

Costs and returns of the crop-cattle system in the Western Province of Zambia

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Key words

Cattle - Economic analysis - Mixed farming - Livestock - Agricultural economics - Cost - Income - Zambia.

Summary

The costs and returns were analyzed per herd (N = 50), and their distribution among families and the relation to other farm and off-farm income were assessed. Cattle sales, ploughing by oxen, the increase in cattle numbers and milk production appeared to be the most important returns (26, 21, 19 and 16 % of total gross returns, respectively). Local slaughter, manure and ox-power for transport played a minor role. The calculated costs were about a third of the gross returns. The net economic efficiency was calculated at US\$ 1.4 per ha per year. The kraal keeper's household (KKH), who owned 60 % of the herd, accrued 64 % from the total gross returns, incurred 73 % of total costs and accrued 58 % of the net returns. Average net returns to the KKH from cattle keeping, crops, sales of other farm produce and off-farm income were 50, 31, 6 and 13 % of the total household income, respectively. The results have shown that the role of draught-power and animal sales could be improved.

■ INTRODUCTION

The Western Province (WP) of Zambia covers an area of 122,000 km² (13) and is divided into six districts. There are over half a million heads of cattle (10) of the Barotse breed, a Sanga breed type (11). They graze on natural pastures for about nine hours daily. At night the herds are kraaled on fields which will be cultivated at a later date. There are four grazing management systems (GMS): two transhumance and two sedentary systems (figure 1). The transhumance is over short distances (up to 40 km) when compared to that found in, for example, the Sahelian region, and occurs because people and cattle are forced to move out of the plains, when flooded in the wet season (GMS-1), or because they are forced to move to the flood plains because of lack of water in the uplands in the dry season (GMS-2) (1).

In many sub-Saharan countries, the provision of veterinary services has been free of charge for livestock owners (12). Meeting the costs involved in the provision of these services has become increasingly difficult for most governments (8). There is a need to rigorously restructure services through involvement of the private sector as well as the design of cost recovery measures. In the WP, the Department of Veterinary and Tsetse Control Services (DVTCS) is investigating the possibilities and requirements to

restructure services (9). Research activities have been initiated in order to establish the position and economic importance of cattle in the rural society (22), of which the present study is one.

The study has three objectives: to assess 1) the economical and financial costs and returns (C&R) of cattle; 2) the various C&R among households; 3) the relative importance of cattle in relation to other farm and off-farm income.

■ MATERIALS AND METHODS

The unit of investigation was the herd: a group of cattle belonging to one or more owners kept in one cattle pen or kraal under the responsibility of a kraal keeper (KK). The KK makes decisions for the whole herd but does not own all the animals.

The assessment was confined to economic and financial C&R. Social C&R, such as position in society, family relations and bride prices, were not considered. The kraal keeper's household (KKH) was defined as the KK and his wife or wives together with children and dependents such as parents, grandchildren etc., but excluded children living elsewhere. All others with cattle in the kraal, whether living in the village of the KK or not, were considered as the other owners.

From 1985 to 1988, the DVTCS has been monitoring 50 herds which were selected on the following characteristics: easy accessibility to enable data collection every two weeks; equal representation of transhumant and sedentary herds, as this is the normal situation in the WP according to the cattle census (10); and

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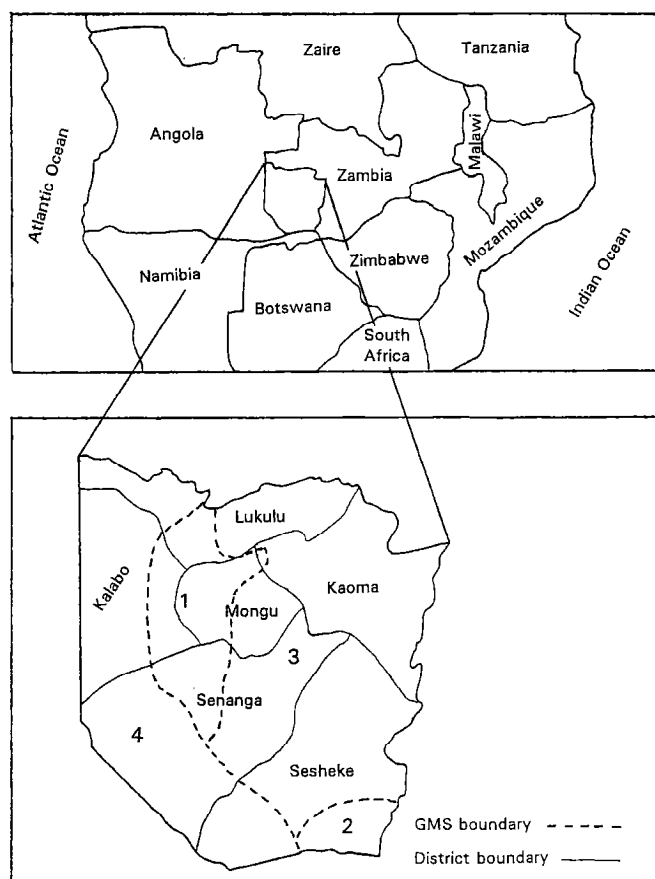


