal Traction. A Resource Book of the Animal Traction Network for Eastern Africa (ATNESA), Harrare, Zimbabwe, Intermediate Technology Publications, London 326 p.

Krecek RC (1999). Management and welfare of working animals: experiences with communities in North-West Province, South Africa. In: Pearson RA, Wythe S, Joubert B, O'Neill D, Simalenga T (Eds.). Management and Feeding of Animals for Work. Proceedings of a Workshop at Fort Hare University, Alice, Eastern Cape. Centre for Tropical Veterinary Medicine, Draught Animal Power Technical Report 4.

Madama EA, Naazie A, Adogla-Bessa T, Adjorlolo LK (2008). Use of donkeys and cattle as draught animals in the Northern and Upper East and Volta Regions of Ghana. Draught Anim. News 46(1):10-13.

Makki EK, Musa EOM (2011). A survey on draught animal technology (DAT) in EN-Nhoud area, North Kordofan State, Sudan. Trop. Anim. Health Prod. 43(5):923-928.

Makki EK, Pearson RA (2011). Training Manual for Extension Workers and Farmers using Draught Animal Technology. School of Rural Extension Education and Development, Ahfad University for Women, Omdurman, Sudan. 79 p. Published by Ahfad University for Women.

Mulanda J, Mwenya E, Namalambo E (2000). Draught animal power: experiences of farmer training in the Northern communal areas of Namibia. In: Kaumbutho PG, Pearson RA, Simalenga TE (Eds.). Empowering Farmers with Animal Traction. Proceedings of the workshop of the Animal Traction Network for Eastern and Southern Africa (ATNESA) held 20-24 September 1999, Mpumalanga, South Africa. 344 p.

Nengomasha E (1999). Feeding and managing donkeys for work in Zimbabwe. In: Pearson RA, Wythe S, Joubert B, O'Neill D, Simalenga T (Eds). Management and Feeding of Animals for Work. Proceedings of a Workshop at Fort Hare University, Alice, Eastern

Cape. Centre for Tropical Veterinary Medicine, Draught Animal Power technical report 4.
Oladeji JO, Ogunleye KY, Aderinto A (2012). Attitude of farmers towards the use of animal traction technology in Savannah zone of Oyo State, Nigeria. Glob. J. Sci. Front. Res. Agric. Vet. Sci. 12(2):17-23.
Pearson A, Wythe S, Joubert B, O'Neill D, Simalenga T (Eds.). (1999). Management and Feeding of Animals for Work. Proceedings of a Workshop at Fort Hare University, Alice, Eastern Cape. Centre for Tropical Veterinary Medicine, Draught Animal Power Technical Report 4.
Pearson RA (1998). Draught animals and their management: The future in rain-fed agriculture. Ann. Arid Zone 37(3):233-251.
Pearson RA, Simalinga TE, Kercek RC (2003). Harnessing and hitching donkeys, horses and mules for work. Centre for Tropical Veterinary Medicine, University of Edinburgh, 34 p.
Starkey P (2000). Empowering Farmers with Animal traction: Worldwide reands, Issues and Challenges. In: Kaumbutho PG, Pearson RA, Simalenga TE (Eds.). Empowering Farmers with Animal Traction. Proceedings of the workshop of the Animal Traction Network for Eastern and Southern Africa (ATNESA) held 20-24 September 1999, Mpumalanga, South Africa. 344 p.

academicJournals

Vol.8(6), pp. 99-110, June 2016
DOI: 10.5897/JAERD2016.0765
Articles Number: 9FAB53758749
ISSN 2141-2170

http://www.academicjournals.org/JAERD

Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Efficiency of chili pepper production in the volta region of Ghana

Jacob Asravor[1]*, Edward E. Onumah[2] and Yaw B. Osei-Asare[2]

[1]Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics, University of Hohenheim, Germany.
[2]Department of Agricultural Economics and Agribusiness, University of Ghana, Ghana.

Received 20 January, 2016; Accepted 29 April, 2016

This study investigates the overall economic efficiency of chili pepper producers in the Volta region of Ghana. The study used farm level data to examine the productivity of selected agricultural inputs, technical, allocative and economic efficiency levels and the determinants of efficiency of chili pepper production. The modified translog stochastic frontier production and cost function models were adopted for the study using the maximum likelihood estimation procedure. Data was collected on 200 chili pepper producers through a multi-stage sampling technique. The results indicate that on average, chili farms were only 65.76% economically efficient, whilst mean technical and allocative efficiencies were estimated to be 70.97% and 92.65%, respectively. The findings also reveal that chili farms in the study are characterized by decreasing returns to scale. The results further show that age, experience and gender among others significantly influence technical efficiency. Allocative efficiency is however influenced by gender, education and access to credit inter alia. The joint effect of these variables explains the variation in the economic efficiency of the chili farms. The study therefore concludes that chili farms in the study area are economically less efficient. The study recommends policies and programs that aim at attracting the teaming youth into chili pepper cultivation to be pursued by giving them incentive packages. Experienced chili farmers are advised by the study not to solely rely on their know-how but should endeavour to complement their knowledge with advisory services given by extension officers. Policy makers should also focus on policies that will facilitate chili farmers' access to low interest bank loans in the form of inputs.

Key words: Stochastic frontier, modified translog model, maximum likelihood estimation, multi-stage sampling technique, chili pepper production.

INTRODUCTION

Vegetable cultivation in both rural and urban Ghana is a germane economic activity. This is because of its importance as a major source of quick employment and income generation for both the rural and urban poor.

***Corresponding author. E-mail: j.asravor@uni-hohenheim.de; djgharo@gmail.com.**

Vegetable farming has the potential to alleviate poverty and improve food security in Ghana. According to the AVRDC (2006), vegetable farming provides smallholder farmers with much higher income and more jobs per hectare than staple crops. Chili pepper (*Capsicum annuum*) is an important high value cash crop in Ghana and it is largely cultivated for export and domestic consumption by both the urban and rural poor. Its cultivation and consumption has long been part of Ghana's agriculture and diet (MiDA, 2010). Chili pepper is called "green gold" by some farmers because of its economic value to them. Chilies produced in Ghana are known for their good reputation in the European markets in contrast to chilies from other parts of the world especially the Legon 18 variety which has become famous for its great taste and longer shelf-life. The Bird's Eye chili variety furthermore offers an emerging opportunity for higher value chili exports in Ghana (MiDA, 2010). Chilies are the fourth most harvested crop in Ghana after cassava, plantain and yam with about 984,586 households engaging in its cultivation (GSS, 2014).

