Ox traction in a long-term perspective: policy implications of a socio-economic study in Ghana

by

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Abstract

Changes in the pattern of use of ox-traction technology in farming systems in northern Ghana are analysed. During the 1993/94 and 1994/95 cropping seasons data were collected in 42 households in three villages. The same households were visited during a study conducted in 1982/83; the same methods were used to ensure comparability.

Since the first study, patterns of adoption have changed substantially. The average proportion of farm area plowed by oxen has increased. However, the number of farmers actually owning oxen has decreased. This indicates that the rental market for animal traction has gained importance. These changes in adoption patterns can be attributed to changes in profitability. Recent findings show that utilisation of ox traction still results in a clear reduction in labour input requirements for crop production, especially in the amount of time spent on soil cultivation. However, a comparison of average physical and monetary productivities of labour and land did not show any statistically significant differences; this contradicts the earlier study. Other factors influencing the adoption pattern include changes in relative prices of farm inputs and outputs, increasing land scarcity, and obstacles to sustaining cattle herds including traditional inheritance laws.

The results of the survey indicate that rental markets are an important, but hitherto neglected, facet of animal traction adoption. Where farmers cannot expand their cultivated area rental markets are likely to be important in ensuring the profitability of animal traction.

Unlike the earlier investigation, this study did not find that animal traction increased yields per unit area. The impact of ox traction on sustainable land use needs to be monitored more closely to establish the cause-effect relationships, especially whether early yield advantages of ox traction reflect more rapid mining of soil nutrients.

Introduction: ox traction and the development of farming systems

The role of ox traction in the development process has been recognised widely. Adoption of the technology has been found to be closely related to its profitability. The profitability of the use of ox traction depends on the net cash flow derived from benefits realised by farmers due to changes in farm size, crop yields, labour costs, and income from hiring ox services, and costs including capital costs, cost of implements, costs of maintaining oxen and equipment, and hiring costs.

A number of authors have analysed the general economic impact of ox traction (eg Sargent et al, 1981; Kirk, 1984; Starkey, 1991; Strubenhoff, 1988; Pingali, Bigot and Binswanger, 1985; in this area Panin, 1988; Hailu, 1990; Runge-Metzger, 1993). Some general results include:

Ox traction allows adopters to save labour when carrying out tillage operations, weeding, and transport (ie increasing labour productivity and substituting labour with capital).

Where land is available, ox traction enables the expansion of farms, sometimes combined with increased cultivation of cash crops. This may lead to increases in farm income.

ox traction permits more timely plowing, sowing, and weeding; it can also improve ridge formation and seedbed preparation. As a result yields per hectare can be increased.

Within the same agroecological zone, the magnitude of these immediate determinants of profitability are influenced by:

population density

relative factor and product prices

institutional factors.

Population density

Boserup (1965) emphasised that agricultural mechanisation is affected by population density. She sees the shift from hand hoe to animal traction as the consequence of reduced fallow periods indicating increased land scarcity. Reduced fallow periods lead to a decline in soil fertility which can be offset by a higher labour input. Under such circumstances animal traction is adopted to increase labour productivity.

The effect of population density on the profitability of ox traction may not necessarily be linear. Increased population density is often associated with increased competition between land for cropping and land for animal feed. The consequences could be threefold. First, as Ruthenberg (1983) describes, the subsequent dangers of overgrazing and land degradation could reduce the potential yield advantages of ox traction. Second, the reduced availability of land may prevent farm expansion and so reduce the potential workload of oxen for traction. Consequently, there would be fewer economies of scale (McIntire, Bouzat and Pingali, 1992) and the costs of ox traction could only be reduced by hiring out (Runge-Metzger, 1991). Third, reduced availability of fodder tends to increase herd maintenance costs, since good pasture areas are increasingly scarce.

Prices and marketing

Hayami & Ruttan (1985) elaborated on the implications of relative price changes on the introduction of agricultural innovations that are closely interrelated with population growth and the growing intensity of land use. They found that the principal effect of population growth is to inflate the price of land relative to that of labour. In the absence of a growing non-farm labour market this would undermine the profitability of mechanisation.