Figure 1: the grazing management systems and districts of the Western Province, Zambia: 1+2 transhumance, 3+4 sedentary.

normal situation in the WP according to the cattle census (10); and a herd size between 20 and 120 animals to avoid exceptionally small or large herds (6). The distribution of the herds in the four main cattle-keeping districts of the WP was: Kalabo 12, Mongu 12, Senanga 17 and Sesheke 9. The distribution in the GMSs was: GMS-1 18; GMS-2 7; GMS-3 14; GMS-4 11.

Production parameters from these herds (from April 1986 to April 1988) and follow-up data, collected through a questionnaire survey among the same herds, were used for the economic assessment. The additional data gathered through the questionnaire related to the price, cost and income of ploughing, transport, milk production, livestock sales, local (emergency) slaughter and manure use. Moreover, data on income from crops and other farm and off-farm activities were collected. If a particular herd had more than one KK, only one of them was interviewed in full. However, all the KKs (55) of the 50 kraals studied were questioned about the household composition and areas cultivated. The kraal size, the area manured through shifting the kraal and the area ploughed were measured.

RESULTS

General profile

Seventy-six percent of the informants considered themselves Lozi, the major tribe, but in fact the majority belonged to Lozi sub-tribes. The pure Lozis accounted for 20%. The youngest KK was

Table I

Average household size and composition of interviewed kraal keepers in relation to the number of wives

Nbr. of wives	N	Average number of people in a household		
		Household size	16 years and over	under 16 years
0	2*	8.0	4.5	3.5
1	34	9.2	4.1	5.2
2	18	11.7	5.2	6.5
4	1	22.0	8.0	14.0
average	55	10.2	4.5	5.7

* 1 female headed household

35 years old and the oldest 75. Fifty-four percent of the KKs were 60 years old or older, 38% were 40 to 60 years old, and 8% were less than 40 years old. Most had less than 5 years' schooling. The composition of the average KKH is shown in table I. In the village of the interviewee there were on average 6.3 households, of which 60%, including the KKH, had cattle in the kraal. The average number of herds in a village was 1.5.

Outputs of cattle-keeping

Ploughing

The average herd size was 66 cattle, of which 11 were oxen. Eighty percent of the adult oxen were trained. Eleven informants used two oxen per team, and the other 39 informants worked with four oxen in a team. Occasionally, teams of more oxen were used. The average time spent on ploughing was 3.5 h (SD = 1.4) per day for 46 days per average herd. The average area cultivated by the KKH was, for the WP and for the districts of Kalabo, Mongu, Senanga and Sesheke, 3.9, 2.5, 4.7, 3.1 and 5.2 ha, respectively. The area cultivated per herd of 100 cattle is shown in table II.

The economic returns of ploughing were based on 1) the amount of cultivated land, 2) labour requirements and 3) yields per ha, obtained by ploughing as compared with hand-hoeing. The following data were used in the calculations: 1) farms using animal traction cultivated 100% more land than farms using hand-hoes (6.6 ha versus 3.3 ha) (19) (based on a survey considering 48 studies in ten sub-Saharan countries including Zambia); 2) an average of 86 working days per ha were required from hand-hoeing to harvesting, as against 68 working days from ploughing by oxen to harvesting (2); 3) data on basic yields of crops were taken from statistics for 1982-1987 collected by the Department of Agriculture in the WP. The yields per ha of maize, sorghum and millet were boosted by 8%, and rice by 20%, compared with yields from manually tilled fields (17). The reduction of labour requirements per ha on ox-ploughing farms was offset by the greater acreage (table III). This resulted in an increased labour requirement of 225 days. Oxen were hired out on only 5% of the ploughing days, mostly for free, and rarely at the "normal" rate of US\$ 2.5 to 3.75 per day.

