ECONOMIC GROWTH AND ANIMAL TRACTION DEVELOPMENT IN AFRICA: AN EMPIRICAL ANALYSIS

by

A. Panin

Botswana College of Agriculture (BCA)
Department of Agricultural Economics, Extension & Education
Private Bag 0027, Gaborone, Botswana.

ABSTRACT

Since the introduction of animal traction technologies (ATT) in many Sub-Saharan Africa (SSA) countries, attempts to propagate its widespread use in the continent have suffered several setbacks. Many factors are responsible for this. However, developments in the African economies are believed to be a prominent factor. This study provides empirical evidence of the impact of economic growth on the performance of ATT in Sub-Saharan Africa (SSA). The analysis uses 1971-1990 time-series data on ATT from Botswana. The performance of ATT is measured on the basis of changes in the total number of households using this technology in any particular year covered under this study. The models used, are a regression model and a trend projection model. Although the regression model is representing a simplified view of the relationship between ATT and economic growth, it takes account of the influence of annual amounts of rainfall.

It is concluded that economic growth has had a negative impact on the performance of ATT in Botswana. As the country's Gross Domestic Product (GDP) steadily increased over the period of the analysis, the number of households using ATT declined at a rate of 2.5% per year. The impact of the GDP on ATT was directly associated with increases in the use of tractor, food imports and beef exports. The results have serious policy implications for agricultural development in many African countries that are not capable of sustaining their economic growth.

Key words: Animal traction, economic growth, development, Africa

INTRODUCTION

Animal traction technology (ATT) was introduced into many African countries over several decades ago (Sargent et al., 1981; Munzinger, 1982). For example, its introduction in Ethiopian farming systems dates back as far as thousands of years ago (Goe, 1987; Panin and Brokken, 1992). Also in some Northern African countries they have been used for centuries, sustained by traditional services. In countries such as Botswana, Kenya, Madagascar and South Africa, ATT was introduced just before the beginning of the present century (Pingali et al., 1987). ATT's introduction in many parts of West Africa began in the early 1900s (Jaeger, 1986). It started in Mali around 1925, Sierra Leone, 1928, Ghana, 1934, Senegal, 1935, Gambia, 1955 and in Nigeria towards the end of 1950 (Mettrick, 1978; Lassiter, 1982; Sargent et al., 1981; Munzinger, 1982; Panin, 1988).

Though, ATT has a relatively long history in SSA, most animal traction projects have suffered a severe blow, particularly, after the colonial era. However, in recent years, interest in the use of ATT in SSA has been rekindled (Panin, 1994). This is believed to be a combined result of bad experience with tractor mechanization that received major support immediately after the colonial period (Panin, 1995) and the increasing deteriorating economies of most SSA countries. in the continent. The renewed interest in ATT has prompted many governments and international donor organizations to expand animal traction-related programmes. In spite of this effort, ATT's adoption rates as observed in many African countries have been sporadic and uneven over the years. Only 15% of total arable land in SSA is being cultivated with ATT. Also ATT accounts for only 10% of the total power use in the region (FAO, 1987; Panin and Ellis-Jones, 1994).

Many factors may contribute to the overall low level use of ATT in SSA countries, it is believed that the developments in SSA economies are very crucial in the context of long-term sustainability of ATT in the region.

The main objective of this study is, to investigate the overall performance trend of ATT in developing African economies, and to quantify the extent at which economic growth and other crucial factors have affected ATT's performance. The performance of ATT is measured on the basis of changes in the total number of households using this technology in any particular year covered under this study.

METHODOLOGY AND SOURCES OF DATA

Methodology

Two empirical models are developed in this analysis. The first one is purely for forecasting purposes. It is aimed at examining the trend in performance of ATT over 1971-1990. The other one specifically focuses on the response of ATT's performance to an economic growth.

1. The trend projection model

A critical examination of the time series data on the performance of ATT over the period 1971/90 revealed that the data exhibit a long term linear trend. As such we assume that it is the linear trend function that would provide the best fit to the data. The empirical equation for ATT's trend function is specified in log-linear form since we were interested in knowing the relative change in ATT's performance over the specified period. The functional form is expressed as follows:

(1) $\ln T_t = b_0 + b_1 t + u_t$

where T_t = trend value for ATT's performance in period t; b_0 = intercept of the trend line; b_1 = slope of the trend line; t = time in years; and u_t = error-term

2. Response Model of ATT's Performance

The second model constructed in this analysis is specified to relate the response of ATT's performance to economic growth over the specified period. However, an annual rainfall amount is incorporated. Other factors such as the number of tractor-using households, total food imports, and total beef exports which are also assumed to have a considerable bearing on ATT's performance had to be excluded from the specified model to prevent multicollinearity.

The empirical equation used for the response of ATT's performance in Botswana to the selected independent variables is specified in log-linear form as:

(2) $\ln Y_t = \ln a_o + a_1 \ln X_{1t} + a_2 \ln X_{2t} + e_t$

where Y_t = number of animal traction using households expressed per 1000 persons in year t,; X_{1t} GDP per capita (in Pula) in year t; X_{2t} total annual rainfall (in mm) and e_t is a disturbance -term summarizing the influence of time series related unobserved factors. in year t. Both equations 1 & 2 were estimated using the ordinary least-squares (OLS) method.

