The economics of animal power in Koinadugu District, Sierra Leone: a case study of the work oxen introduction and credit programme

by

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Abstract

Information on animal power and farming systems was obtained through an economic survey of three villages and by monitoring the Loan Scheme of the Koinadugu Integrated Agricultural Development Project (KIADP), Sierra Leone.

The area is very hilly. Swamp farms averaging 1.3 ha are used for rice in the rainy season, and for vegetables and sweet potatoes in the dry season. There is no water control in swamps and rice yields average 1000 kg ha-1 (range 335-2020 kg ha^{-1}). Upland farms averaging 1.6 ha are used in the rainy season for upland rice and groundnuts, and small areas of tomatoes, maize, millet and cassava. Groundnuts yield 500 kg ha^{-1} (range 110-980 kg ha^{-1}). Men and women have different responsibilities for crop cultivation. Family labour is a limiting resource and hired or exchanged labour is required for 60-80% of farm work.

The Loan Scheme has provided 167 loans to purchase oxen and/or plows. The oxen loan is below the cost of suitable animals, so farmers buy young, small animals. Oxen are branded with project marks to reduce fraud and theft. Village level training created logistical problems so training is being centralized. The Pecotool toolbar is expensive and is not used as a multipurpose implement. Traders sell cheaper, less complex plows smuggled in from Guinea. There is no insurance against mortality. Veterinary drugs are not available to farmers. Ox mortality is 8% (4% disease, 4% accidents) and 6% of oxen have to be changed due to sickness or injury. The animal health services in Koinadugu urgently need strengthening.

Average annual use of oxen is 41 days' plowing for swamp rice (41%), millet (19%), upland rice (17%), groundnuts (15%), maize (4%) and cassava (3%). Increased use is constrained by lack of flat or cleared land. Most (78%) farmers hire out their animals, for an average of 11 days a year. Grazing is supervised by young boys belonging to the family. Most farmers have to pay compensation payments for damage caused by their draft animals.

Economic data on the costs of maintaining oxen are provided. The cash needed to adopt animal power with a KIADP loan is equivalent to the annual sales of farm products, and is twice the annual labour expenditure. Thus investing in ox cultivation is difficult. Existing farms are small and could be plowed in just 15 days, if they were level. Most upland farms are steep, rocky and full of stumps. Farming is risky and yields erratic due to pests. Most dry season crops are grown on raised beds and alternative systems using animal power are unproven. However labour constraints and the appreciating value of oxen make animal traction potentially attractive, if if can be combined with increased farm size, diversified operations (ridging for tuber crops) and hiring out animals.

Introduction

This is a condensed version of two detailed papers that were prepared for the Networkshop and circulated in both English and French (Corbel, 1986a, 1986b, 1986c and 1986d). The information contained in this paper was obtained through the regular monitoring and evaluation of the Work Oxen Loan Scheme of the Koinadugu Integrated Agricul-

tural Development Project (KIADP) based at Kabala, in the north of Sierra Leone. It also includes the results of a one-year economic survey in three villages in the vicinity of Kabala.

Being an economic study, many figures are provide in the local currency, the Leone (Le). The Leone has changed greatly in value in recent years, so that international comparisons are difficult. During the period covered by the survey the Leone was effectively devalued by about 350% (Le1 = US$0.17 in 1984 to Le1 = US$0.05 at the time of the networkshop in 1986). A further complication is that during the period covered by this survey, much of the economy was influenced by parallel exchange rates (black market) up to twice those of the official rates, a problem which was greatly reduced when the Leone was officially "floated" and effectively devalued. These forces have fuelled inflation and so comparisons of figures in Leones between years are difficult. In these circumstances, Leone figures are quoted mainly to allow a comparison of *relative* costs and prices for farm inputs and outputs during the same season. The absolute value of the figures quoted is now mainly of historical interest!

The prevailing farming systems

Cropping systems

The Kabala area is noted for its hilly terrain. It has two main agro-ecological conditions: upland (level land, slopes or steep hills) and inland valley swamp. During the rainy season, which lasts from mid-April to mid-November, these ecologies are planted with rice in the swamps and with groundnuts, tomatoes, cassava, millet and maize in the upland. During the dry season a second rice crop may be grown in the swamps. More commonly the swamps are used in the dry season to grow groundnuts and sweet potatoes, together with vegetables such as okra, cabbage, onions and aubergines.