Ghana has been identified to have both comparative and competitive advantages over other African countries in terms of chili pepper production. Despite these advantages, the country is currently ranked fourth in chili production in Africa after Egypt, Nigeria and Algeria (MiDA, 2010). The world's chili demand is on the ascendancy and this continuous increase in demand means that the world's chili production still has space for improvement, through increasing land productivity and raising its yield potentials. In fact, enormous yield gaps which are still rife on chili farms need to be improved. Presently, the average yield of chili pepper in Ghana is 8.30 Mt/ha which is far below the achievable yield of 32.30 Mt/ha (MoFA, 2014). Improvement in yield is therefore a necessity and needs to be pursued with all the resources it requires for efficient production.

Knowledge of the overall productive efficiency status and its determinants, in addition to the key drivers of productivity of chili farms are relevant from policy perspective in a country where new technologies are scarce and productive resources are inadequate. This is because, gains in the efficiency and productivity of chili farms are essential for increasing the farm income of both the rural and urban dwellers who are engaged in its cultivation. The challenge of low productivity on Ghanaian chili farms can be attributed to some key constraints militating against the attainment of the potential frontier output. Such constraints may include the attack of pests and diseases, limited land, poor prices of produce, low adoption of improved chili pepper cultivation technologies and inefficiencies arising from the allocation of production resources. This implies that efforts at improving the productivity of chili farms cannot overlook identifying and addressing these key factors. As a result of the lack of access to productive resources, coupled with the low rate of adoption of improved chili production technologies in Ghana, improvement in the efficiency of chili farms has become paramount for enhancing the productivity level of chili farms. Although a plethora of efficiency studies on Ghana's agricultural production exist in the literature, much of these studies focus on technical rather than allocative and economic efficiencies. However, it is only through substantial gains in overall economic efficiency that significant gains in output can be achieved (Bravo-Ureta and Pinheiro, 1993). The need to boost the productivity and efficiency status of chili farmers in Ghana has led to the following research questions; what are the current levels of technical, allocative and economic efficiencies and what are the major determinants of inefficiency of chili farms in the Volta region of Ghana?

MATERIALS AND METHODS

Study area and data collection

The study considered a cross sectional data from four districts in the Volta region of Ghana. The Volta region is endowed with abundant water resources which make all year-round production of vegetables possible. A multi-stage sampling technique was used to select 200 chili farms from the Volta region. The first stage involved the purposive selection of the four districts based on the Millennium Development Authority's observation that the southern horticultural belt of Ghana is made up of 7 districts of the Volta region (MiDA, 2010). The second stage involved the purposive selection of the communities noted for chili pepper production and the third stage involved the random selection of chili farmers. The selected districts were South Tongu district, Ketu-South district, North Dayi district and Keta municipality. A total of 50 chili farmers were sampled from each district/municipality leading to a sample size of 200 respondents. The data was collected through personal interview whilst using a well-structured questionnaire.

Analytical framework

This study adopts the stochastic frontier production and cost function models to analyze the technical, allocative and economic efficiencies of chili farms in the Volta region of Ghana. The stochastic frontier approach is adopted because of its ability to segregate the inefficiency effect from the noise effect. The stochastic frontier approach as simultaneously proposed by Aigner et al. (1977) and Meeusen and Van den Broeck (1977) is specified as:

$$Y_i = f\left(X_i;\beta\right).\exp\left(v_i - u_i\right) \quad u_i \geq 0 \tag{1}$$

where Y_i denotes the maximum output for the i^{th} farm. $f\left(X_i;\beta\right)$ represents a suitable production function of row vector of inputs X_i for the i^{th} farm and a vector β of unknown parameters to be estimated. The stochastic frontier model specified above attributes the total variation in output to an error term which is made up of two components $\left(v_i - u_i\right)$. Where v_i is the random error which captures the effects of the conditions beyond the control of the farmer and u_i is the non-negative error term which accounts for technical inefficiency (conditions under the direct control of the farmer).

The i^{th} farm's technical efficiency (TE_i) measure is given by the ratio of the realized output (Y_i) given the values of its inputs and inefficiency effects to the corresponding maximum potential output (Y_i^*) assuming there were no inefficiencies arising from the production process. Thus the technical efficiency of the i^{th} farm is given as:

$$TE_i = \frac{Y_i}{Y_i^*} = \frac{f(X_i;\beta)\cdot \exp(v_i - u_i)}{f(X_i;\beta)\cdot \exp(v_i)} = \exp(-u_i) \quad (2)$$

Equation 2 shows that the difference between Y_i and Y_i^* is captured by u_i. And if u_i = 0, then Y_i = Y_i^*, denoting that the output lies on the frontier and thus the farm is technically efficient and obtains its maximum potential output given the level of inputs. However, if u_i > 0, the production lies below the frontier and the farm is technically less efficient. Following Battese and Coelli (1995), v_i is assumed to be independent of u_i and it is also assumed to be independently, identically and normally distributed with a mean of zero and a constant variance, $\sigma_v^2, [v_i \sim \mathrm{N}\ (0, \sigma_v^2)]$. u_i is also assumed as a truncation of the normal distribution with mean μ_i and variance $\sigma_u^2, [u_i \sim \mathrm{N}\ (\mu_i, \sigma_u^2)]$, such that the mean is defined as:

$$\mu_i = Z_i \delta \quad (3)$$

where Z_i is a vector of inefficiency factors and δ is a vector of unknown parameters to be estimated. Based on the distributional assumptions which underpin the random error term, this study adopts the single-stage maximum likelihood estimation procedure to estimate the parameters of the stochastic frontier and the inefficiency models concurrently (Onumah et al., 2010). The farm-specific TE_i are parameterized according to Battese and Corra (1977) as:

$$\sigma^2 = \sigma_v^2 + \sigma_\mu^2 \text{ and } \gamma = \sigma_\mu^2 / \sigma^2 = \sigma_\mu^2 / (\sigma_v^2 + \sigma_\mu^2)$$

Gamma (γ) has a value which ranges between zero and one. For $0 < \gamma < 1$, then output variability is as a result of the presence of both technical inefficiency and the stochastic errors.

According to Coelli et al. (2005), when information on prices are given and firms are assumed to be operating under the assumption of cost minimization, then the cost frontier can be used to estimate the economic characteristics of the production technology and also to predict the cost efficiency of the firms. The stochastic frontier cost function for a cross-sectional data can be stated as:

$$C_i \geq g(Y_i, P_i; \varphi).\exp(v_i + u_i), \quad i = 1,2,\ldots,N \quad (4)$$

where C_i denotes the total cost of production of the i^{th} farm, $g(Y_i, P_i; \varphi)$ represents a suitable cost function, Y_i is a vector of output produced by the i^{th} farm, P_i denotes a vector of input prices, φ is a vector of parameters to be estimated, u_i denotes inefficiency and v_i is the random noise. The composed error term, $(v_i + u_i)$ is positive because inefficiencies arising from the production process are always assumed to increase production cost (Coelli et al., 1998). This equation shows that the production cost is greater or equal to the minimum cost of production.

