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Technological Experience and Crop Production in Dryland Farming Systems in Africa: The Case of Draught Animal Power in Ghana

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ABSTRACT

Considerable controversy exists about the trend of animal traction effects on crop production in dryland farming systems in sub-Saharan Africa (SSA). This problem arises on account of the failure of the few available empirical studies to recognise the importance of technological experience of the individual adopting farmers.

This study hence addresses this issue by examining the effects of experience in animal traction technology (ATT) on farm size, cropping emphasis, total crop output and farm productivity. It is based on farm management survey data on 42 smallholder farm households from Ghana. Thirty of these households used animal traction technology (ATT) for crop cultivation and the rest, mainly hand-hoe. The animal traction sub-sample is classified into three groups according to farmers' years of experience with the technology, thus, those with 1-2, 3-10, and more than 10.

Evidence from the study shows that the progression of years of experience with ATT leads to intensification of labour and land use systems, enhancement of degree of motivation to enter into the market economy, increases in total crop output and farm productivity resulting from decreases in cultivated acreages.

The implication of the findings is that institutional and technical support that do accompany the introduction of such technologies should be structured to last for a relatively longer period to accomodate the learning process.

Key Words: Technology, Experience, Draught animal power,
Dryland farming, Ghana

INTRODUCTION

Crop production in dryland farming systems in Africa is dominated by smallholder farmers majority of whom rely mainly on traditional hand cultivation. Land and family labour are their main factors of production (Singh, 1988; Panin, 1992). Low productivity, an underscoring factor for the continuing declining in food production per capita in many African countries, characterizes their production systems.

Among several bottlenecks, seasonal labour shortages are a key factor to the productivity. The use of animal draught power, widely referrred to as animal traction technology (ATT), in performing farm operations was identified and introduced for decades in many SSA countries as a technology appropriate for smallholder farmers (Sargent et al., 1981, Munzinger, 1982). ATT, as a power source to supplement or partially replace human power has the potential in enabling farmers to increase labour productivity through alleviation of seasonal labour shortages and increasing yields. While there is concrete evidence elsewhere in the world indicating that animal traction-using farmers have benefited from these gains, similar evidence cannot be found in sub-Saharan Africa (SSA) region.

In SSA countries, there exits considerable controversy in the literature about the particular trend of ATT's effect on dryland crop production systems (Singh, 1988). For example, in more recent studies, Lasitter (1982) and Francis (1988) found out that animal traction using households (ATHs) in Burkina Fasso and in northern Zambia used 17% and 36% less total labour input per hectare, respectively, than their counterparts using hand cultivation. Panin (1988), on the other hand, noted an increase of 10% associated with ATT over hoe cultivation among farmers in northern Ghana.

In another instance, the findings of Singh et al. (1984) and Panin and de Haen (1989) revealed a positive association between the use of ATT and total agricultural output. This contradicted earlier reports by McIntire (1981) who in Mali found out that both yield and cropping-pattern effects for animal traction households reduced the value of farm production and Delgado and McIntire (1982) who concluded that ox traction in the sahel is not profitable.

These conflicting evidence and viewpoints on the effects of ATT on crop production in dryland farming systems in Africa arise on account of the failure of the few available empirical studies on ATT's performance in SSA region to

recognise the importance of technological experience of the individual adopting farmers and their subsequent treating of all farmers as being homogeneous element with regard to technological experience.

The differences in farmers' experience with the use of ATT will surely have a varying impact on its performance on crop production. For example, as noted by Jaeger (1986) and Barret et al.(1982), the intensity of the use of the technology is largely influenced by the experience factor.

To assist in the clarification of the trend of ATT's performance in dryland crop production systems in SSA countries, this paper examines its efeects on farm size, cropping emphasis, crop mixture, total crop output, and farm productivity with respect to various farmers' experience with the technology using farm management survey data on smallholders from northern Ghana.

THE STUDY AREA AND DATA USED

The study area covered three villages (Nakpanduri, Sakogu and Gbingbalanchet) in the Gambaga district of northerneastern Ghana. It is about 900 km from the capital, Accra. The general infrastructure of the area, particularly the transportation net work, is highly undeveloped.

The study area, like the rest of northern region, has a unimodal rainy season which starts mostly from April and ends in October with peak rains occuring between June and September. The average annual rainfall is about 950 mm and the average monthly temperature is about 30°C, with a maximum of 33°C recorded in March. The vegetation is grassland savanna with scattered trees.