Each village has its particular cropping patterns. However, on average, swamp farms account for 31% of the overall area cultivated during the rainy season, and upland farms account for the remaining area. Since swamps are also cultivated in the dry season, swamp farms represent 44% of the area cultivated during the whole year. Swamp farms average 0.8 ha during the rainy season and 1.3 ha over a full year, while the upland farms average 1.6 ha. During the rainy season the major crops cultivated in terms of area are swamp rice (31% by area), upland groundnuts (28%) and upland tomatoes (10%). While all farmers grow significant quantities of swamp rice and groundnuts, crops like maize, millet and cassava are not universally grown.

Swamp rice farms, as well as upland millet and cassava farms, are generally under the control of the head of the household, although some swamp rice farms can be allocated to the wives. Upland groundnut and okra farms are under the control of women, while such cash crops as tomatoes, carrots and sweet peppers are cultivated by both men and women, whatever their position in the household. Maize is also cultivated as a cash crop by the head of the household and women often have their own small backyard plots for home consumption.

During the dry season, the major crops in terms of area grown are sweet potatoes (0.1 ha) and groundnuts. The area planted with onions, cabbage and sweet peppers is quite small.

Land suitability for ox traction

The ecology, size, shape and location of the farms often make it difficult to contemplate the introduction of animal traction. Most upland farms are totally unsuitable for ox cultivation due to the gradient and the presence of rocks and stumps. The swamps are not developed, so that lack of water control combined with swamp vegetation prevents farmers from plowing all their swamp. A survey of 14 farms suggested that between 30-80% of the farm-land was unsuitable for animal traction.

The average area of land suitable for ox plowing was just 1.1 ha per farm.

During the dry season, most crops are grown on raised beds and large heaps. Unless farmers consider that ox ridging could be appropriate to their conditions, they are likely to continue to employ external labour to prepare these high heaps.

With farms of their present size and crops, oxen could achieve most of the plowing in just 15 days. With such low utilization, the daily cost of the oxen would be prohibitive, even compared to relatively expensive hired labour. Thus if animal traction is to be profitable and adopted, farmers would have to increase the annual utilization by:

- increasing the total area of the farm with suitable land,
- increasing the area cropped in the dry season,
- making use of oxen for more operations (ox ridging and weeding),
- hiring out animals to other farmers.

Household labour

In the present system, labour is the main productive resource. It is also the main input since both hired and exchanged labour are frequently used to perform farm operations. Family labour alone cannot cope with the overall amount of work needed and "companies of work" have developed as one social custom designed to alleviate the labour constraint. In the area of the survey, most of the farmers are men with two wives. 25% of farmers have three or more wives. There are large numbers of children in families and one third of household members are not engaged in farming activities due to their young age. Teenagers of 15 years or more have their own farms. The average land cultivated per full-time farmer is 0.4 ha.

Farm operations are allocated to different gender groups. Men perform most primary cultivation. Men also control most of the land suitable for ox plowing. Thus if draft animals are adopted, the main beneficiaries will be men. In the first instance, women would be unlikely to use animal traction since they are not involved in swamp plowing and most of their farming is performed on upland terrain that is unsuitable for ox cultivation.

External labour

External labour is regularly used on most farms in the area. *Hired labour* is paid with cash plus daily meals. *Exchanged labour*, derived from the informal labour organizations, receives meals but no fee. Only 6% of the farms surveyed were cultivated entirely by family labour. Data collected on 21 swamp rice farms indicated that on all farms 81% of the work-days recorded by farmers for brushing (farm clearance) was done by external labour (both hired and exchanged), as was 73% of the soil tillage. Data collected on 31 upland groundnut farms indicated that hired labour was used for 78% of the overall amount of work necessary for brushing and 72% for primary tillage. Exchanged labour was used in 87% of the farms to perform 74% of the overall work for planting and weeding. During the dry season, less external labour (particularly exchanged labour) is used. However of 102 farms belonging to 21 households, 51% had been entirely brushed with hired labour and 48% had been cultivated with hired labour.

Since external labour is systematically used for primary cultivation whatever the crop, the ecology, the season, or the size of the farm, the introduction of animal power would seem appropriate. The major constraint therefore would seem to be that of land suitability.

The KIADP Work Oxen Loan Scheme

The Musaia Ox Unit was set up within the livestock department of KIADP, based at the Musaia Livestock Station. During 1980 and 1981, extension agents were recruited and trained under the guidance of a British volunteer, as-

sisted by a Sierra Leonean. By 1982 14 ox-trainers were trained and sent to various stations in Koinadugu including Mongo, Falaba, Koindu, Gbentu, Sinkunia, Gbenikoro, Dogolaia and Ganya. Four ox-trainers remained at the Musaia Station and among other activities provided an ox-hiring service for local farmers.