According to Ogundari and Ojo (2007), the farm-specific allocative efficiency (AE_i) of the i^{th} farm is calculated by the ratio of the predicted minimum cost of production (C_i^*) to the corresponding actual total cost of production (C_i) and it is specified as:

$$AE_i = \frac{C_i^*}{C_i} = \frac{E(C_i / P_i, u_i = 0)}{E(C_i / P_i, u_i)} = \exp(u_i) \quad (5)$$

The measure of AE_i has a value ranging from zero to one, where one indicates a fully efficient farm and zero implies a fully inefficient farm.

Empirical model specification

Although the Cobb-Douglas functional form is easy to implement, it imposes a severe constraint on the technology of the firm by restricting the production elasticities to be constant and the elasticities of input substitution to be equal to one (Wilson et al., 1998). The translog functional form also suffers from multi-collinearity problems (Dawson et al., 1991). However, Coelli (1995) observed that the translog frontier functional form is less restrictive, allowing for the combination of squared and cross product terms of the explanatory variables with the view of obtaining goodness of fit of the model. Based on the strengths and weaknesses of the two functional forms, the translog functional form is adopted for this study, after testing for the significance of the interaction terms of the model.

In this study, the translog model of the production function was modified to capture the productivity associated with the price of fertilizer (PFert), family labour (Flabour) and hired labour (Hlabour) due to the effect of zero observations. For further information on this specification, see Battese and Coelli (1995), Battese and Broca (1997), Onumah and Acquah (2011) and Villano et al. (2015). The model is stated as:

$$InY_i = \beta_0 + \alpha_1 DFL_i + \alpha_2 DHL_i + \alpha_3 DPF_i + \sum_{n=1}^{6} \beta_n InX_{ni} + 0.5 \sum_{n=1}^{6}\sum_{m=1}^{6} \beta_{nm} InX_{ni} InX_{mi} + (v_i - u_i) \quad (6)$$

where Y_i denotes the total quantity of chili pepper produced in kilograms (kg), DFL_i is the binary variable for family labour which has a value of one if family labour is used and zero if otherwise, DHL_i is the binary variable for hired labour which has a value of one if hired labour is used and zero if otherwise and DPF_i is the dummy variable for the price of fertilizer which has the value of one if the farmer uses fertilizer and zero if otherwise. According to

Battese (1997), without the inclusion of DFL_i, DHL_i and DPF_i, the estimator for the responsiveness of chili output with respect to the use of family labour, hired labour and price of fertilizer could be biased. Flabour (X_1) represents the number of family labour used (in man-days). In Equation 6, $In(X_{1i})$ is expressed as $In[\max(Flabour_i, 1 - DFL_i)]$ which denotes zero usage of family labour. Hlabour (X_2) denotes the number of hired labour used (in man-days) and $In(X_{2i})$ in Equation 6 is expressed as $In[\max(Hlabour_i, 1 - DHL_i)]$ which represents zero usage of hired labour. PFert (X_3) denotes the price of the quantity of fertilizer used (GH¢) and $In(X_{3i})$ in Equation 6 is expressed as $In[\max(\text{PFert}, 1 - DPF_i)]$. Farm size (X_4) denotes the quantity of land (hectares) cultivated to chili pepper. Quantity of seed (X_5) is the total quantity of chili pepper seed (kg) that is used in the planting process. Othercost (X_6) comprises of the price of chemicals, price of capital inputs and price of irrigation water (GH¢) used during the cropping season under consideration. v_i and u_i have their usual meanings. This study assumes that the elasticities of chili output associated with other input factors (except family labour, hired labour and price of fertilizer) are the same for farmers who did not use family labour, hired labour or fertilizer as for those who did use these inputs.

The modified cost frontier of the translog functional form which provides the basis for estimating the AE of chili farms in the Volta region of Ghana is specified as follows:

$$lnC_i = \beta_0 + \alpha_1 DPFL_i + \alpha_2 DPHL_i + \alpha_3 DPF_i + \alpha_4 DFR_i + \sum_{n=1}^{6} \beta_n InP_{ni} + \frac{1}{2}\sum_{n=1}^{6}\sum_{m=1}^{6} \beta_{nm} InP_{ni} InP_{mi} + (v_i + u_i) \quad (7)$$

where C_i is the total cost of chili pepper production by the i^{th} farmer in GH¢, $DPFL_i$ is the dummy variable for the price of family labour which has a value of one if family labour is used in production and zero if otherwise, $DPHL_i$ is the dummy variable for the price of hired labour which has a value of one if hired labour is used and zero if otherwise, DPF_i is the dummy variable for the price of fertilizer which has a value of one if fertilizer is used and zero if otherwise and DFR_i is the dummy variable for the price of farm land which has a value of one if the farm land on which the chilies are cultivated is paid for and zero if otherwise. Without the inclusion of the intercept changes ($DPFL_i$, $DPHL_i$, DPF_i and DFR_i), the estimator for the responsiveness of total cost of chili production with respect to the prices of family labour, hired labour, fertilizer and farm land could be biased (Battese, 1997). PFlabour (P_1) is the price of family labour used (in GH¢). In Equation 7, $In(P_{1i})$ is expressed as $In[\max(PFlabour_i, 1 - DPFL_i)]$ which denotes zero usage of family labour. PHlabour (P_2) denotes the price of hired labour used (in GH¢) and $In(P_{2i})$ in Equation 7 is expressed as $In[max(PHlabour_i, 1 - DPHL_i)]$ which represents zero usage of hired labour. PFert (P_3) denotes the price of the quantity of fertilizer used (in GH¢) and $In(P_{3i})$ in Equation 7 is expressed as $In[max(PFert_i, 1 - DPF_i)]$ which represents zero usage of fertilizer. Rent (P_4) represents the price of farm land used (in GH¢) and $In(P_{4i})$ in equation (7) is expressed as $In[\max(Rent_i, 1 - DFR_i)]$ which represents no payment for the farm land. PSeed (P_5) is the price of the quantity of chili pepper seed (GH¢) used in the planting process. Othercost (P_6) comprises of the prices of chemicals, capital inputs and irrigation water that were used during the planting period (in GH¢). v_i and u_i have their usual meanings. This study assumes that the elasticities of total cost associated with other input price factors (except for prices of family labour, hired labour, fertilizer and farm land) are the same for farmers who did not use family labour, hired labour, fertilizer and farm rent as for those who did use or pay for these inputs.

Economic efficiency, which is the focus of this study is estimated from the multiplicative interaction of both technical and allocative efficiencies and specified as:

$$EE_i = TE_i * AE_i \quad (8)$$

where EE_i, TE_i and AE_i denote economic efficiency, technical efficiency and allocative efficiency of the i^{th} producer respectively.