The relative costs of farm implements to product prices have a direct impact on the profitability of ox traction. During the course of structural adjustment programmes input prices generally increase because in the past many African governments subsidised agricultural inputs heavily. However, it is also assumed that output prices increase because African governments tended to favour urban consumers. If trade is liberalised the overall effect therefore depends very much on the magnitude of subsidies at the various levels as well as the level of world market prices. Because of the potential impact of economic policies on relative prices, Lele & Stone (1989) argued that Boserup's hypothesis (Boserup, 1965) should be extended, and called for an inclusion of policies and incentives for explaining technological change.

Pingali, Bigot and Binswanger (1985) stressed the importance of market access and higher product prices. Usually it is assumed that with increased population growth road infrastructure improves, demand for transport increases, and so transport costs decrease. In addition, access to credit could be an important determinant for the introduction of ox-traction technology as the initial capital requirements for ox-traction owership are substantial.

Rental markets

An important feature of the adoption of mechanisation in smallholder farming systems are rental markets. Rental charges are likely to be high if farms are large (land is plentiful) and ox owners utilise the full capacity of the oxen on their own fields. If the net benefit of animal ownership decreases relative to renting costs, there is likely to be a shift from ownership of oxen to rental of traction services. This could occur if, for example, costs of herd maintenance increase due to disease or increasing fodder costs, or if crop production revenues decrease because of increasing land scarcity, decreasing yields per unit area or a decreasing ratio of output to input prices, or simply if actual rental charges decline or market transactions become cheaper.

At the level of the individual household, changes in adoption are related to the life-cycle of the households. One important institutional feature after the death of the head of a household is the prevailing customary law of inheritance of oxen, related assets and land.

In general, the theoretical remarks show that it is difficult to predict precisely the impacts of a changing socioeconomic environment on the adoption of ox traction. Therefore, empirical field studies, like the present one, are necessary to explore the relationships more closely. The objectives of this study are:

to identify the major changes in the pattern of adoption of ox traction over the past twelve years in Northern Ghana

to determine possible factors for changes in the pattern of adoption

to identify the implications of the empirical findings for the formulation of policies which facilitate the introduction of ox traction into the farming systems.

Background to the study area

The Guinean savanna zone of West Africa is predominantly grassland savanna with scattered trees, and is believed to have the highest agricultural production potential in West Africa. There is one rainy season that lasts from April to October with an average rainfall of about 1000 mm. The general infrastructure of the area is not highly developed. The introduction of modern farm practices has been regarded as a promising way of exploiting the agricultural potential of the area. However, since the introduction of such practices into the area during the 1950s, 1960s, and 1970s the socioeconomic environment has changed drastically. For instance, population growth has been above 3% in the study area (Government of Ghana, 1984a) so competition for land has increased gradually. In addition, Ghana's economy has undergone major changes since 1983, when the national economic policy was harmonised in accordance with the concepts of the World Bank and the International Monetary Fund (IMF). As structural adjustment measures were implemented, the exchange rate of the Ghanaian Cedi was liberalised, state-owned assets were privatised, and a substantial part of the labour force in the public sector was retrenched (Herbst, 1993). The availability of consumer goods and farm inputs in particular of all imported goods, has improved. Compared to non-food items the prices of food items in the country have declined (Commander, Howell and Seini, 1989; Government of Ghana, 1994b).

Such dramatic changes affect the adoption of modern farm practices; this paper discusses changes in the utilisation of ox traction in northern Ghana. Animal traction was introduced to farmers in northern Ghana in the early1930s by colonial authorities (Lynn, 1937) but was neglected immediately after independence because it was considered to be outdated and inappropriate. After tractorisation attempts failed in the 1960s and early 1970s, ox traction received new attention. Subsequently, new government and NGO projects were launched to support further diffusion of ox traction (Famiyeh, 1993; Herbst, 1993). Some of these projects ended in the early 1990s.

In Nakpanduri, the main village in the study area of Northern Ghana, the Ghanaian German Agricultural Development Programme (GGADP) worked from the late 1970s to the mid-1980s to improve the agricultural extension station in cooperation with the Ministry of Food and Agriculture (MoFA). Today, the structures still exist, but no practical work is carried out on the station. As part of the structural adjustment programme MoFA adopted new extension strategies (training and visit), and extension activities are now concentrating on farmers' fields. MoFA also stopped the subsidy and distribution of farm inputs. Ox-traction implements which used to be available at the station are no longer supplied by the agricultural extension services. Private traders have taken over the supply instead and ship the implements from a factory in Tamale (200 km south west) or private blacksmiths in Bawku (60 km north). The availability of farm inputs including ox-traction implements is thus ensured, but prices have become higher.

