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IMPACT OF ANIMAL TRACTION ON AGRICULTURAL PRODUCTION AND FARM INCOME IN SOKOTO STATE, NIGERIA

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ABSTRACT

The impact of the Work-Oxen Credit Model 36 of the Second Pilot Livestock Development Project on resource use, crop yield, crop output, and farm income was examined. Data collected from 25 randomly selected beneficiaries and 25 non-beneficiaries were analysed using descriptive statistics and farm budgeting. The beneficiaries cultivated larger farm areas and used more chemical fertilizer than the non-beneficiaries. There was no significant difference in crop yield between the two categories of farmers, but the total crop output was significantly higher ($P<0.01$) for the beneficiaries. The total net income realised by the beneficiaries was also significantly higher ($P<0.01$). It was, therefore, concluded that the credit model has made positive impact on resource use, agricultural output and farm income.

Keywords: Animal Traction; Agricultural Production; Income; Sokoto

INTRODUCTION

Depending on the power source, three levels of mechanization can be distinguished in agricultural production. At the first level, power is supplied by human labour while at the second, power is supplied by draught animals. The third level of mechanization is characterised by the use of tractors and other engine-powered machines for accomplishing farm operations. The level of mechanization employed could affect agricultural output and farm income obtained by farmers.

Nigeria is largely at the first level of mechanization with manual labour contributing up to 90% of total power input in agriculture (Musa, 1990). According to Baba and Rikin (1998), this high dependence on manual labour places a premium on the farm size a farmer and his family could effectively maintain and has negative implications for agricultural output and farm income.

In apparent recognition of the short-comings of manual labour, other levels of mechanization have been explored in Nigeria. During the 1970s, the mechanization policy thrust was directed at tractor mechanization (third level) leading to massive importation of tractors. However, high costs of tractors, mismanagement, spare parts and maintenance problems, as well as incompatibility with the environment and the prevailing farming systems, led to the failure of the tractor mechanization policy (Musa, 1990).

Probably due to the failure of the tractorization schemes in Nigeria, coupled with the dwindling revenue from oil, attention appears to be shifting towards the second level of

mechanization - animal traction (Baba and Mohammed, 1996). Animal traction, as a farm power source, is not entirely new to Nigeria; its first introduction dates as far back as 1922. Its spread was, however, curtailed by the shift in policy towards tractor mechanization in the 1970s. With the current attention animal traction is receiving, it is likely that its popularity among farmers, particularly those in northern Nigeria, will increase.

The potential benefits of animal traction in the farming systems of northern Nigeria have been adequately documented (Musa, 1990; Suleiman, 1990; Kaufman and Blench, 1990; Mijindadi, 1990; Baba and Mohammed, 1996). Baba and Rikin (1998) have summarised the potentials of animal traction as follows:

- animal traction requires less foreign exchange than tractors,
- it allows farmers formerly using manual labour to increase their farm sizes,
- it is less expensive than tractors,
- it enables the farmer to increase his revenue base by hiring out of draught animals,
- the animals could be slaughtered for meat or sold at the end of their useful life, and
- the animals enrich the soil with farm yard manure while they feed on crop residue.

Notwithstanding the numerous advantages of animal traction, it has been argued that their widespread adoption could encounter difficulties because of the inability of small-scale farmers to afford draught animals and the requisite implements (Bolaji, 1990; Suleiman, 1990). Although it has been observed that it is less expensive than tractors, the financial burden of adopting animal traction is still above what the average small-scale farmer could afford. Therefore, financial assistance in the form of credit to farmers, has to be treated as an integral part of the animal traction package.

The Second Pilot Livestock Development Project (SPLDP) in Sokoto State appears to have realised the significance of credit in animal traction adoption and introduced the Work Oxen Credit Model 36 in 1994.

The Work Oxen Model 36

With financial support from Federal Ministry of Agriculture and Sokoto State Government, the Work Oxen Model 36 was implemented by the SPLDP, in collaboration with the Nigerian Agricultural and Cooperative Bank (NACB). Thirty-six farmers were provided with credit in cash (₦ 16,000.00) and kind (₦ 12,060.00) making a total of ₦ 28,060.00. The amount disbursed in kind included ox-plough (N2,550.00), ox-ridger (₦ 4,650.00), ox-cart (₦ 3,500.00), cotton seed cake (₦ 984.00), Molasses (₦ 250.00), and salt lick (₦ 105.00). The farmers were not required to provide collateral but had to provide two guarantors. They were also not required to make mandatory financial contribution but were to pay 16% interest on the loan. All the loan was disbursed at the beginning of the project and the loan had three-year repayment period with one year grace. The farmer had to be a Nigerian and must produce tax-clearance certificate in addition to being introduced by other farmers who were already beneficiaries of the project.