The various farm-specific and operational factors hypothesized to influence the technical and allocative inefficiencies of chili farms in the Volta region are defined by the model:

$$\mu_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 \quad (9)$$

where μ_i denotes either technical or allocative inefficiency and δ are vectors of unknown parameters to be estimated. Z_1 denotes gender, which is a dummy variable (value of 1 if the chili farmer is a male and 0 if otherwise), Z_2 is the age of the farmer in years, Z_3 is the experience of the farmer in years, Z_4 is the interaction term for age and experience in years, Z_5 denotes the household size of respondents in number of persons, Z_6 is the dummy variable for access to credit (value of 1 if yes and 0 if otherwise), Z_7 is the number of years of education of the farmer, Z_8 is the dummy variable for access to off-farm income (value of 1 if yes and 0 if otherwise) and Z_9 is the dummy variable for access to chili cultivation related training (value of 1 if yes and 0 if otherwise).

Tests of hypotheses

These hypotheses were tested to ascertain the appropriateness of

Table 1. Hypotheses test for the stochastic frontier production function.

Null hypothesis	Log-likelihood value	Test statistic (λ)	Critical Value ($\lambda^2_{0.001}$)	Decision
1. H_o: $\beta_{nm} = 0$	-154.623	59.323***	38.932	Reject H_o
2. H_o: $\gamma = \delta_o = \delta_1 = \delta_2 =, \ldots, = \delta_7 = 0$	-	18.074[a]	16.670	Reject H_o
3. H_o: $\gamma = 0$	-	2.852[a]	2.706	Reject H_o
4. H_o: $\alpha_1 = \alpha_2 = \alpha_3 = 0$	-162.664	16.083***	12.838	Reject H_o

[a]Obtained from Table 1 of Kodde & Palm (1986, p. 1246), *** corresponds to 1% significance level.

Table 2. Hypotheses test for the stochastic frontier cost function.

Null hypothesis	Log-likelihood value	Test statistic (λ)	Critical value ($\lambda^2_{0.001}$)	Decision
1. H_o: $\beta_{nm} = 0$	10.493	386.425***	50.993	Reject H_o
2. H_o: $\gamma = \delta_o = \delta_1 = \delta_2 =, \ldots, = \delta_7 = 0$	-	37.001[b]	22.956	Reject H_o
3. H_o: $\gamma = 0$	-	23.751[b]	9.500	Reject H_o
4. H_o: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$	230.047	160.892***	14.860	Reject H_o

[b]Obtained from Table 1 of Kodde and Palm (1986, p. 1246), ***Corresponds to 1% significance level.

the specified frontier function and the presence of inefficiency effects and the relevance of farm-specific and socio-economic factors in explaining the inefficiency of the chili farms. The tested hypotheses are: (1) $H_0: \beta_{nm} = 0$, the null hypothesis that the coefficients of the second-order variables in the translog models are zero; (2) $H_0: \gamma = \delta_0 = \delta_1 = \delta_2 =, \ldots, = \delta_9 = 0$, the null hypothesis that inefficiency effects are absent from the models at all levels; (3) $H_0: \gamma = 0$, the null hypothesis that the inefficiency effects are non-stochastic and (4) $H_0: \alpha_1 = \alpha_2 = \alpha_3 = 0$, the null hypothesis that there are no intercept changes.

These hypotheses were validated using the generalized likelihood-ratio statistic, λ, which is specified as:

$$\lambda = -2[\text{In}\{L(H_o)\} - \text{In}\{L(H_1)\}] \quad (10)$$

where $L(H_0)$ and $L(H_1)$ denote the values of the likelihood function under the specification of the null (H_0) and alternative (H_1) hypotheses, respectively. λ has a Chi-square distribution if the given null hypothesis is true with a degree of freedom equal to the number of restrictions in the model under the null hypothesis. Coelli (1995) proposed that all critical values can be obtained from the appropriate Chi-square distribution. However, if the null hypothesis involves $\gamma = 0$, then λ has a mixed chi-square distribution and hence the critical values for λ should be read from Table 1 of Kodde and Palm (1986).

RESULTS AND DISCUSSION

Tests of hypotheses

As shown in Tables 1 and 2, the first hypotheses evince that the translog rather than the Cobb-Douglas functional form is a valid representation of the data. This is shown by the rejection of the first hypotheses in both the stochastic frontier production and cost functions. The second hypotheses which specify that inefficiency effects are absent from both models at all levels are also rejected, implying that technical and allocative inefficiency effects are present in both models. The third hypotheses that the inefficiency effects are non-stochastic are also rejected implying that the traditional average response (OLS) function is not an adequate representation of the data. The fourth hypotheses that there are no intercept changes are also rejected in favour of the alternate, implying that the estimates of the parameters of the stochastic frontier production and cost functions would have been biased if these dummies to account for intercept effects in dealing with zero observations in some of the input variables had not been introduced.

Results of the stochastic frontier production function

The maximum likelihood estimates of the stochastic frontier production function are shown in Table 3. The results show that the estimated intercept coefficients for hired and family labour are negative and significant while that of price of fertilizer is positive but has a weak relationship. The estimates of the parameters of the stochastic frontier production function would have been biased if the combined effect of these dummies to account for zero observations in hired labour, family labour and the price of fertilizer were not incorporated in the model. This is further validated by the rejection of the fourth hypothesis in Table 1 (that is, there is no intercept change) in the test of hypotheses. The gamma value is 0.7323 and it is statistically significant at 1%, implying that about 73% of the total deviations from the efficient chili frontier output is due to inefficiencies arising from the production process while the random effects constitute about 27%. This further means that technical inefficiency effects dominate the noise effect in explaining the total variation in chili output. The findings also show that chili pepper output responded positively to all the input variables except family labour. This implies that a percentage increase in farm size, hired labour, price of fertilizer, quantity of seed and othercost will result in 0.34, 0.28, 0.21, 0.09, and 0.18% increase in chili output, respectively. However, a percentage increase in family labour may decrease chili output by 0.29%. This may be attributed to the excessive use of family labour for chili pepper cultivation which leads to diminishing returns. Since majority of the farmers are resource poor and are unable to pay for the services of hired labour, they tend to depend heavily on the services of their family members for production activities, resulting in the excessive use of family labour. The estimated elasticities for farm size, family labour, hired labour and price of fertilizer are statistically significant at 1%, whiles that of other cost is at 10%. The estimated return to scale is 0.82, implying that on average, chili farms in the Volta region of Ghana are characterized by decreasing returns to scale. This means that a proportionate increase in all the inputs will result in a less than proportionate increase in chili output. The realized return to scale is higher than the 0.304 obtained by Wosor and Nimoh (2012) in their study of the resource use efficiency of chili farms in the Keta municipality of the Volta region.