From the early stages it was clear that there was significant interest in the adoption of draft animals in Koinadugu, but that unless credit could be made available, the training programme would only be able to reach the richer farmers who already owned cattle. Thus a loan scheme was devised and implemented by KIADP, with the Musaia Ox Unit providing technical advice.

The Musaia Ox Unit has been responsible for arranging two types of loan. A loan to purchase oxen (which stood at Le2200 in 1986) and a loan to purchase ox plows (Le800 in 1986). Both loans attract interest rates of 15% and are repayable in four annual instalments. Between 1984 and 1986 a total of 167 loans were dispersed, at a rate of about 55 per year. Half of the loans (85) have been for both animals and plows, and a quarter each (41) for equipment only or animals only. The demand for work oxen loans has been increasing, so that in 1985, 250 applicants were registered, and in 1986, 396 were registered.

Selection of loan recipients

At the start of the loan scheme, it was decided to work in close co-operation with paramount chiefs at the chiefdom level, and it was directly through them that the selection was made in 1984. Subsequently other people also assisted in the selection of suitable individuals, including the ox-trainers and the KIADP extension agents. Each applicant has to complete a form giving details of their experience (if any) of oxen, cattle and traditional animal health practices, and also the characteristics of the farm(s) and the present sales of agricultural products. Priority is given to full-time farmers whose main income originates from agriculture and who spend most of their time on farming.

On the basis of this written information, and any comments of the extension agents, the commercial agents, the ox-trainers and the paramount chief, a first selection is made. During the second stage of selection, one or more visits are made to the applicants' farms, in order to assess their level of production and land suitability for ox cultivation. All KIADP farmers are organised into credit groups and loan applicants must not have any debts outstanding to KIADP. All loan agreements are countersigned by the paramount chief and the KIADP credit group leader.

Characteristics of the loan recipients

Studies carried out in 1983 showed that 59% of the private ox-owners in the KIADP area were Fulahs. Another 11% were Mandingoes and 11% were Yalunkas. Most of the private ox-owners were to be found in Sinkunia chiefdoms where several previous ox-traction schemes have taken place since 1928. During the three years of the KIADP loan scheme 40% of the oxen and plow loan recipients have been Yalunkas. The Yalunka is a minor tribe in Koinadugu District, and only 11% of traditional ox owners have been Yalunka. Thus the animal traction programme has had a major impact with this tribal group. In contrast, Limba farmers, who according to the 1974 census represent 20% of the Koinadugu population, are almost absent among recipients. These people are not cattle owners by tradition. As a tribe, Fulahs comprise 18% of the population, but 59% of the long-standing oxen users. Almost all loan applications from people wanting only to purchase a plow (and not animals) were Fulahs and a total of 26% of the loans went to Fulahs. 22% of the loan recipients are Korankos, a figure in keeping with the representation of Koranko chiefdoms in the KIADP area.

One of the conditions favouring the success of the loan scheme is the small but significant

numbers of former owners and users of work oxen. These people, together with cattle herd owners, have the knowledge and capability to ensure good care of the work oxen. The majority (59%) of loan recipients have had previous experience with oxen. Of the 41% of recipients completely new to animal traction, many already own cattle, or have previously owned cattle. Such a high percentage of former ox-owners and ox-users among loan recipients reduces the likelihood of the loans being misused. In addition a knowledge of cattle and traditional animal husbandry is important since no veterinary drugs are available on a regular basis in the KIADP area.

Loan disbursement, bull acquisition and animal training

The cash provided for purchasing oxen (Le2200) was deliberately set below the market price of animals to make the loan recipients commit themselves financially from the beginning. Unfortunately this has caused delays in the purchasing of animals, resulting in delayed training. It may be wise in the future to include a statement within the loan agreement concerning the personal financial commitments required of recipients, as well as a clause preventing delays between cash disbursement and purchase of oxen.

The best time for loan disbursement is January, as this allows recipients to use their oxen from the onset of the rainy season in April. In 1984 most (74%) of the loans were dispersed in January and February. In 1985 most (86%) were dispersed in May, while in 1986 no loans were made available before July. The delays have been due mainly to internal constraints within KIADP and represent one of the weaker aspects of the loan scheme.