The economy of the area is based on predominant subsistence farming activities with households cultivating an average area of 4 ha (Panin, 1988). Except livestock, the capital stock of the farmers consists mainly of hand tools, livestock huts, grain stores and household seeds. The main farming technology is the traditional hand hoe cultivation. Nevertheless, the use of ATT is becoming increasingly, an integral part of the the area's farming systems, about 20% of the farming population are currently using it (Panin, 1988). The introduction of ATT in the area dates back to 1930 (Munzinger, 1982). Its use there is limited to ridging. Bullocks are the main draught animals. Panin (1989) found out that investment in animal traction technology in the area is profitable.

The main food crops usually grown in mixtures are early and late millet, maize and sorghum. Groundnut is the main cash crop. Crop production in the study area and throughout northern Ghana suffers from climatic variations and is mostly for home consumption, only about 10% of the farm produce is sold (Panin, 1988).

The data used here are drawn from a 1982/83 survey of 42 randomly selected farming households in the study area. Twelve of these mainly used hoes for cultivation and 30 used ATT. The ATT sub-sample which was deliberately overrepresented was stratified into three groups according to farmers' years of experience with the technology. These are those with 1-2, 3-10 and more than 10 years.

Inspite of the sample size, it is considered to be representative of the farming population in the area as a whole due to the homogeneity of the households as reflected in their main resources, way of life and the predominantly subsistence agricultural based economy in the area. Data were collected on personal characteristics and various aspects of of the crop-livestock production systems through formal and informal interviews, direct measurement and observation.

RESULTS AND DISCUSSION

Characteristics of hoe and animal traction households

Important household characteristics for hoe and animal traction-using sub-samples are presented in Table 1. From the table, it can be seen that animal traction households in general had larger families, more adult workers and higher literacy rates than their hoe counterparts.

Also heads of households among the animal traction sub-samples were older and had more wives than those in the hoe sample. This trend is consistent when comparing the same information for each animal traction sub-sample with that of hoe separately. The only exception is the literacy rate for newly adopting animal traction households (1-2 yrs of experience) found to be less than the value obtained for the hoe households. Again the literacy rate increases with years of household's experience in ATT. Since better educated people are more likely to adopt new agronomic innovations, the results suggest that more experienced ATT-using households are likely to have higher yileds. Comparison of the respective mean household characteristics within the animal traction sub-groups reveals higher values of these for subgroups with 3-10 and more than 10 years of experience than the newly adopting farmers, indicating a positive relationship between such variables and experience in ATT.

Effects on land use systems

The land use systems by various sub-samples with regard to labour intensity, cultivated area, cropping emphasis and crop mixture are found in Table 1. As revealed by the table, average cultivated area of each ATT sub-sample is larger than that of hoe-using households. The mean difference was significant for the newly adopting farmers ($P<0.10$) and those with 3-10 years of experience ($P<0.01$) but not for the most experienced farmers. Examination of these results reveals no discerning trend in cultivated areas for the ATT sub-samples. The largest area of 6.7 ha and the smallest of 4.5 ha are found among farmers with 3-10 and those with more than 10 years of experience, respectively. On the basis of cultivated area per adult, a better indication of acreage effect of ATT, there is a consistent pattern within the groups. As the years of experience with ATT progress, cultivated area per adult decreases. The latter still remain larger for ATT than hoe farmers except those with the highest years of experience.

One possible reason for the decreasing trend in acreage per adult during the progression of ATT experience is the probable inaccurate assessment of problems involved in the use of ATT by newly adopting farmers. As such at the early stages of its adoption, farmers cultivate larger areas with the hope of getting more total crop output. But this hope is seldom fulfilled because the increased areas raise the demand for weeding and harvesting operations to a level exceeding the available household labour supply.

In such a situation the farmers have to look for non-household labour at additional cost, or they may not be in a position to cultivate their farm thouroughly and this may result in decreased total output. Consequently, the farmers with time, change their attitude towards extensification of the land use system and adopt intensification process to enable them utilize their resources (labour and land more efficiently.

As regards cropping emphasis, since farming is at subsistence level in the area, the traditional hoe farmers allocate 81% of their total cultivable land to major food crops with only 19% going to cash crops (Table 1). With the adoption of ATT, still larger portion (75%) of the land is planted with the major food crops. Nevertheless, the average share of cash crops increases from 19 to 25%. The inter animal traction group comparison of the area allocated to cash crops reveals that this increases from 17% for those farmers with 1-2 years of experience to 30% for the most experienced ones. This implies that the degree of motivation to enter into the market economy increases with the increasing years of experience in ATT.

respect to ATT's experience. The proportion of cultivated land under the tradional hoe farming systems raises from 81 to 86% with the adoption of ATT (Table 1). However, this varies considerably within the animal traction sub-groups. Newly adopting farmers allocate 95% of their total cultivated land to the growing of crops in mixtures, but this gradually decreases to 75% with acquisition of more experience with ATT. This decreasing trend in favour of sole crops may be explained by the fact that with progression of experience in ATT, the farmers recognize that labour constraints under crop mixtures are severer than under sole crops as noted by Norman et al. (1981).