Results of the stochastic frontier cost function

The maximum likelihood estimates of the stochastic frontier cost function for the allocative efficiency are presented in Table 4. The predicted elasticities for all the input price variables are positive and significant at 1%. This means that all the input prices contributed significantly and directly to the total cost of chili pepper production. This implies that a percentage increase in the price of farm land, price of hired labour, price of family labour, price of fertilizer, price of seed and other costs will increase the total cost of chili pepper production by 0.0398, 0.3999, 0.4087, 0.0791, 0.0370 and 0.0599%, respectively. Output however has a weak positive relationship with the total cost of chili production. This positive relationship might mean that a 1% increase in chili output will lead to a 0.0047% increase in the total cost of chili production. The findings also show that the estimated intercept coefficients for the price of farm land, price of fertilizer, prices of hired and family labours are significantly positive. These estimated parameters show that the estimates of the parameters of the cost frontier function would have been biased if these dummies to account for intercept effect in dealing with zero observations in the price of farm land, price of fertilizer, price of hired labour and price of family labour were not included in the model. This is further confirmed by the rejection of the fourth null hypothesis in Table 2 (that is, there is no intercept change) in the test of hypotheses. The estimated gamma (γ) value of the allocative efficiency model is 0.9853 and it is significant at 1%, implying that the inability of the chili farmers to operate at the minimum cost frontier is largely due to conditions under their direct control while conditions beyond their control constitute about 1.47% of that inability.

Distribution of technical, allocative and economic efficiency scores

The frequency distribution of the various estimates of technical, allocative and economic efficiencies of chili farms in the Volta region of Ghana are presented in Figure 1.

Technical, allocative and economic efficiency scores varied greatly among the sampled chili farms. The predicted technical, allocative and economic efficiencies ranged from 18.62 to 92.06%, 69.76 to 99.58% and 17.40 to 91.10%, respectively with their means being 70.97, 92.65 and 65.76%, respectively. This mean TE estimate shows that on average, chili farms are operating at 29.03% below the efficient frontier output. This therefore implies that with the current level of technology and resource endowment, chili farms in the Volta region can increase chili output by 29.03% through the adoption of the best farm practices. The mean AE estimate of 92.65% implies that on average chili farms are operating at 7.35% above the minimum attainable cost frontier. Consequently, there is the possibility for the chili farmers to minimize cost by an average of 7.35% through the adoption of the practices of the best cost efficient farm. These high allocative efficiency estimates of the sampled chili farms confirm the hypothesis formulated by Schultz (1964) that resource-poor farmers in developing countries are highly efficient in allocating the scarce financial resources at their disposal. The mean EE of 65.76% shows that on average, the ability of the chili farmers to produce a

Table 3. Maximum likelihood estimates of the stochastic frontier production function.

Variable	Parameters	Coefficients	Standard error
Constant	β_0	4.5768***	1.1274
LnFarmsize	β_1	0.3437***	0.1426
LnHLabour	β_2	0.2845***	0.0803
LnFLabour	β_3	-0.2880***	0.0846
LnCFert	β_4	0.2065***	0.0776
LnQntySeed	β_5	0.0938	0.1103
LnOthercost	β_6	0.1795*	0.1102
Dummy for Hlabour	α_1	-2.2433***	0.7674
Dummy for Flabour	α_2	-1.9802**	0.8877
Dummy for CFert	α_3	0.1757	0.8736
0.5Ln(Farmsize)^2	β_7	0.3975**	0.2202
0.5Ln(HLabour)^2	β_8	0.0657*	0.0481
0.5Ln(FLabour)^2	β_9	-0.2736***	0.0958
0.5Ln(CFert)^2	β_{10}	0.0461	0.0721
0.5Ln(QntySeed)^2	β_{11}	0.0722	0.1042
0.5Ln(Othercost)^2	β_{12}	-0.3602*	0.2188
LnQntySeed*LnFLabour	β_{13}	-0.0072	0.0447
LnCFert*LnFLabour	β_{14}	-0.0381	0.0341
LnCFert*LnQntySeed	β_{15}	-0.0475	0.0424
LnOthercost*LnFLabour	β_{16}	0.0336	0.1118
LnOthercost*LnQntySeed	β_{17}	0.0307	0.0835
LnOthercost*LnCFert	β_{18}	-0.0163	0.0532
LnHLabour*LnFLabour	β_{19}	-0.0533	0.0678
LnHLabour*LnQntySeed	β_{20}	0.1390***	0.0568
LnHLabour*LnCFert	β_{21}	-0.0097	0.0201
LnHLabour*LnOthercost	β_{22}	0.1154*	0.0749
LnFarmsize*LnFLabour	β_{23}	-0.0100	0.0842
LnFarmsize*LnQntySeed	β_{24}	-0.1033	0.0964
LnFarmsize*LnCFert	β_{25}	0.0812	0.0715
LnFarmsize*LnOthercost	β_{26}	0.0277	0.2318
LnFarmsize*LnHLabour	β_{27}	-0.2893***	0.0939
Sigma squared	σ^2	0.6429***	0.2163
Gamma	γ	0.7323***	0.1245
Log-likelihood	-	-154.6230	-

*, **, ***Statistically significant at levels of 0.1, 0.05, and 0.01, respectively.

Table 4. Maximum likelihood estimates of the stochastic frontier cost function.

Variable	Parameter	Coefficients	Standard error
Constant	β_0	-5.4968***	0.3815
LnFarmRent	β_1	0.0398***	0.0069
LnCHLabour	β_2	0.3999***	0.0087
LnCFLabour	β_3	0.4087***	0.0071
LnOthercost	β_4	0.0599***	0.0109
LnCFert	β_5	0.0791***	0.0079
LnCSeed	β_6	0.0370***	0.0107
LnOutput	β_7	0.0047	0.0095
Dummy for FarmRent	σ_1	0.0171	0.0471
Dummy for CHLabour	σ_2	2.7098***	0.2858
Dummy for CFLabour	σ_3	2.5757***	0.1882
Dummy for CFert	σ_4	0.1717**	0.1003
0.5Ln(FarmRent)^2	β_8	0.0144***	0.0060
0.5Ln(CHLabour)^2	β_9	0.1823***	0.0088
0.5Ln(CFLabour)^2	β_{10}	0.1654***	0.0077
0.5Ln(Othercost)^2	β_{11}	0.0968***	0.0172
0.5Ln(CFert)^2	β_{12}	0.0387***	0.0080
0.5Ln(CSeed)^2	β_{13}	0.0002	0.0114
0.5Ln(Output)^2	β_{14}	-0.0052	0.0136
LnCSeed*LnOutput	β_{15}	-0.0119*	0.0089
LnCFert*LnOutput	β_{16}	-0.0002	0.0046
LnCFert*LnCSeed	β_{17}	0.0053	0.0044
LnOthercost*LnOutput	β_{18}	0.0191*	0.0145
LnOthercost*LnCSeed	β_{19}	0.0050	0.0120
LnOthercost*LnCFert	β_{20}	-0.0137***	0.0050
LnCFLabour*LnOutput	β_{21}	0.0174***	0.0060
LnCFLabour*LnCSeed	β_{22}	0.0174***	0.0044
LnCFLabour*LnCFert	β_{23}	-0.0125***	0.0025
LnCFLabour*LnOthercost	β_{24}	-0.0167***	0.0072
LnCHLabour*LnOutput	β_{25}	-0.0142*	0.0090
LnCHLabour*LnCSeed	β_{26}	0.0153**	0.0087
LnCHLabour*LnCFert	β_{27}	0.0018	0.0030
LnCHLabour*LnOthercost	β_{28}	-0.8190***	0.0114
LnCHLabour*LnCFLabour	β_{29}	-0.1186***	0.0052
LnFarmRent*LnOutput	β_{30}	-0.0109**	0.0058
LnFarmRent*LnCSeed	β_{31}	-0.0079*	0.0055
LnFarmRent*LnCFert	β_{32}	0.0009	0.0019