The Musaia Ox Unit advises its farmers to purchase bulls that are two and a half years old, which can be castrated before the onset of the training programme. Due to the sharp increase in the price of cattle, farmers have a tendency to buy younger bulls (just two years old) to avoid having to meet the difference between the loan (Le2200) and the cost of recommended animals (Le3000). Although it is stated in the loan agreement that the borrower is responsible for identifying the bulls which would be purchased on his behalf by the Musaia Ox Unit, this procedure was abandoned in 1985 as being too tedious and time-consuming. This lack of control has allowed farmers to opt for younger, less expensive animals.

Each pair of animals is castrated and branded with marks specific to oxen for whom loans were supplied. Animals with the loan scheme branding marks may not leave the District without permission, and the brands have proved valuable in tracing stolen oxen. Nose rings are inserted to facilitate control from behind. At present yokes are not provided by the unit, but in future a carpenter will be employed to manufacture them.

A few weeks after the oxen have been castrated, training starts at the village level, on the farm of each recipient, under the guidance of the ox-trainer. Training lasts four weeks and each recipient must provide two ox-handlers who will be taught how to train oxen. Training at the village level has created many problems for the ox-trainers who do not have transport. Thus it has been decided to centralize future training at the seven Livestock Centres in the KIADP area.

Equipment used

There are three main types of plow. The Pecotool is a toolbar of British design that has both 6"(15 cm) and 9"(23 cm) plow bodies. It was first tested in Sierra Leone in 1979, and following a series of trials and modifications it was found to be appropriate to local conditions. It is now assembled from imported components by the Work Oxen Project at the Rolako Workshop. It is presently subsidized by the KIADP which buys the set at Le1000 and sells it to farmers at Le800. In principle, several working bodies could be attached to the Pecotool frame to allow a farmer to weed, make

ridges or lift groundnuts. However there have been no demonstrations of these at chiefdom level since the beginning of the loan scheme and none has been introduced at the farm level. Due to the economic situation, the price charged for the Pecotool is well below its current production cost, which in August 1986 was estimated to be as high as Le5500. In the Koinadugu District, where cheaper and less complex plows smuggled from Guinea can be purchased from traders, the spread of the Pecotool may stop when prices are raised.

To satisfy the demand for the lighter, cheaper plows, the Musaia Ox Unit has contacted local traders to try to obtain a batch of "Guinea" plows. These include the plows of Chinese design made by USOA (Usine des Outillages Agricoles, Mamou, Guinea) and the large "Otma" plows made in Italy. In 1986 the price for an Otma plow was Le500, whilst second-hand USOA Guinea plows were bought at Le400 by farmers. These prices do not represent the true value of either plow, since both are subsidized by the Guinean authorities.

The Unit is thus facing a difficult situation. On the one hand there is the expensive Pecotool whose components are imported officially from England, and over which the Unit has control in terms of availability, delivery dates and supply of spare parts. On the other hand there are two simpler plows, very attractive because of their price, but smuggled into the country without spare parts and over which there can be no control to allow forward planning. Since the project receives funding from the EEC, it might be possible to order simple plows from overseas for local assembly.

The Ox Unit has decided to promote the use of wooden triangular harrows, since harrows are frequently requested by farmers. To a lesser extent, ox carts will be introduced.

Animal health

There is no insurance in the credit package against mortality. According to the loan agreement, "the project undertakes to vaccinate bulls against haemorrhagic septicaemia, anthrax and black-quarter before training, and subsequently each year at least for the period of the loan, free of charge, given the availability of drugs". In practice, drugs have not been available for farmers since the beginning of the 1985 rainy season. In 1986 it was decided that all drugs (previously provided free of charge) should be sold to the farmers, but as yet they are still unavailable.

It is clearly of great importance that oxen are well looked after, particularly as it is the increasing value of the oxen which makes investment in animal traction worthwhile. Survey data relating to the farmers who received loans in 1984 and 1985 are available. In general, apart from the common problems of irritation by ticks and flies, the health status of the oxen during that year was quite good, and 37% of recipients reported that they had had no trouble that prevented them from using their oxen. However animal health problems did adversely affect work programmes so that 32% of the recipients had to stop work for periods ranging from less than one week to more than one month. Furthermore, during the past year, 4% of the oxen have died of disease and another 4% have died from accidents. It would appear that the launching of a loan scheme in a situation where disease control is minimal and where there is no insurance in the case of animal death should have been a cause for concern. For this reason the failure of the KIADP to procure and distribute adequate drugs appears to be the weakest aspect of the work oxen loan scheme.