As can be seen in the same table 1, per hectare labour used was higher for all ATHs except those with 1-2 years of experience than their hoe counterparts. Examination of the labour intensities of the ATT sub-samples reveals again a consistent increasing trend of this input usage. Even though, none of the mean differences were significant, there is a strong indication that with adoption of ATT, labour intensity increases over the requirement by the traditional farming systems and these increases progress with ATT's experience.

Effects on crop production income and land productivity

As shown in table 1, per hectare total crop output and net income are higher among ATHs than those obtained for hoe households. Both variables depict increasing trend with progression of ATT's experience. Of remarkable interest is to note that the respective mean differences between the levels achieved in crop output and income by hoe and ATT sub-samples were significant for only the more experienced ATT users.

The effects of ATT's experience and labour intensity on crop production income were also investigated using regression analysis. This was to account for the variations of the mean values within the the sub-samples. The results of the analysis presented in Table 2 reveal a positive relationship between years of experience in ATT and per hectare crop production income. Also it shows that intensification of labour use which has been found to relate positively to ATT's experience leads to achievement of higher crop production income.

These results underscore the importance of recognising technological experience in any study on ATT. For, if the study had consisted of only newly adopting farmers, it would have been concluded that ATT has no significant effects on total crop production and income.

CONCLUSIONS

It is concluded from the analysis that the progression of years of experience with ATT leads to intensification of land use systems, enhancement of degree of motivation into the market economy, increases in total crop output and farm productivity resulting from decreases in cultivated areas. Hence, institutional and technical support that do accompany the introduction of such technologies should be structured to last for a relatively longer period to accomodate the learning process.

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Table I. Average household characteristics and land use systems by sub-sample in the study area, 1982/83

Characteristic	HHs	All ATHs	ATHs by years of experience		
			1 - 2	3 - 10	> 10
Number of persons	10.8 [33]	14.5** [35]	12.0 [37]	16.1*** [35]	15.5*** [28]
Number of adults (16-55 yrs)	3.7 [31]	6.1*** [44]	5.2* [45]	6.6*** [48]	6.5*** [40]
Age of household head (years)	49.3 [27]	59.0** [23]	51.4 [30]	62.9** [14]	62.7** [20]
Number of wives per household head	1.3 [67]	2.1** [44]	2.0 [53]	2.2* [52]	2.0 [47]
Literacy rate of HHM[1] (%)	8.5	9.2	5.2	9.9	12.3
Land use systems					
Total acreage (ha)	3.56 [60]	5.58*** [46]	5.53* [50]	6.73*** [40]	4.5 [41]
Acreage/adult (ha)	1.01 [61]	1.05 [56]	1.21 [67]	1.1 [24]	0.83 [66]
% of land under -cash crops -sole crops -crop mixtures	 19.1 19.1 80.9	 24.6 13.9 86.1	 17.9 5.4 94.6	 26.0 13.2 86.8	 29.9 25.1 74.9
Labour use per ha (ME-hr)	568 [29]	625 [38]	562 [32]	624 [37]	688 [41]
Total crop output per ha (Kcal)	2861 [26]	3327* [27]	3045 [22]	3287* [14]	3650* [35]
Net crop income per ha (C/ha)[2]	20831 [29]	26647*** [32]	22552 [30]	27851*** [18]	29537*** [39]

1/. Defined as proportion of household members (HHM) that have completed at least six years of primary education. Coefficient of variation in [parentheses]. 2/. C=cedi (in 1982, C2.75=US$1). HHs=hoe household; ATHs=animal traction household; ME-hr=man equivalent hour. Significant mean differences between ATHs and HHs are defined as follows: ***=P<0.01, **=P<0.05, *=P<0.10.

Table 2. Effects of animal traction experience and labour intensity on crop production income in the study area, 1982/83: Linear regression analysis.

Independent variable	Net crop production income[1]
Labour (ME-hr/ha)[2]	17.54 [4.76]*
Animal traction experience (in years)	403.15 [3.10] *
Constant	11006.80
No.of observation	42
F-Ratio	21.36*
R^2	0.52
Adjusted R^2	0.50

1/. Dependent variable is net crop production income in cedis per hectare (C/ha)
2/. ME-hr = man equivalent hour. Significant level *= P<0.01. Figures in [parentheses] are T-values.