The objectives of the Model are to increase food production by increasing the sizes of farms and to increase farm incomes. Although the Model was introduced in 1994,

no attempt has been made to evaluate its impact on agricultural production and farm incomes. This study attempts to bridge this gap in knowledge.

METHODOLOGY

The Study Area

The study covered Bodinga, Kware, Dange-Shuni, Wamakko and Yabo Local Government Areas (LGAs) of Sokoto State. The LGAs are located in the northern part of the State within latitudes 12°-14° N and longitudes 5°- 6° E. The climate of Sokoto State is semi-arid with mean annual rainfall and temperature of about 550 mm and 34.9° C, respectively. Most of the rain falls in July and August although the rainy season may last from May to September. Vegetation of the State is typically Sudan savanna, although in some areas the Sahel type may also be found.

Arable and livestock farming are the major occupations in the area. Major upland crops include millet, sorghum and cowpea, while cotton, groundnut and sweet potato are grown as minor crops. Vegetable crops such as onion, tomato, pepper, garlic and eggplant are grown in the *fadama*, in addition to rice. Livestock raised consists of cattle, sheep, goats, donkeys, camels and horses.

Sampling Procedure

The sampling procedure adopted was dictated by the location of the 36 beneficiaries of the Work Oxen Model who were scattered across many LGAs in the State. From the list provided by the SPLDP, 25 beneficiaries of the Model were randomly selected for the study. The selected farmers were distributed over 10 villages in five LGAs in the State. A corresponding number of non-beneficiaries was also randomly sampled from each of the 10 villages to permit paired-comparison of the variables of interest between beneficiaries and non-beneficiaries. The total sample size was, therefore, 50 farmers. The distribution of the sampled farmers according to villages and LGAs is presented in Table 1.

Data Collection and Analysis

Data for the study were collected in a field survey conducted by the authors and trained enumerators during the 1997/98 cropping season using pre-tested questionnaires. Data were collected on farm sizes, cropping patterns, labour use, seed and fertilizer input, amount of loans received, costs of bulls, feeds, implements, tools and veterinary care, value of principal and interest payments on loans, crop yields and revenue received.

The data were analysed using descriptive statistics, student T test of statistical significance and farm budgeting. The farm budgeting was used to determine net farm income of respondents. Three categories of net income were computed. These include net farm income per hectare (NFI/ha), net hiring income per farmer (NHI) and total net income per farmer (TNI). The NFI/ha is the net income realised from one hectare of cropping activities, while the NHI is the net income obtained from hiring out work animals. TNI is NFI/ha multiplied by average farm size and then added to the NHI.

Table 1: Distribution of respondents according to local government arears and villages.

LGA	Village	Beneficiaries	Non beneficiaries	Total
Bodinga	Bodinga	1	1	2
	Milgoma	3	3	6
Dange/Shuni	Gala Kanwa	1	1	2
	Dange	2	2	4
	Shuni	1	1	2
Kware	Kware	5	5	10
	Runji	4	4	8
Wammako	Kassarawa	2	2	4
Yabo	Kilgori	1	1	2
	Yabo	5	5	10
Total		25	25	50

RESULTS AND DISCUSSION

Resource Use

Information on farm sizes in Table 2 shows that the beneficiaries cultivated an average of 4.92 ha as compared to the 2.34 ha cultivated by the non-beneficiaries. This shows an increase of 110.26% in area cultivated by the beneficiaries over the non-beneficiaries. This confirms the commonly held view that one of the important benefits of switching from manual labour to animal traction is that it enables farmers to increase their farm sizes (Mathewman *et al*, 1990; Baba and Rikin, 1998). It is perhaps, the desire for larger farm areas that encouraged more beneficiaries (36%) to hire additional land for cultivation than the non-beneficiaries (8%).