Present use of work oxen

The survey recorded 1425 ox-pair working days for the loan scheme recipients and showed that oxen are used mainly for plowing for swamp rice production (41%), and also for cultivation of upland or boliland soils for growing millet (19%), rice (17%), groundnuts (15%), maize (4%) and cassava (3%). The average perfor-

mance per set of oxen was 30 days of household farm work for the farmers who had bought their animals in 1984. For more recent adopters (those who had received loans in 1985), only 17 days of household farm work were achieved, the bulk of this being performed during the rainy season. Among the 1984 loan recipients, the highest performance was obtained by oxen who worked on household farms during both the rainy and the dry season and which were also hired out during the rainy season. Their average performance was 41 working days.

It appears that most recipients are already plowing all their suitable land at the household level, since the main reason cited for the non-use of oxen (for each crop) was land unsuitability. For the future it will be important for each farmer to have access to new unfarmed land that is suitable land for ox cultivation. The survey suggests that with the latest loan recipients, this is indeed the case.

Economic implications of introducing animal traction

In order to assess the financial implications of animal power introduction, some of the major cash flows within the present farming systems will be briefly discussed. It is not intended that a detailed economic model of the complete farming systems will be presented. Rather information will be presented to indicate whether animal power should be considered a viable investment, worthy of a loan.

Labour costs

In 1985, the average daily wage for a hired man was Le4 for brushing, tilling and making heaps. For women the wage was Le2 for planting and weeding and Le4 for uprooting the seedlings of swamp rice for transplanting. During 1986 daily wages rose to Le6 for a woman and Le8-10 for a man. In some cases labourers will not be paid on a daily basis but will establish contracts for working particular areas. The payment in kind for both hired and exchanged labour comprises a meal, plus cigarettes and kola nuts. The cost per labourer will depend on gender, since women eat less rice and seldom smoke or eat kola nuts. Men are allocated up to two cups of rice, while a woman is provided with only one. Five to ten cigarettes must be attributed to each smoker, as well as a kola nut. Those who do not enjoy these may receive a small cash compensation. Thus the daily cost of employing a hired man may be as much as Le10, while it may be as little as Le3 for a woman.

Among the villages surveyed, it was reported by farmers that an average of 51 days ha^{-1} of work was necessary for tilling swamp rice farms. Family labour could provide (on average) only a third of the overall work needed, so that much was done by exchanged labour (44%) and hired labour (25%). The average cost in 1985 was Le170 ha^{-1}.

A survey of 14 swamp rice farms where ox cultivation is used to plow some of the farm showed that labour input for plowing was only 25 man-days ha^{-1} of work. Much of this was still performed by exchanged (43%) and hired labour (34%), giving a total labour expenditure of Le105 ha^{-1}.

Similar surveys on upland groundnut farms showed that the average cost of tillage was Le194 ha^{-1}, since most (85%) of the work was done by external labour. The labour cost for primary tillage represented about 30% of the overall labour expenditure for this crop. On average 42 women-days ha^{-1} were necessary to weed groundnuts, with family labour providing 30% and exchanged women providing 66% of the work. The low rates paid to women explain the relatively low labour cost of Le90 ha^{-1}.

The main characteristic of dry season farming is that most crops are cultivated on circular heaps or longitudinal raised beds. Among 21 households, 84% of the dry season farm was cultivated in raised beds, while only groundnuts and rice (16% by area) were tilled on the

flat. Sweet potato farms were cultivated by 18 households (out of 21 surveyed) and the average farm size was 0.1 ha. It is assumed that a man can make 15-20 longitudinal heaps per day. Most (80%) of the work is done by hired labour, whatever the size of the farm, leading to the high cost of Le710 ha^{-1} for heap making. If sweet potatoes could be grown on ridges made by oxen, it could greatly increase the profitability of this important cash crop. However farmers are not yet convinced that the small and low ridges made by oxen are appropriate to their conditions.

Labour expenditure per household

It is useful to determine the total labour costs per household per year to assess the potential savings that could be made using ox cultivation, assuming that more crops could be grown on suitable land. This data would indicate if the cost of animal power introduction would be marginal or important compared to other farm costs.