Data Sources

The study uses 1971-1990 time-series data on ATT from Botswana. Botswana was selected as a case study because it is one of the few countries in SSA with a long history with ATT and at the same time has been experiencing an impressive economic growth over the past two decades. Data collected covered the number of households using animal traction as well as those using tractors for ploughing, GDP per capita, quantity of livestock exported, quantity of food imports, and amount of annual rainfall. The sources of the data are published documents from ministries of Agriculture, Finance & Development Planning (Government of Botswana), and the Food and Agriculture Organization (FAO).

RESULTS AND DISCUSSION

The Trend Model

Table 1 shows results for the estimated linear trend model for ATT's performance in Botswana.

Table 1. Estimated Coefficients of ATT's Performance[1] in Botswana, 1971-1990

Independent variable	Estimated coefficient
Time (year)	-0.0249 [-6.922]***
Intercept	59.5316 [8.362]***
F-value	47.918***
R^2	0.71

1/. The dependent variable is the log of number of households using animal traction technologies. Figures in parentheses are 't' values. *** = significant at 1% level

The parameter estimates of the derived equation, $\ln T_t = 59.53 - 0.025\ Time$, are satisfactory on both theoretical and statiscal grounds. The statistical fit of the equation is acceptable as indicated by the R^2 and F statistic. The results imply that for the period 1971-1990, the number of animal traction using households was reducing at the rate of 2.5 percent per year while the economy of the country steadily increased at the same time. It is estimated that in real terms GDP growth in Botswana averaged around 13% per annum since 1982 (IFAD,1992).

The Response Model of ATT's Performance

The parameter estimates and statistical measures for the ATT's response model are presented in Table 2. All the regression coefficients are significantly different from zero at or above the 5 percent level, and they carry signs which are consistent with theoretical expectations. As indicated by the F-value and R^2, the goodness of fit of the model is acceptable.

Table 2: Regression estimates of ATT's response model[1], Botswana, 1971-1990

Independent variable	Estimated coefficients
Gross Domestic Product	-0.2289 [-8.561]**
Annual Rainfall amount	0.2644 [2.753]***
Intercept	0.8870 [3.42]***
F-value	56.45***
R2	0.87

1/. The dependent variable is the log of number of households using animal traction technologies. Figures in parentheses are 't' values. ***, ** = significant at 1% and 5% level respectively.

The high R^2 value of 0.87 implies that 87% of the variation in ATT's performance is explained by changes in economic growth and those in annual rainfall amounts. While economic growth led to a decreased in ATT's performance, increased amounts of annual rainfall encouraged more households to use ATT. The estimated coefficient of GDP is -0.229 ($P < 0.05$) and it is 0.264 ($P < 0.01$) for rainfall.

The established negative relationship between ATT's performance and economic growth is plausible for various reasons. First, with a growing economy, the government can afford to subsidize some activities of the farmers. It has been observed that most African governments try to substitute tractor for ATT or to complement its use. Botswana is not an exception to this practice. Currently the government is providing grants to farmers in the form of tractor hiring schemes (Panin, 1995). This practice leads to a situation where some smallholder farmers abandon the use of ATT.

As shown in Table 3, the number of tractor-using households is positively correlated to GDP (r = 0.9702) and negatively to animal traction-using households. This indicates that economic growth encourages the substitution

of tractor mechanization for ATT. A similar situation has been observed in other African countries. For example, in the early 1960s, the government of Ghana placed more emphasis on the use of tractor farming technology by importing thousands of tractors into the country and thereby neglected the traditional sector based mainly on hoe and cutlass technology farming (Panin, 1981). This was possible due to the healthy economy of the country at that time. Also in Nigeria, after the first oil boom of 1973/74, which significantly increased the government's revenues, the government imported a lot of crawler tractors, agricultural tractors and complementing agricultural machinery for establishment of land clearing units (Makanjoula et al. 1990).

Table 3: Results of Correlation Analysis of ATT Performance and some selected variables

ATT	1					
Rainfall	0.552	1				
Tractor power	-0.834	-0.472	1			
GDP/capita	-0.902	-0.368	0.857	1		
Food imports	-0.870	-0.441	0.913	0.970	1	
Beef exports	-0.809	-0.259	0.721	0.874	0.801	1
	ATT	Rainfall	Tractor	GDP	Food Im	Beef Ex

Note: all coefficients are significantly different from zero at or above 5 percent level

Furthermore, the positive correlation between economic growth and food imports (r=0.972)(Table 3) implies that the two variables move in a tandem suggesting that as the country's economy has been growing, food imports have been on the increase at the same time. This also serves as disincentive to farmers to grow food crops. Because in most instances, the imported food tends to be cheaper than the local produced food since the prices of the former are usually subsidized. As a result the use of ATT loses its importance.