Table 4. Cont'd

LnFarmRent*LnOthercost	β_{33}	0.0023	0.0069
LnFarmRent*LnCFLabour	β_{34}	0.0106***	0.0027
LnFarmRent*LnCHLabour	β_{35}	-0.0089**	0.0044
Sigma-squared	σ^2	0.0066***	0.0007
Gamma	γ	0.9853***	0.0444
Log-likelihood	-	310.4927	

*, **, ***Statistically significant at levels of 0.1, 0.05, and 0.01 respectively.

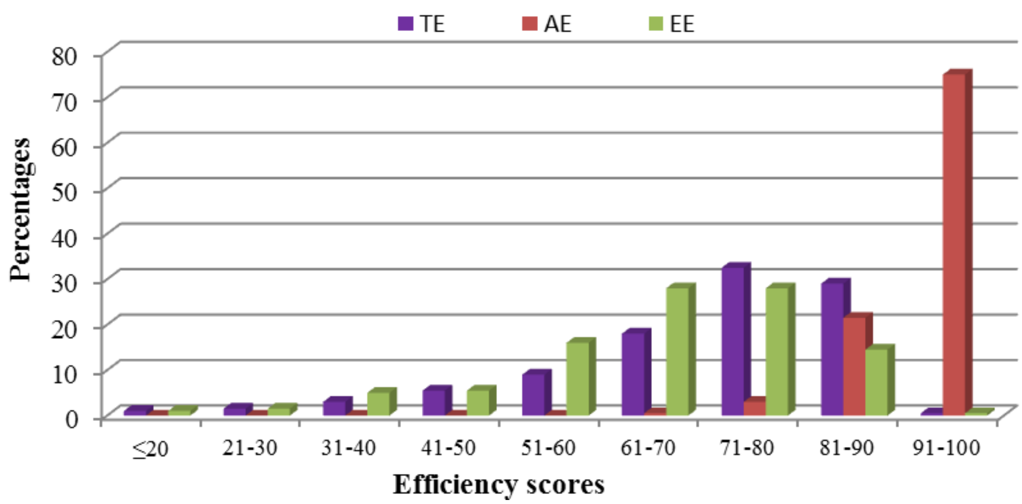

Figure 1. Distribution of efficiency scores (Author's Computation from Field Survey, 2013).

predetermined level of output at the lowest attainable cost is relatively low. The findings further show that substantial gains in EE can be achieved by improving the technical and allocative efficiencies of the chili farmers.

Following the work of Bravo-Ureta and Pinheiro (1997), the efficiency scores also indicate that if the average chili farmer is to attain the efficiency level of the most technically efficient chili farm among the sampled chili farms, that farmer will have to realize a 22.91% cost savings (that is, 1- [70.97/92.06]). Also, the most technically inefficient chili farmer will have to realize a cost reduction of 79.77% (that is, 1- [18.62/92.06]) in order to achieve the technical efficiency level of the most efficient chili farm. From the allocative efficiency scores, the average and least efficient chili farms will have to realize cost reductions of 6.96% (that is, 1- [92.65/99.58]) and 29.95% (that is, 1- [69.76/99.58]), respectively before they can attain the efficiency level of the most allocative efficient chili farm among the sampled chili farms. The results further show that the average and the most economically inefficient chili farms must save cost by 27.82% (that is, 1- [65.76/91.10]) and 80.90% (that is, 1- [17.40/91.10]), respectively to be able to attain the efficiency status of the most economic efficient chili farm among the sampled chili farms. It is evident from these findings that substantial gains in EE can be achieved and that technical inefficiency effects pose more challenge to EE than allocative inefficiency effects.

Determinants of technical and allocative inefficiency

The results of the analysis of the technical and allocative inefficiency models are shown in Table 5. Since EE is composed of technical and allocative efficiencies, economic inefficiency also arises from the joint effects of technical and allocative inefficiencies (Bravo-Ureta and Pinheiro, 1993). Knowledge of these inefficiency factors according to Bravo-Ureta and Pinheiro (1993) is of great importance in formulating appropriate policies towards the attainment of the frontier output given the technology level. The results of the inefficiency models revealed female chili farmers to be technically more efficient than their male counterparts. Male farmers however are allocatively more efficient than their female counterparts. This finding is not surprising since much of the labour that

Table 5. Technical and allocative inefficiency models.

Variable	Parameter	Coefficients	
		TE	AE
Constant	δ_0	-3.475 (2.478)*	0.085 (0.077)
Gender	δ_1	0.602 (0.448)*	-0.051 (0.026)**
Age	δ_2	0.043 (0.029)*	-0.002 (0.001)
Experience	δ_3	0.263 (0.155)**	0.012 (0.005)**
Age*Experience	δ_4	-0.006 (0.003)**	-0.002 (0.001)**
Household size	δ_5	0.085 (0.046)**	0.001 (0.003)
Credit	δ_6	0.600 (0.356)**	0.043 (0.020)**
Education	δ_7	-0.036 (0.033)	-0.006 (0.003)**
Off-farm income	δ_8	-0.213 (0.219)	-0.038 (0.021)**
Training	δ_9	0.325 (0.516)	0.070 (0.032)**

Values in parenthesis are standard errors; *, **Statistically significant at levels of 0.1 and 0.05, respectively.