The survey indicated that in the rainy season the overall expenditure per household was Le300 for swamp farms and Le700 for upland farms, leading to an average overall labour expenditure per household during the rainy season of Le1000. These figures represent average costs of Le375 ha^{-1} for swamps and Le600 ha^{-1} for upland farms. In villages where oxen are already used, the overall labour expenditure per household was Le273 on swamp farms, while the labour cost was Le320 ha^{-1}. In these villages only one quarter of the labour cost was attributed to primary tillage since oxen were performing much of this work, while in the other villages almost half of the labour cost goes on tillage.

During the dry season, average overall labour costs per household were Le466, with costs varying between Le725 ha^{-1} and Le1120 ha^{-1} depending on the proportion of crops cultivated on heaps. In most cases 60% of this was spent simply on making heaps, which shows the potential savings that could be achieved by using oxen to make ridges for cassava and sweet potato.

The overall annual labour costs at the household level varied from Le648 to Le2388, according to the size of the farms and the management of the farmer.

Costs of equipment, seeds and fertilizers

Farm tools are a capital resource. Hoes, cutlasses and harvesting knives were the most commonly owned tools, many of them locally produced and repaired. The estimated lifespan of these farm tools is: 3-5 years for hoes, 2-4 years for swamp cutlasses and 8-10 years for forest cutlasses. The present value of these implements for an average household can be estimated at Le400. Thus the annual replacement cost can be assumed to be about a quarter of this amount, that is Le100.

None of the farmers surveyed used fertilizer, except for cabbages grown during the dry season. No chemicals were applied on any of the farms to protect against pests and rodents. For most crops, seeds and cuttings are systematically kept from the previous year and thus seeds do not generally require an outlay of cash. The exceptions are cabbages and sweep peppers, for which farmers purchase seeds. To buy seeds for rice, groundnuts and tomatoes, the major crops of the rainy season, would be expensive, perhaps Le270 ha^{-1} for swamp rice and Le620 ha^{-1} for groundnuts. This is in comparison with overall labour expenditure of Le375 ha^{-1} for swamp rice and Le625 ha^{-1} for groundnuts. Thus the management of the farmer in keeping seeds and cuttings from previous harvests is crucial in terms of keeping costs minimal.

Crop yields and sales income

The survey indicated great variations in yields. In a few cases farmers may have deliberately underestimated their yields. However it is evident that very low yields are quite possible

since rodents, monkeys and birds can destroy a great deal of the harvest. During the dry season sweet potato yields are very low due to lack of water. Yields on swamp rice averaged 1000 kg ha^{-1} and varied from 335-2020 kg ha^{-1}. Previous studies had indicated that yields in such conditions averaged 1170 kg ha^{-1}. Yields of upland groundnuts averaged 500 kg ha^{-1} (range 110-980 kg ha^{-1}), while previous studies in the area had estimated them at 860 kg ha^{-1}. Yields for upland tomato farms varied from 960 kg ha^{-1} to 1700 kg ha^{-1}.

Using these figures it can be shown that upland groundnuts can provide an average farm household with a harvest worth Le1700. However only a fraction of the harvest is ever sold and no farmers whatsoever reported selling rice. In fact none of them was self-sufficient in this staple food, and all farmers reported they had to buy rice for home consumption.

The average value of sales per household was Le1359 during the rainy season and Le1351 during the dry season. Dry season farming is an intensive period of vegetable growing in the swamps. Animal power could make it even more profitable if ox ridging and weeding were shown to be practicable in this situation.

The costs of animal power introduction at the farmer level

The cost of animals

The cost of owning and using a pair of oxen and a plow in 1986 will now be estimated, assuming a farmer is a loan recipient during the first year of use. The price of bulls ranges from Le2900 to Le3300 per pair of animals 2-3 years old. As noted above, price increases have encouraged farmers to purchase younger bulls since the animal loan package of Le2200 is not sufficient to meet the full cost of the animals. Under present loan conditions, farmers have to repay capital of Le550 every year for four years. In the first year the farmer must find about Le500 to cover the additional cost of the cattle, over the loan amount. This implies that about Le1000 will be needed in the first year. The loan has a 15% interest on the reducing balance which means that the first year the recipient will pay Le330 (Le2200 x 0.15).

Under the present system there is no insurance against death or loss of oxen. The survey indicated that over a period of a year, 4% of oxen died of disease, while another 4% died of accidents and 6% were changed following disease or other trouble. Thus the risk of death could be considered to be covered by a theoretical insurance cost of 8% of the mean value of oxen over a year, which would be about Le250. Since this is a theoretical cost, it will not be included in the present calculations.