Inorganic fertilizer was used by 96% of the beneficiaries but only 56% of the non-beneficiaries used the input. Average levels of fertilizer use presented in Table 2 shows that beneficiaries used an average of 52.60 kg/ha while the non-beneficiaries used 24.16 kg/ha, indicating a significant increase ($P<0.01$) of 117. 7% for beneficiaries over non-beneficiaries. The Table also reveals that beneficiaries spent more on seeds than non-beneficiaries.

Table 2 also shows that the beneficiaries used an average of 33.10 man-days/ha which is significantly lower ($P<0.01$) than the 59.10 man-days/ha used by the non-beneficiaries. Therefore, the use of animal traction has reduced labour use by 43.99%. Table 3 shows that the highest reduction in labour utilization was observed in land preparation where beneficiaries used 12.9 man-days/ha less than the non-beneficiaries.

This is not unexpected given that animal traction was used to replace human labour only in land preparation by the beneficiaries.

Table 2: Average levels of input use

Input	Beneficiaries		Non-beneficiaries		t-value
	Mean	SD	Mean	SD	
Land (ha)	4.92	3.47	2.34	1.29	5.49*
Labour (man-days/ha)	33.10	7.47	59.10	17.41	10.41*
Fertilizer (kg/ha)	52.60	18.92	24.16	26.63	4.32*
Seed (naira/ha)	487.24	277.05	823.43	352.77	3.72*

+SD = standard deviation; * = Significant at P<0.01
Source: Field survey, 1997/98

Both family and hired labour were used by the two categories of respondents although family labour use was more common. Harvesting consumed the highest proportion (34.40%) of total labour used by the beneficiaries, followed by weeding (31.40 %) and land preparation (19.30%). In the case of the non-beneficiaries, however, land preparation used the highest proportion (32.70%) of total labour, followed by harvesting (29.80%) and weeding (21.70%).

Table 3: Labour use according to farm operations (man-days/ha)

Operation	Beneficiaries				Non-beneficiaries			
	Family	Hired	Total	%	Family	Hired	Total	%
Land preparation	3.4	3.0	6.4	19.3	15.4	3.9	19.3	32.7
Planting	1.6	0.0	1.6	4.8	3.0	0.0	3.0	5.1
Weeding	5.3	5.1	10.4	31.4	9.0	3.8	12.8	21.7
Fertiliser application	1.2	0.0	1.2	3.6	2.5	0.0	2.5	4.2
Harvesting	7.5	3.9	11.4	34.4	11.7	5.9	17.6	29.8
Threshing	1.1	0.0	1.1	3.3	2.0	0.0	2.0	3.4
Winnowing	1.0	0.0	1.0	3.0	1.9	0.0	1.9	3.2
Total	21.1	12.0	33.1	100	45.5	13.6	59.1	100

Source: Field survey, 1997/98

Cultural Practices and Cropping Patterns

Land preparation (ploughing and ridging) was the only operation accomplished by the beneficiaries through animal traction. The animals were worked for an average of 4.8 hours a day usually in the morning, although a few beneficiaries (13.64%) worked their animals both in the morning and late afternoon. All the other operations were accomplished manually using simple tools such as cutlasses and hoes. For non-beneficiaries, all operations from land preparation to harvesting were accomplished manually using simple tools.

Table 4 shows that all beneficiaries and non-beneficiaries grew millet/sorghum/cowpea mixture. Millet/sorghum mixture was grown by 36% of the beneficiaries and 24% of the non-beneficiaries. Eight percent and 4% of beneficiaries and non-beneficiaries, respectively, grew sorghum/cowpea mixture, while 4% and 12% combined millet with cowpea. Sole sorghum was grown by 12% of the beneficiaries and 4% of the non-beneficiaries. Only 4% of the non-beneficiaries grew sole millet and none of the respondents grew sole cowpea. The respondents claimed that they grew crops in mixtures because the income realised was higher than what could be obtained under sole cropping.