is required for farm operations (weeding, transplanting, harvesting, processing, etc) are supplied by women. Since chili plants are very delicate, they require care and patience in handling them and this is done better by females than males. On the other hand, male farmers who may mostly be the heads of their respective households may want to minimize cost in order to save money for the upkeep of their farm families and by so doing may end up producing at the minimum attainable cost. This finding contradicts the views of Onumah et al. (2013) who found male cocoa growers to be technically more efficient than their female counterparts. It is however in consonance with Amewu and Onumah (2015) who found male NERICA rice farmers to be allocatively more efficient than their female counterparts. The age of chili farmers has a positive relationship with technical inefficiency, implying that aged farmers are less efficient relative to their youngsters. This result agrees with the findings of Asante et al. (2014), Mariano et al. (2011) and Khan and Saeed (2011). The implication of this finding is that policies that are aimed at persuading the teaming youth to go into chili pepper cultivation should be implemented since it has the potential to boost chili production. Surprisingly, experienced chili farmers are found to be technically and allocatively less efficient than their inexperienced counterparts. This may be attributed to the fact that most experienced farmers may tend to rely solely on their knowledge and so may not seek advisory services from extension officers and this may lead to their inefficiency compared to their inexperienced counterparts who may be willing to seek extension advice. This finding concurs with the findings of Onumah and Acquah (2011) and Onumah et al. (2010) who posit that new farmers are progressive and willing to implement new farming systems, leading to high level of efficiency as opposed to their experienced counterparts. Even though the individual effects of age and experience of the farmers are found to influence technical and allocative inefficiency positively, this study illustrates that the joint effect of these factors impact technical and allocative inefficiency negatively. This implies that aged farmers with numerous years of experience in chili pepper cultivation are relatively more efficient as opposed to aged farmers who are less experienced or experienced young farmers. This finding reveals that people who go into chili farming at old age (e.g. after retirement) are less efficient as opposed to those who enter at tender age since they tend to acquire more experience as they grow. Onumah and Acquah (2011) also realized a similar relationship in their study of the technical efficiency and its determinants of Ghanaian fish farms. Contrary to expectations, farm families with relatively larger household sizes are found to be relatively less efficient than those with relatively smaller sizes. This finding is confirmed by the negative contribution of family labour to chili output. A summary statistic of the data revealed that more than 92% of the sampled chili farms are less than 2 hectares and increasing labour inputs on these atomized land holdings will lead to diminishing returns. This finding lends support to Effiong (2005) and Idiong (2006) who argued that larger household sizes do not necessarily ensure increased efficiency since family labour is made up of children who are always in school. Contrary to the findings of Onumah et al. (2013), Khan and Saeed (2011) and Mbanasor and Kalu (2008), but consistent with the findings of Okike et al. (2001), chili farmers who had access to credit facilities operate with less technical and allocative efficiency than those without access. This may be ascribed to the fact that majority of the farmers who had access to credit facilities may not have used the credits for the planned purposes. Since most of the chili farmers are resource poor and have large family sizes, a high possibility of credit diversion into meeting their daily needs may exist among them. Consistent with the results of Bravo-Ureta and Pinheiro (1997), Khan and Saeed (2011), and Abdulai and Huffman (2000), chili farmers with more years of education are found to be allocatively more efficient than their counterparts who are less educated. According to Khan and Saeed (2011), education helps to sharpen the managerial skills of farmers thereby enabling them to be good decision makers with regards to input usage. Chili farmers who engage in other forms of income generating activities are found to be allocatively more efficient than their counterparts who do not engage in such activities. Engagement in off-farm activities yield returns which increase the purchasing power of the farmers, enabling them to purchase productivity enhancing inputs for chili cultivation. This result contradicts the views of Abdulai and Eberlin (2001), Nkegbe (2012) and Mariano et al. (2011). Contrary to expectations, chili farmers who had access to some form of training in chili cultivation operate with less allocative efficiency than those who do not have access to such forms of training. This can be attributed to the infrequent nature of the training since majority of those who were trained could not remember the last time they received such forms of training. This result contradicts the views of Galawat and Yabe (2012) and Rahman et al. (2015) who found participation in rice training programs to have increased the efficiency of rice producers in Brunei Darussalam and Bangladesh, respectively.

CONCLUSIONS AND POLICY RECOMMENDATIONS

Based on the findings of the study, the following conclusions are drawn. Chili pepper output in the study area is greatly influenced by farm size, hired labour, family labour, price of fertilizer and othercost of production. The production technology of chili farms is characterized by decreasing returns to scale. The total cost of chili pepper cultivation in the study area is significantly influenced by the price of farm land, price of hired labour, price of family labour, price of fertilizer, price of seed and othercosts. However, output does not significantly influence total cost though they are positively related.

Chili farms in the study area are economically less efficient and this is largely due to the presence of both technical and allocative inefficiencies in chili production with technical inefficiency effects constituting a more serious problem to economic efficiency than allocative inefficiency effects. This implies that economic efficiency could be improved substantially by improving both technical and allocative efficiencies, however improvement in technical efficiency offers a higher potential for enhancing economic efficiency than in allocative efficiency. This further implies that chili farmers in the study area generally make good decisions with respect to input allocation rather than good decisions regarding the perfect conversion of inputs into output.

The results also demonstrate the import of examining not only technical efficiency as a measure of productivity but also allocative and economic efficiency components. The current economic efficiency level of the farmers implies that the ability of the chili farmers to produce a potential level of output at a lower cost is relatively low on average and needs to be improved. There is the presence of both technical and allocative inefficiencies among the chili pepper producers in the study area and these inefficiencies are greatly influenced by farmers' socio-economic characteristics as well as technical and institutional factors. The joint effects of technical and allocative inefficiencies are responsible for explaining the level of variations in the economic efficiency of chili farms although the individual effects of some variables are statistically non-significant.

On the basis of the findings, the study recommends that chili farmers should rely more on the services of hired labour rather than family labour and those who desire to make efficient use of the services of their large farm families should increase their farm-sizes so as to commensurate the quantity of available family labour. The study also recommends policies that aim at attracting the teaming youth into chili pepper cultivation to be pursued by the government and other stakeholders of the chili industry. These policies should focus on giving incentive packages such as enhancing the access of the youth to improved inputs at subsidized prices, especially young female chili farmers since female farmers are found to be technically more efficient than their male counterparts. The study further recommends that experienced chili farmers should not rely solely on their know-how but should endeavour to complement their knowledge with advisory services. Furthermore, financial institutions and other credit providers should focus on providing credit to the farmers in the form of inputs rather than cash and these inputs should directly be channeled into production activities so as to avert the possible diversion of these inputs.

Conflict of Interests

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENT

Funding support for this study was provided by the International Food Policy Research Institute (IFPRI), Ghana under the Ghana Strategy Support Program (GSSP) and the authors wish to thank them.

REFERENCES

Abdulai A, Eberlin R (2001). Technical efficiency during economic reform in Nicaragua: Evidence from farm household survey data. Econ. Syst. 25(2):113–125.

Abdulai A, Huffman W (2000). Structural adjustment and economic efficiency of rice farmers in Northern Ghana. Econ. Dev. Cult. Change 48(3):503-20.

Aigner DJ, Lovell CAK, Schmidt PJ (1977). Formulation and estimation of stochastic frontier production function models. J. Econ. 6:21-37.

Amewu S, Onumah EE (2015). Cost efficiency of NERICA producing households in Ghana: a modified non-neutral stochastic frontier analysis. Am. J. Exp. Agric. 9(6):1-13.

Asante BO, Villano RA, Battese GE (2014). The effect of the adoption of yam minisett technology on the technical efficiency of yam farmers in the forest-savanna transition zone of Ghana. Afr. J. Agric. Resour. Econ. 9(2):75-90.