Feeding and health

Grazing supervision is invariably performed by young boys belonging to the family. These boys are also the ox-handlers in most cases. It is difficult to ascertain the cost of such labour, since it does not require outlay of cash, and the opportunity costs for the boys will be limited, in financial terms. The head of the household may occasionally compensate his sons with a few Leones. Some authors recommend accounting for this supervision with some daily cost, but this leads to a severe overestimate of the real cash expenditure. In this paper, an annual cost of Le40 will be assumed.

Provision of salt varies considerably. Here it can be assumed to be a fixed cost of one cup of salt per week when oxen are not working, with a smaller cup every day during working periods (a variable cost).

Expenditure on health can be considered variable costs since it may be related to the stress of work. Although no imported drugs are currently available in the Koinadugu District, it is worth estimating what the cost of possible medicaments. According to the survey, the main health troubles are flies, ticks, worms and wounds. A budget can therefore be assumed for a chemical spray/dip against flies and ticks

("Supona" at Le40), a worming agent ("Coopane" at Le30), some wound powder ("Negasunt" at Le35) and some vaccines against major diseases (say Le30). These animal health items together cost about Le135. However in the present situation none of these drugs is available and farmers are buying traditional medicines or chemicals intended for other purposes from the local market; the survey indicated that 53% of loan recipients spent money for animal health reasons, with average figures of about Le10 per month. Thus an annual health budget of about Le120 per year seems realistic.

Housing and damage compensation

During working periods oxen are tied up at night, generally in the open in the backyard but sometimes in a room of an existing house. The building of a paddock is unusual and therefore the cost of housing is presently almost nil. During periods of inactivity (often the whole dry season) oxen may be sent to a large herd (warreh). In the survey, 32% of loan recipients did this. These people will pay Le10-40 per month, while the others will not have such charges. For the purposes of an illustrative budget, housing costs can be estimated at Le40.

Compensation payments for damage is an important cost identified during the monitoring and evaluation survey. If the animals cut their ropes while grazing they may damage crops, and possibly hurt people. It was found that 27% of farmers obtaining a loan to buy oxen had to pay damages, with an average payment ofLe67. An annual figure of Le50 should therefore be anticipated.

Cost of equipment

Most farmers have purchased Pecotool plows from the KIADP. Some plows are smuggled into the country from Guinea, but since these transactions involve black-market dealings, it is difficult to obtain realistic figures for the prices of such equipment. Only 19% of the loan recipients have a harrow and these implements will not be considered here. The value of a Pecotool equipment set in 1986 was Le800. Every year a farmer has to refund Le200 capital and the interest for the first year is Le120. Farmers may purchase at least one plow share a year costing Le40.

A farmer will have to buy ropes to control the oxen during grazing, whether they work or not. According to the survey, some farmers purchased thick nylon ropes costing Le40-60 which lasts one year, while others buy locally made ropes costing Le10-20 and lasting only 2-4 weeks. A realistic annual cost may be Le100. Yokes are bought from local blacksmiths at prices of Le10-20, with an expected life of three 3 years.

Total overhead costs

Using the figures discussed, the overall cost of introducing a pair of oxen and a plow can be estimated, as illustrated in Table 1.

Table 1. Estimated cost of introducing oxen

	Leone (Le)
Purchase of oxen	1050
Interest	330
Ropes and reins	165
Damage and compensation	50
Housing and keep	40
Grazing supervision	40
Salt	40
Health	120
Plow	360
TOTAL	**2195**

Variable costs

The use of family labour (generally the young sons or brothers of the ox-owner) is normal for looking after oxen. The involvement of the head of the household as ox-handler is not common, and the hiring of labour to handle the oxen is rare. It is still worth including some value for this operation since family labour

used to do ox plowing at a period of intensive farm operations could be used to perform manual work instead. Only one ox-handler is likely to be capable of much work, since the boy in charge of the control rope is often only 10 years old. A daily cash wage of Le6 without food can be included in the estimates.

During working periods ropes for grazing control and harnessing must be purchased regularly. According to farmers, harnessing ropes must be changed almost every week while grazing ropes last longer. A realistic budget for ropes could be a daily cost of Le1. The consumption of salt during working periods can be estimated at one small cup, costing Le0.50 a day. This gives a total variable cost of about Le8 per day. Thus employing oxen for 40 days a year might incur variable costs of Le300.