Table 4: Distribution of respondents according to crop enterprises

	Beneficiaries		Non-beneficiaries	
Enterprise	Freq.	%	Freq.	%
Millet	0	0.00	1	4.00
Sorghum	3	12.00	1	4.00
Cowpea	0	0.00	0	0.00
Millet/sorghum	9	36.00	6	24.00
Millet/cowpea	1	4.00	3	12.00
Sorghum/cowpea	2	8.00	1	4.00
Millet/sorghum/cowpea	25	100.00	25	100.00
Total*	40	160.00	37	148.00

*Total of frequencies and percentages may be greater than 25 and 100, respectively, due to multiple responses

Source: Field survey, 1997/98

Evidently, millet/sorghum/cowpea mixture was the most widespread in terms of number of farmers. It was also the most predominant in terms of land area, accounting for

90.07% and 89.57% of the total area cultivated by the beneficiaries and non-beneficiaries, respectively (Table 5).

Table 5: Land areas devoted to various enterprises (ha)

	Beneficiaries		Non-beneficiaries	
Enterprise	Area (ha)	% of total	Area (ha)	% of total
Millet	0.00	0.00	0.50	0.85
Sorghum	1.95	1.59	0.50	0.85
Cowpea	0.00	0.00	0.00	0.00
Millet/sorghum	8.50	6.92	2.75	4.70
Millet/cowpea	1.00	0.81	1.75	2.99
Sorghum/cowpea	0.75	0.61	0.60	1.03
Sorghum/Millet/ cowpea	110.70	90.07	52.40	89.57
Total	122.90	100.00	58.50	100.00

Source: Field survey, 1997/98

Crop Yield

The analysis of crop yield was conducted for the millet/sorghum/cowpea mixture which was the most predominant. The yields of the three crops in the mixture are presented in Table 6 which shows that beneficiaries obtained an average millet yield of 389 kg/ha while the non-beneficiaries obtained 332 kg/ha. Sorghum yield of 221 kg/ha and 249 kg/ha were obtained by beneficiaries and non-beneficiaries, respectively. The yields of cowpea in the mixture were 148 kg/ha for the beneficiaries, and 127 kg/ha for the non-beneficiaries.

It is striking that the yields of the three crops were not significantly different between the two categories of respondents. However, since the beneficiaries cultivated larger farm areas on the average, they obtained significantly higher ($P<0,01$) output levels for the three crops than the non-beneficiaries. For instance, millet output per beneficiary was 1,758 kg which exceeded the 747 kg recorded by the non-beneficiaries by 135.34%. Similarly, the average beneficiary recorded an increase of sorghum and cowpea output of 126.09% and 173.95%, respectively, over the non-beneficiary. Thus, the use of animal traction appears to have increased agricultural output in the area. These results agree with the suggestion that animal traction normally increases agricultural production from an extension of the area cultivated rather than production per hectare (Mathewman *et al*, 1990).

Table 6: Average crop yield (kg/ha) and output (kg) of the respondents in millet/sorghum/cowpea mixture

Crop	Beneficiaries		Non-beneficiaries		t-value
	Mean	SD	Mean	SD	
Millet					
Yield	389	106	332	160	1.44^{ns}
Output	1,758	1,068	747	592	4.06**
Sorghum					
Yield	221	55	249	147	0.88^{ns}
Output	1,092	861	483	321	3.25**
Cowpea					
Yield	148	77	127	92	0.85^{ns}
Output	652	531	238	191	3.60**

+SD = standard deviation. **, ns = significant at P<0.01 and not significant, respectively.
Source: Field survey, 1997/98

Costs and Returns

Variable costs accounted for 77.74% of the total cost of the beneficiaries and 97.88% of that of the non-beneficiaries (Table 7). Labour was the most important cost item accounting for 30.63% and 77.58% of the total cost of the beneficiaries and non-beneficiaries, respectively. The relative contribution of labour to production cost was lower for the beneficiaries than the non-beneficiaries. This could be attributed to the replacement of manual labour with animal traction in land preparation which reduced the amount of labour input by the beneficiaries.

The other important variable cost items for the beneficiaries include feeds (which accounted for 28.84% of total cost) and fertilizer (11.57%). For the non-beneficiaries, labour was followed by seeds which accounted for 11.95% of the total production costs.

Fixed costs accounted for 22.26% and 2.12% of the total cost of beneficiaries and non-beneficiaries, respectively. The fixed costs were higher for the beneficiaries because of the relatively high fixed investments in work animals and associated implements.