Panin (1988) compared households owning oxen to those not owning oxen. His findings from 1982/83, which serve as a reference situation for the present study, can be summarised as follows:

ox owning households were better equipped with land, labour and capital

cultivated area per active worker did not differ between ox owning and non-owning households

the area cultivated per active worker declined with the number of years of experience with the technology

farmers with more experience cultivated more cash crops

ox-owning households achieved higher yields per hectare. Ox traction was found to have a positive impact on the yields per hectare

labour requirements of ox-owning households and ox-cultivated fields were reduced

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ox-owning households achieved higher net farm incomes and cash incomes

the investment in ox traction technology was highly profitable

the provision of credit facilities was recommended, because the heavy cash outlays caused by the initial investment in purchasing oxen were identified as a major constraint of adoption.

Methods

In principle, long-term changes in adoption can only be investigated by a longitudinal study in the same communities and households. This paper presents preliminary results of such a panel study. Fieldwork was carried out in the Northern Region of Ghana from March 1993 to April 1995. The study covers 42 households in the three villages of Nakpanduri, Sakogu, and Gbinbalanchet in Gambaga District in the Northern Region of Ghana. Data were collected at village, household, and field level. The villages and households are identical to the ones studied in 1982/83 (Panin, 1987, 1988, 1989,1990). In 1982/83, the household sample was a stratified random sample consisting of 30 ox-owning households and 12 non-ox-owning households.

Direct measurement (record keeping), observation, formal and informal interviews were used for data collection. To achieve a maximum degree of comparability, it was attempted to employ the same methods as Panin (1987,1988,1989,1990) and Panin and de Haen (1989).

The dynamics of adoption patterns

A declining trend of ox ownership was confirmed by village census and informal interviews. In 1982, Panin (1988) found 20% of the households possessing oxen but ox ownership in all three villages declined to 16% within the last decade. However, this trend was not equal across the three study villages. In Gbinbalanchet an increase of 3% in the number of households possessing oxen was observed in 1994 as compared to 1982. On the contrary, the relative number of ox owners declined by 4% and 5% in Sakogu and Nakpanduri, respectively. Furthermore, the surveys show that within the original household sample of 42 households the actual

Table 1:Changes in proportion of farm area plowed with ox traction

	Number of housholds	*% of total population*	*Mean farm area (ha)*	*Area plowed with oxen*	
				ha	*% of farm area*
Non-ox-owning households					
1982/83	12	80	3.6	0.6	16
1993/94	28	84	2.7	1.0	36
Ox-owning households					
1982/83	30	20	5.6	4.2	75
1993/94	14	16	4.5	3.0	68
Estimate for total population[1]					
1982/83	–	–	4.0	1.3	32
1993/94	–	–	3.0	1.3	44

Notes:
1) Calculated on basis of total number of households (1982: 614; 1994: 1096 households) in the three villages studied.

Table 2: The impact of tillage technology on labour demand for various farming operations (times in work days per hectare)

	A) Hoe n=49		*B) Hired oxen n=77*		*C) Own oxen n=77*		*Total n=203*		
	Mean	*CV (%)*	*Mean*	*CV (%)*	*Mean*	*CV (%)*	*Mean*	*CV (%)*	*Significance*[1]
Clearing	6.1	91	5.5	106	8.8	128	6.9	121	AC, BC
Tillage	16.3	101	10.3	116	6.6	127	10.3	122	AB, AC, BC
Planting	14.1	112	9.0	96	10.9	122	11.0	115	AB
Weeding	26.4	136	16.1	92	20.9	132	20.4	128	AB
Harvesting	61.4	96	31.4	86	52.8	123	46.7	114	AB, BC
Applying fertiliser	0.1	509	0.1	708	0.1	724	0.1	659	
Other	–	–	0.8	105	0.6	160	0.5	130	AB
Total	**124.4**	**68**	**73.2**	**60**	**100.7**	**102**	**96.0**	**86**	AB, BC

Notes:
1) Letters represent columns which are significantly different at alpha=0.1 level using a Duncan test

number of ox-owning households dropped from 30 to 14 (-53%).