AVRDC (Asian Vegetable Research Development Centre) (2006). Vegetables Matter. AVRDC – The World Vegetable Center. Shanhua, Taiwan.

Battese GE (1997). A note on the estimation of Cobb-Douglas production functions when some explanatory variables have zero values. J. Agric. Econ. 48:250-252.

Battese GE, Broca SS (1997). Functional forms of stochastic frontier production functions and models for technical inefficiency effects: a comparative study for wheat farmers in Pakistan. J. Prod. Anal. 8:395-414.

Battese GE, Coelli TJ (1995). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. Empir. Econ. 20:325-332.

Battese GE, Corra GS (1977). Estimation of a production frontier model: with application to the pastoral zone of Eastern Australia. Aust. J. Agric. Econ. 21:169-179.

Bravo-Ureta BE, Pinheiro AE (1993). Efficiency analysis of developing country agriculture: a review of the frontier function literature. Agric. Resour. Econ. Rev. 22(1):88-101.

Bravo-Ureta BE, Pinheiro AE (1997). Technical, economic, and allocative efficiency in peasant farming: Evidence from the Dominican Republic. Dev. Econ. 35(1):48-67.

Coelli TJ (1995). Estimators and hypothesis tests for a stochastic frontier function: A Monte Carlo analysis. J. Prod. Anal. 6:247-268.

Coelli TJ, Rao DSP, Battese GE (1998). An Introduction to Efficiency and Productivity analysis. Kluwer Academic Publishers. Boston. USA.

Coelli TJ, Rao DSP, O'Donnell CJ, Battese GE (2005). An introduction to efficiency and productivity analysis, 2nd edition. Springer Publishers, New York, New York, USA.

Dawson PJ, Lingard J, Woodford CH (1991). A generalized measure of farm-specific technical efficiency. Am. J. Agric. Econ. 73(4):1099-1104.

Effiong EO (2005). Efficiency of Production in Selected Livestock Enterprises in Akwa Ibom State, Nigeria. Ph.D Dissertation. Dept. of Agricultural Economic, Michael Okpara University of Agriculture, Umudike. Nigeria.

Galawat F, Yabe M (2012). Profit efficiency in rice production in Brunei Darussalam: A stochastic frontier approach. J. Int. Soc. Southeast Asian Agric. Sci. 18(1): 100–112

Ghana Statistical Service (GSS) (2014). Ghana Living Standards Survey Report of the Sixth Round (GLSS 6), Accra, Ghana.

Idiong IC (2006). Evaluation of Technical, Allocative and Economic Efficiencies in Rice Production System in Cross River State, Nigeria. Ph.D Thesis, Michael Okpara University of Agriculture, Umudike, Nigeria.

Khan H, Saeed I (2011). Measurement of Technical, Allocative and Economic Efficiency of Tomato Farms in Northern Pakistan. International Conference on Management, Economics and Social Sciences (ICMESS' 2011) Bangkok Dec., 2011.

Kodde DA, Palm FC (1986). Wald criteria for jointly testing equality and inequality restrictions. Econometrica . 54:1243-1248.

Mariano MJ, Villano R, Fleming E (2011). Technical Efficiency of Rice Farms in Different Agroclimatic Zones in the Philippines: An Application of a Stochastic Metafrontier Model. Asian Econ. J. 25(3):245-269.

Mbanasor JA, Kalu KC (2008). Economic efficiency of commercial vegetable production system in Akwa Ibom State, Nigeria: A translog stochastic frontier cost function approach. Trop. Subtrop. Agroecosyst. 8(3):313-318.

Meeusen W, Van den Broeck J (1977). Efficiency Estimation from Cobb-Douglas Production Functions with composed Error. Int. Econ. Rev.18:435-444.

MiDA (Millennium Development Authority) (2010). Investment opportunity in Ghana chili pepper production. A publication of MiDA in conjunction with the United States Millennium Challenge Corporation.

MoFA (Ministry of Food and Agriculture) (2014). Agriculture in Ghana: Facts and Figures (2013). Annual Report compiled by the Statistics, Research and Information Directorate (SRID), Ministry of Food and Agriculture as part of MoFA's Policy Planning Monitoring and Evaluation activities. Accra, Ghana.

Nkegbe PK (2012). Technical efficiency in crop production and environmental resource management practices in northern Ghana. Environ. Econ. 3(4):43–51.

Ogundari K, Ojo SO (2007). Economic Efficiency of Small Scale Food Crop Production in Nigeria: A Stochastic Frontier Approach. J. Soc. Sci. 14(2):123-130.

Okike I, Jabbor MA, Smith KV, Akinwumi JW, Ehui SK (2001). Agricultural Intensification and Efficiency in West Africa Savannahs: Evidence from Northern Nigeria. Socio-economic and Policy Research Working Paper 33. ILRI, Nairobi.

Onumah EE, Acquah HD (2011). A stochastic production investigation of fish farms in Ghana. Agris on-line Papers in Economics and Informatics 3(2):55.

Onumah EE, Bruemmer B, Hoerstgen-Schwark G (2010). Productivity of hired and family labour and determinants of technical inefficiency in Ghana's fish farms. Agric. Econ. 56(2):79-88.

Onumah JA, Onumah EE, Al-Hassan RM, Bruemmer B (2013). Meta-frontier analysis of organic and conventional cocoa production in Ghana. Agric. Econ. 6(59):271-280.

Rahman MC, Hussain CNB, Hossain MR, Rahaman MS, Chowdhury A (2015). Comparative Profitability and Efficiency Analysis of Rice Farming in the Coastal Area of Bangladesh: The Impacts of Controlling Saline Water Intrusion. IOSR J. Agric. Vet. Sci. 8(10):89–97.

Schultz TW (1964). Transforming Traditional Agriculture. Stochastic Frontiers: A Monte-Carlo Analysis. Discussion Paper in Economics, Exeter University. New Haven: Yale University Press.

Villano R, Bravo-Ureta B, Solís D, Fleming E (2015). Modern Rice Technologies and Productivity in the Philippines: Disentangling Technology from Managerial Gaps. J. Agric. Econ. 66(1):129–154.

Wilson P, Hadley D, Ramsden S, Kaltsas L (1998). Measuring and Explaining Technical Efficiency in UK Potato Production. J. Agric. Econ. 48(3):294-305.

Wosor DK, Nimo F (2012). Resource use efficiency in Chili Pepper production in the Keta municipality of Volta Region of Ghana. Elixir Prod. Manage. 47(2012):8595-8598.


Journal of Agricultural Extension and Rural Development
Related Journals Published by Academic Journals
■ Journal of Plant Breeding and Crop Science
■ African Journal of Agricultural Research
■ Journal of Horticulture and Forestry
■ International Journal of Livestock Production
■ International Journal of Fisheries and Aquaculture
■ Journal of Development and Agricultural Economics
academicJournals