The beneficiaries obtained income both from their own farming activities and from hiring out their oxen to other farmers. Table 8 shows that the beneficiaries earned less (but insignificant) net farm income (average NFI of ₦ 13,067.32) per hectare than non-beneficiaries (₦ 13,637.84). When the NFI/ha was multiplied by the farm size, however, the average beneficiary earned ₦ 71,432.48 as against ₦ 34,482.71 obtained by the average non-beneficiary. In addition to the net farm income, the average beneficiary earned an extra

₦ 12,209.98 from hiring out work oxen to other farmers. When this is added to the net farm income, it is evident that the average beneficiary earned a total net income (TNI) of ₦ 83,642.46 compared to the ₦ 34,482.71 obtained by the non-beneficiary. This represents a significant increase (P<0.01) of nearly 143% in the TNI of the beneficiary over that of the non-beneficiary. The relatively high TNI of the beneficiaries could be attributed to their larger farm holdings and the fact that they obtained extra income from hiring out of oxen.

Table 7: Average production costs of beneficiaries and non-beneficiaries (naira/ha)

Cost Item	Beneficiaries		Non-beneficiaries	
	Average Cost	% of Total	Average Cost	% of Total
Variable Cost				
Seed	497.25	5.22	823.45	11.95
Fertilizer	1,102.56	11.75	574.76	8.34
Labour	2,919.68	30.63	5,343.97	77.58
Feed	2,749.13	28.84	0.00	0.00
Vet. Drugs	142.15	1.49	0.00	0.00
Total variable cost	7,410.77	77.74	6,742.18	97.88
Fixed Cost				
Depreciation on animal traction implement	276.68	2.90	0.00	0.00
Depreciation on farm tools	86.55	0.91	46.33	2.12
Annual cost of oxen	564.00	5.92	0.00	0.00
Annual interest	1,194.41	12.53	0.00	0.00
Total fixed cost	2,12.64	22.26	146.33	2.12
Total cost	9,532.41	100.00	6,888.51	100.00

Source: Field survey, 1997/98

Table 8: Net income of respondents

Income type*	Beneficiaries		Non-beneficiaries		
	Mean	SD	Mean	SD	t-value
NFI (naira/ha)	13,067.32	7,289.98	13,637.84	6,707.15	0.28^{ns}
NHI (naira)	12,209.98	4,853.56	0.00	0.00	na
TNI (naira)	83,642.46	72,414.66	34,482.69	27,995.56	3.06^{**}

*NFI, NHI, TNI = net farm income per hectare, net hiring income per farmer, total net income per farmer, respectively;

**, ns = significant at P<0.01 and not significant, respectively; na = not applicable.

Source: Field survey, 1997/98.

POLICY IMPLICATIONS AND CONCLUSION

The study revealed limited use of improved inputs by both categories of farmers. For instance, majority of all respondents identified high cost and inadequate supply of fertilizer as a major constraint to crop production. Furthermore, all the respondents used only local varieties of crops cultivated, while none used either herbicides or insecticides. It must be recognised that the full potentials of animal traction technology being promoted cannot be achieved unless farmers simultaneously utilise improved inputs which would increase crop yield and farm incomes. Agencies seeking to promote animal traction in the area should, therefore, include improved crop production inputs as part of the credit package to the farmers, rather than concentrate only on the provision of oxen and accessories.

The results further revealed that the use of animal traction was restricted only to the primary cultivation (ploughing and ridging). The farmers still relied on manual labour for planting, weeding, fertilizer application and harvesting operations. This caused labour constraints particularly during weeding and harvesting for the beneficiaries who had difficult time coping with their larger farm holdings. It may be necessary for future animal traction projects to consider introducing other animal-drawn implements for weeding, planting, fertilizer application and harvesting to relax the labour bottle-necks currently experienced by farmers.

In this study, feeds, which were largely purchased, constituted a significant proportion (28.84%) of the total production cost of the animal traction users. The possibility of encouraging farmers to establish their own pastures should be considered. But this should be done only after the additional resource requirement and cost of establishing such pastures have been investigated and found to be lower than the cost of purchasing feeds.

It can be concluded on the basis of the findings of the study, that the Work-Oxen Model 36 of the Second Pilot Livestock Development Project in Sokoto State has increased crop production and farm incomes of rural farmers, but opportunities still exist for further increasing them particularly if improved inputs are provided to farmers along with the animal traction technologies.

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