Table II

Average area (ha) ploughed and/or manured annually for various crops per herd of 100 cattle

Type of crop	Ploughed + manured	Only ploughed	Only manured
Maize	0.71	4.01	-
Rice	0.03	1.36	-
Sorghum	0.12	1.33	-
Millet	0.03	0.54	-
Cassava	0.03	0.57	0.12
Vegetables	0.05	0.27	0.003
Total	0.96	8.07	0.12

The average return of ploughing over hoeing per 100 cattle was US\$ 435, calculated at \$ 519 for the increased acreage being tilled and higher yields per ha being produced, minus \$ 84 for the extra labour.

Transport

Sixty-five percent of the 50 days that oxen per herd of 100 cattle were harnessed for transport were spent moving firewood while 25 % were spent transporting foodstuffs to and from the fields or markets. Other transported commodities were luggage, poles for houses or kraals, water, grass and people. Sledges were mostly used for transport.

The average number of oxen used per team for transport was four. Ox-teams were hired out in the same way as for ploughing. Since only 13 out of 50 kraals had occasionally hired out oxen, the opportunity cost of transport was low and assessed at \$ 1.25 per transport day (based on \$ 0.75 for labour of two persons and \$ 0.5 for hiring of equipment), or \$ 62 per year per herd of 100 cattle (table IV).

Manure

At night most cattle were kraaled for an average period of 11 months on fallow fields which were destined for cropping the next season. The kraal was usually made from local poles, occasionally thorn bushes and/or barbed wire. The barbed wire had been provided free of charge in the past. The cattle density during kraaling, including young-stock, was 0.6 animals per m² (SD = 0.44). How often the kraal was re-sited depended on the soil type and season. On average, kraals were shifted every three days in the rainy season and every five days in the dry season, leading to an average manured area of 1.08 ha (SD = 0.62) per 100 cattle (table II). Excluding herds which were not kraaled for the purpose of manuring the field, the average area manured per 100 cattle per year was 1.22 ha. Once a field had been manured, the kraal was re-sited there after a period of 3.3 years (SD = 1.5).

The effect of manure on the sandy soils was to increase yields of cassava, millet and sorghum by 60 % and those of other crops by 70 % in the first season after manuring. The residual effect of manure on crop yields in the second season after application was

Table III

Average costs and returns of land cultivation per kraal of 100 cattle with full access to ploughing compared to farms without access to ploughing

	Access to Ploughing	No. access (hoeing)
Cultivated area (ha)	9.03	4.52
Harvest/ha (US \$)	108	101
Total harvest (US \$)	975	456
Labour/ha (days)	68	86
Total labour (days)	614	389
Total labour (US \$)	230	146
Harvest-labour (US \$)	745	310

40 % compared with yields from fields without manure application (17). The total average value for increased crop yields was calculated as \$ 84 in the first year after the field had been manured and \$ 35 for the second year.

Milk

The average price of one litre of milk was \$ 0.10. The highest price was charged in Mongu District (\$ 0.13), followed by Sesheke District (\$ 0.11) and Senanga and Kalabo Districts (\$ 0.09). Bessell and Daplyn (3) and the herd monitoring programme in the WP (6) estimated a milk production, both sold and self-consumed, of on average 122 and 211 litres per cow per year, respectively. The average of these two figures, 167 litres per cow per year, was used. The output was calculated as:

$$\text{Nbr. of adult cows present} \times \text{calving rate} \\ \times 0.5\text{-}1 \text{ abortion rate} \times \text{price} \times 167$$

and amounted to \$ 341 per year per 100 cattle.

Herd increase and meat production

The herd increase was calculated as:

$$\text{Births} + \text{purchases} - \text{sales} - \text{slaughters} - \text{deaths}$$

and amounted to 7.0 animals, sales to 6.4, purchases to 2.9 and local (emergency) slaughter to 7.8 animals per average herd of 100 cattle per year (table V). Slaughter was calculated as "slaughter + 0.614 deaths" because most animals that had died were consumed. The average price of purchased cattle (\$ 39) was much lower than that of sold cattle (\$ 86) because purchases often concerned young stock. The average value of a locally slaughtered animal was \$ 24. The herd increase was calculated by using the average value of \$ 58 per animal.

Hides

Only 45 % of the hides of the animals that had been slaughtered or had died (3.8 per herd per year) could be sold or used, because of the lack of a market outside Mongu District and because not all hides were accepted for processing. The average value of the hides which were used was \$ 1.29. The contribution of hides to the income derived from cattle was \$ 9 per 100 cattle per year.