However, in 1993/94 the study revealed that a considerable number of farmers who did not possess oxen rented them. It was also observed that in some cases households that own oxen also plow fields by hoe. Ox ownership is only a simple index of technology adoption and the degree the technology is utilised at field level may be more revealing. The proportion of the total field area plowed by oxen is shown in Table 1.

The results of this comparison are surprising: while the non-ox-owning households increased the proportion of ox-plowed fields from 16% to 36% of their total farm area, ox-owning households reduced the ox plowed area from 75% to 68% of their total farm area. At the overall village level, the percentage of fields plowed with oxen increased, since non-ox-owning households represent the majority of households in the study area. It is estimated that the utilisation of ox traction increased from 32% to 44% of the total cultivated area, which is a relative increase of 35%.

Overall, the following non-uniform changes in the pattern of adoption were observed:

- in two out of three villages ox ownership declined in relative terms, while in one it has increased
- ox owners plowed a smaller proportion of their total farm area with oxen than they did in 1982/83
- non-ox owners hired ox-plowing services much more than in 1982
- overall, utilisation of ox traction has increased over the past decade.

Determinants of the changing pattern of adoption

As the data analysis is still in its initial stages only preliminary indications are presented which have to be interpreted with caution until a full model can be tested.

Impact on labour input

A total of 203 separate plots were analysed in order to identify the advantages of ox traction compared with those found by Panin (1988). Three groups of plots were compared: those tilled by hand hoes, those tilled by hired oxen and those

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Table 3: The impact of tillage technology on soil and labour productivity

	A) Hoe n=49		*B) Hired oxen n=77*		*C) Own oxen n=77*		*Total (A+B+C) n=203*	
	Mean	*CV (%)*	*Mean*	*CV (%)*	*Mean*	*CV (%)*	*Mean*	*CV (%)*
Yield (kg/ha)	3,706	132	3,526	172	4,549	158	3,957	158
Returns (Cedis/ha)[1]	150,567	107	146,241	140	195,618	139	166,243	135
Variable costs (Cedis/ha)								
Seed	6,150	110	4,993	110	6,291	134	5,765	122
Fertiliser	2,054	438	509	809	625	877	926	660
Hired labour	7,065	215	7,084	176	4,312	218	6,028	202
Hired bullocks	–	–	3,453	181	–	–	1,310	320
Interest[2]	1,527	117	1,604	117	1,123	140	1,403	131
Gross margin (Cedis/ha)	133,771	123	132,051	123	183,268	147	152,122	149
Gross margin (Cedis/workday)	1,367	126	1,595	126	2,281	164	1,803	155

Notes:
None of the columns differed significantly (Duncan test at alpha=0.1 level)
1) In 1994 US$1=1100 Cedis
2) assumed to be 10% for 6 months

tilled with the farmer's own oxen. One of the striking characteristics of ox traction was its ability to reduce the workload for the farmer at times of labour peaks, for example during tillage. Table 2 shows a comparison of the amount of labour spent on different farming operations in 1993/4.

The saving in labour occured with hired as well as with owned oxen. Plots which were ridged by hoe also had a higher input of labour for most of the other operations. This might be due to economies of scale because the average size of hoe plowed plots is significantly smaller (0.38 ha) than for those plowed by hired or own oxen, which are 0.43 ha and 0.6 ha, respectively. The coefficients of variation of the figures are rather high; this is probably due to pooling of plots across different crop enterprises and land-use intensities.

Economics of ox traction

In a first, rather simple, approach the economic performance is compared by calculating average factor productivities in physical and monetary terms for the three groups of plots plowed with different tillage technologies. Table 3 shows that neither soil productivity nor labour productivity show any statistically significant difference depending on the tillage technology.

This result is substantially different from Panin's observations in 1982/83, which indicated a significant increase in yields with bullock traction. If consistent, it will certainly have a major negative impact on the profitability of investment in ox traction and hence discourage its adoption. In addition, this result means that it cannot be assumed that ox owners are able to maintain a higher degree of soil fertility. However, results have still to be interpreted with caution as yields

and other factor productivities depend also on factors others than the tillage technique. These relationships will be analysed in more detail by production function analysis.