The costs of work oxen relative to the farm budget

The cash needed to support the introduction of animal power at the household level based on 1986 loan terms can therefore be estimated at about Le2500 during the first year. This is twice the overall annual labour expenditure at the household level in the area (Le1185). It is almost as much as the overall annual sales of agricultural products at the household level (Le2700). The cost of the Pecotool plow set at the beginning of 1986 represents 8 years of normal annual investment in farm tools. It is clear that investing in ox cultivation in an area where yields fluctuate greatly and where entire farms can be damaged by uncontrolled pests is likely to require a major financial effort.

Other sources of income will therefore be important for loan recipients, for example farmers may have additional income from trading, employment or chiefdom administration. The keeping of goats and sheep can be profitable, and these can be rapidly sold to meet the cost of loan repayments. For example the present value of a small herd of goats (one male, two females and three kids) is Le800, while sheep are even more valuable.

Potential benefits from animal power

The interesting question now is what kind of benefit a farmer introducing animal power can expect in the face of such an increase in fixed costs and operating risk. The potential savings using oxen for plowing will be considered here, since plowing is the operation most commonly performed by oxen at the farm level. In addition the bulk of present labour expenditure is incurred by primary tillage, as well as brushing (an operation which oxen will not perform).

During the rainy season, it was found that the average labour expenditure for swamp rice was Le170 ha^{-1} or Le124 per household. During the dry season, labour expenditure (mainly for raised beds) was Le710 ha^{-1} or Le300 per household. Thus in the present cultivation systems, there is certainly scope for savings in labour costs, particularly since ox-handlers are generally family labour. Savings with cash crops such as sweet potatoes, sweet peppers, tomatoes and groundnuts could alone be Le424 per household, or 35% of the overall annual labour expenditure.

Nevertheless for animal power to be economically viable, farmers will have to increase their farm area. According to the survey, the great majority of farmers do have access to suitable, uncultivated land, which they do not currently farm due to lack of money and/or labour. The cost of tilling additional swamp land by hand would be high (perhaps Le460 ha^{-1}), since family labour is already fully employed. Animal power could become more competitive with intensive use, and make additional farming more profitable, as long as new labour bottlenecks do not hinder the process.

Income from hiring

Hiring out oxen is already done by a majority (78%) of the loan scheme recipients after their preliminary year of use. The average hiring is for 11 days a year. Income from hiring during the year following animal power introduction is not high because the owner is not yet famil-

iar with the oxen and tries only to assist family and relatives. The survey indicated that most (63%) of the days worked during the first year of operation were for relatives, without cash payment. Hiring for cash was done only for an average of five days per set, for daily cash payments of Le27 in 1985, rising to Le50 in 1986. At the new rate, only 25 days of work would be needed to meet the first annual loan repayment for oxen and plow.

Appreciation of oxen value

In the present economic situation, it is difficult to quantify the real appreciation of oxen over a period of years, but it is clear that the increase in value of oxen makes ox cultivation a very attractive investment. Due to the combined effects of inflation and increase in weight, a two-year-old bull purchased for Le800 in 1985 could be sold for Le1450 in 1986. Provided oxen remain alive and are not stolen, farmers purchasing animals in 1985 have already made a theoretical profit in the region of Le1300. When compared with the overall expenditure incurred by the oxen and plow during the first year of Le2195, this appreciation indicates the importance of looking after the animals well. The simple fact that oxen are well looked after and stay alive will have as much economic effect on the farmer, as whether they are used for 10 or 60 days each year.

Conclusions

From the foregoing discussion, there is a clear need to make investment in animal power more viable and farming more profitable. One major way this could be achieved would be to promote the use of ox power for expanding farm size and for undertaking more farm operations. There are also important implications for the extension services. The animal health services in Koinadugu need urgent strengthening if they are to assist in the success of the credit scheme.

In conclusion, the future development of animal traction in the area will greatly depend on:

- The provision of an appropriate animal health service. This should be responsible for veterinary advice and drugs and also for disseminating information on proven traditional animal health practices. With problems of disease and injury, ox traction is a speculative investment and it is of paramount importance that oxen under work stress are well looked after so that they increase their weight every year.
- The provision of demonstrations of alternative uses of animal power, notably for ridging, so that farmers can assess the value of these practices.
- The provision of credit to individual farmers that have access to suitable land in order to allow them to invest in animal power. For maximum rate of reimbursement, farmers should offer strong assurance of repayment ability, and favourable criteria would include farmers who have previously owned cattle or oxen and farmers currently owning small ruminants.

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