As can be seen from Table 3, beef exports relate negatively to ATT (r = 0.810). The use of ATT in Botswana depends mainly on the availability of cattle. As observed in the country, since the establishment of Botswana Meat Commission (BMC) - a quasi-government parastatal in charge of livestock marketing in the country, the prices offered to farmers for the sales of their cattle by the commission have been more attractive than returns from arable farming. Some farmers, therefore, go to the extent of selling their trained oxen to the BMC than maintaining the cattle for crop production purposes

The results presented in Table 3 , reveal a positive relationship between rainfall and ATT's performance. This relationship emphasizes the point that rainfall is a major determining factor for arable farming. With good rainfall, more feed become available to sustain the draught animals and also farmers expect higher yields and higher farm incomes. This leads to an increased use of ATT. Botswana has experienced several severe droughts during the period under study. One strategy commonly adopted by the smallholder farmers to avoid any devastating effects on their livestock herd and also to maintain their subsistence level is to sell the animals. This can be inferred from the correlation matrix (Table 3) which reveals a negative correlation between rainfall and beef exports (r= -0.26). An indication of the fact that with relatively good average rainfall, more cattle will be kept on the farm rather than selling to the BMC.

CONCLUSION

The study concludes that economic growth impacts negatively on the performance of ATT. This will likely have some serious repercussions on the sustainability of ATT in the smallholder farming systems in Africa. It is important, therefore, to encourage the wide use of ATT and its sustainability among smallholder farming systems in Africa. Because by considering the chaotic economic situations in most African countries, the characteristics of the farming systems, and the level of skill required for ATT's operation, ATT is currently an appropriate technology. The consequence of its declining use will be severer for smallholder farmers living in fragile economies that cannot afford to purchase and maintain tractors.

REFERENCES

Goe, M.R. (1987). Animal traction on smallholder farms in the Ethiopian Highlands. Ph.D.Dissertation. Department of Animal Science, Cornell University, Ithaca, New York, USA.

FAO (1987). African agriculture: the next 25 years. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

IFAD (1992). Identification Report, Botswana.The International Fund for Agricultural Development (IFAD), Rome, Italy.

Jaeger, W.K. (1986). Agricultural mechanization: The economics of animal draft power in West Africa. Westview Press, Inc.; Praeger Publisher, Boulder, Colorado.

Lassiter, G.C. (1982). The impact of animal traction on farming systems in Eastern Upper Volta. Ph.D. Dissertation. Department of Agricultural Economics, Cornell University, Ithaca, New York, USA.

Makanjoula, G.A.; Abimbola, T.O. and Anazodo, U.G.N.(1990). Agricultural mechanisation policies and strategies in Nigeria. In: Mrema G. C. (ed), Agricultural mechanisation policies and strategies in Africa. Proceedings of the workshop held at the Institute of Agricultural Research, Ahmadu Bello University, 13-17 August 1990, Zaria, Nigeria. Food Production and Rural Development Division, Commonwealth Secretariat, London, UK. 313p.

Mettrick, H. (1978). Oxenization in the Gambia: An evaluation. Ministry of Overseas Development, London.

Munzinger, P. (1982). Animal traction in Africa. GTZ Schriftenreihe, Bd 120, Eschborn, Germany.

Panin, A. (1981). Agraprobleme und Agrarpolitik von Ghana seit 1957: Konzepte, Methoden, Ergebnisse und Kritik. Diplomarbeit, Institut fuer Agraroekonomie, Universitaet Goettingen, Goettingen, Germany.

Panin, A. (1988). Hoe and Bullock Farming Systems in Northern Ghana: A comparative socio-economic analysis. Joseph Magraf Publishers, Langen, Germany, 182 pp.

Panin, A. (1994). Animal traction and sustainability of deyland farming systems in Africa. *Agricultural mechanization in Asia, Africa, and Latin America* , 25 (3):67-73.

Panin, A. (1995). Empirical evidence of mechanization on smallholder crop production systems in Botswana.Agricultural Systems, 47, 192-210.

Panin, A. and Brokken, R. (1992). Effects of alternative animal traction systems on farm output and income for smallscale farmers in the Ethiopian Highlands. *Quarterly Journal of International Agriculture*, 31 (2):162-174.

Panin, A. and Ellis-Jones, J. (1994). Increasing the profitability of draught animal power. pp 94-103 in: Starkey, P., Mwenya, E. and Stares J. (eds), Improving animal traction technology. Proceedings of the first workshop of the Animal Traction Network for Eastern and Southern Africa (ATNESA) held 18-23 January 1992, Lusaka, Zambia. Technical Centre for Agricultural and Rural Cooperation (CTA), Wageningen, The Netherlands. 490p.

Pingali, P.L., Bigot, Y. and Binswager, H. P. (1987). Agricultural mechanisation and the evolution of farming systems in sub-Saharan Africa. John Hopkins University Press, Baltimore, Maryland, USA.

Sargent, M., J. Lichte, P. Matlon and R. Bloom (1981). An assessment of animal traction in Franco-phone West Africa. East Lansing, michigan State University, Dept. of Agr. Eco., African Rural Economy Working Paper No. 34.