Population growth

One major influence on patterns of ox ownership is population growth, which affects the profitability of keeping oxen for traction. In particular, limitations on land availability directly affect the benefits of ox-traction ownership. As shown in Table 1 the mean farm size of ox owners declined by 20% between 1982 and 1993. This could mean that oxen cannot be employed fully by their owners on their own fields. Limited land availability has apparently facilitated the rapid expansion of rental markets for ox services.

However, population growth was not equal in the three study villages. The growth rate of 2.8% per annum in Gbinbalanchet was low compared to an average of 5.3% per annum for all the villages. As a result land scarcity is likely be less of a problem compared to the other villages. For these reasons, ox owners in Gbinbalanchet engaged their animals primarily on their own fields and were unwilling to hire them out. However, the situation in this village is exceptional as the rate of population growth was low due to violent ethnic conflicts at the end of the 1980s.

Changes in relative prices

Relative prices of inputs and outputs have changed dramatically since 1983. The ratio of output prices to agricultural input prices has declined (Runge-Metzger, 1993), ie farming is less profitable. The people in the study area also reported an increasing number of incidents of cattle theft. Farmers perceive cattle ownership to be more risky than a decade ago; this is negatively affecting the benefits expected from ox traction. Both of these factors tend to discourage farmers from investing in ox traction and may explain part of the stagnation in ox ownership that was observed in the two villages.

Cultural factors

In some cases, traditional inheritance rules clearly jeopardised the sustainability of cattle ownership within a household. According to observations, if a head of household passes away his closest senior male relative becomes the trustee of all the household's cattle. He is supposed to keep the cattle for the benefit of the family clan. This is a much larger social unit than the household. Traditionally, cattle have an important function in the social security of the extended family. In emergency an animal of the family herd is supposed to be made available for sale to generate funds, for example for paying hospital bills. All clan members are entitled to this kind of traditional social support. The magnitude of the support is often subject to difficult negotiations. Remarkably, trained oxen suitable for traction are treated in the same way as ordinary cattle. In other cases, relatives of a deceased person were not in agreement on the mode of redistribution of cattle among the members of the family clan. In particular, when the number of disposable oxen is rather small, the animals are likely to be sacrificed and consumed at the event of the funeral. As can be seen from these examples, inheritance rules can have a major impact on the pattern of adoption of ox traction at the level of individual households.

Implications for agricultural policy

The direct benefits, population growth, relative prices and cultural factors discussed in this paper all contributed to some extent to the changes in the pattern of adoption of ox traction that was observed in northern Ghana. However, many other factors are likely to be imprtant. Although the situation has not yet been analysed in detail, some preliminary conclusions will be drawn with respect to the formulation of policies facilitating the introduction of ox traction into the farming systems in northern Ghana.

Farmers in the study area generally perceived ox traction as a potential method of improving crop production. For example, ox traction enabled farmers to reduce the labour burden of farm work. However, adoption of ox traction technology does not necessitate ox ownership by all farmers. Whereas the number of farmers owning oxen dropped on the average, the area plowed with oxen increased significantly. This finding generally helps to arrest fears that during the implementation of structural adjustment programmes, or due to rapid population growth resulting in smaller farm sizes, rates of adoption of agricultural technologies might be declining. On the contrary, scarce resources seem to be used more wisely.

So far, the potential of rental markets for further development of animal traction has been neglected

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by agricultural research and extension in Ghana. Very little is known about the advantages of this kind of market transaction. The renting of animal traction services has advantages compared to ownership: there are no learning costs for farmers who rent, there is less pressure on limited cash resources, and rental payments might be organised in accordance with local arrangements, for example, the provision of informal credits in kind. Moreover, if farmers cannot expand their farms it would probably not be economical to adopt ox traction. Under these circumstances, calls for formal credit schemes and programmes for purchasing oxen and implements seem to be justified only on a limited scale and when rental markets evolve at the same time. In addition, local potential for improved utilisation of oxen should be explored more intensely.

The yield advantages of ox traction reported by a previous study can no longer be observed in the study area. If these preliminary findings are confirmed by a more detailed analysis, the impact of ox traction on sustainable land use needs to be monitored more closely to establish the cause-effect relationships. In particular, investigations should study whether early yield advantages of ox traction reflect a more rapid mining of soil nutrients.

The effects of cultural rules for inheritance of cattle on the adoption of animal traction have been neglected. More detailed analysis of this aspect is necessary before definite policy conclusions can be drawn.

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