Table IV

Average costs and returns per grazing management system (GMS) (in US \$ per 100 cattle per year)

	GMS-1	GMS-2	GMS-3	GMS-4	Mean	Cash
Ploughing	513 ^a	463 ^a	438 ^a	286 ^b	435	5
Transport	58	62	56	76	62	4
Manure	143 ^a	52 ^b	129 ^a	110 ^a	119	0
Milk	392 ^a	425 ^a	283 ^b	278 ^b	341	66
Cattle sales	537 ^a	366 ^b	455 ^b	815 ^c	551	551
Slaughter	292 ^a	90 ^b	137 ^c	141 ^c	186	140
Hides	13 ^a	6 ^b	8 ^b	8 ^b	9	9
Herd increase	373 ^a	778 ^b	465 ^a	144 ^c	405	0
Gross return	2321	2243	1969	1857	2109	776
Labour	330	346	350	349	342	125
Drugs	2	2	2	2	2	2
Purchase	102	97	138	111	114	114
Depreciation	35	35	35	35	35	35
Interest	289	289	289	289	289	0
Total cost	758	769	814	786	782	276
Net return	1562	1474	1155	1072	1327	500

Values with different superscripts in row differ significantly (ANOVA; $P < 0.05$).

Costs

Labour

On average, 2.5 people were involved per ploughing day of 3.5 h, or 607 h for the total ploughing period per 100 cattle. On average two people at five hours each were engaged per day trip in transport or 497 h in total. Kraal re-siting, 119 times per year, required on average 714 h per 100 cattle per year. Milking and herding took 282 and 5,194 h per year for the average herd, respectively. In total, the labour required by the average herd of 100 cattle was 7,294 h or 912 working-days at 8 h per day.

The average KKH size was 10.2 persons (table I), of whom 4.5 persons (43 %) were available for work within their own household and for farm work. Most of them were 16 years and older. When persons younger than 16 years were counted as 50 %, the labour availability was 5.0 persons for polygamous households and 3.5 for other households, or 4.2 on average. If it is assumed that a person works 230 days per year, available labour was calculated at 966 days per KKH per average herd or 1,455 days per 100 cattle.

The opportunity cost of labour, as determined through the questionnaire survey, was \$ 0.38 per day, based on piecework as indicated by the respondents. The reported rates ranged from

\$ 0.25 (Sesheke rural) to \$ 1.25 (Mongu, provincial headquarters) per day. In the case of contracted herding, payments amounted to \$ 0.14 per day plus an estimated value of \$ 0.25 for board and lodging. The total cost for labour was estimated at \$ 342.

Capital

The capital consisted mainly of cattle and of some draught-power implements such as ploughs and sledges. Capital cost was calculated on the basis of the real interest at 5 %. Depreciation for implements was set at 20 %. The average value of the animal inventory was calculated by using \$ 86 per animal of 3 years and over (selling price), \$ 39 per animal aged 2 to 3 years (buying price) and \$ 12.5 per calf. The total value amounted to \$ 5,766 with a cost of \$ 289 for real interest, which is the interest forgone for having money capital tied in the animal. Other costs were of minor importance (table IV).

C&R per grazing management system

For the costs, the four GMSs were rather similar (table IV). In Sesheke District (GMS-2) manuring of fields was less common: only three out of nine interviewees mentioned manuring of fields by their herds. In the transhumant systems (GMS-1 and 2) a higher

Table V

Average herd structure and productivity parameters per grazing management system (GMS)

	GMS-1	GMS-2	GMS-3	GMS-4	Av/tot
Area (x 1000 km ²)	19	5	57	40	122
Herds (nbr.)	18	7	14	11	50
Herd size (nbr.)	65.4 ^a	95.8 ^b	58.3 ^a	59.7 ^a	66.4
Calves < 1 yr (%)	16.0 ^a	20.8 ^b	17.3 ^a	16.9 ^a	17.2
Females > 3 yrs (%)	41.9 ^a	41.2 ^a	38.7 ^b	38.5 ^b	40.2
Others (%)	42.1	38.0	44.0	44.6	42.6
Calving rate (%)	51.62 ^a	59.75 ^b	55.56	55.18	54.64
Calf mortality (%)	25.92 ^a	15.62 ^b	19.44	20.28	21.42
Births (1) (%)	21.63 ^a	24.62 ^b	21.50 ^a	21.24 ^a	21.94
Purchases (2) (%)	2.61 ^a	2.48 ^a	3.52 ^b	2.82 ^a	2.89
Sales (3) (%)	6.24 ^a	4.25 ^b	5.28 ^{ab}	9.46 ^c	6.40
Slaughters (4) (%)	1.95	1.73	2.25	2.22	2.06
Mortality (5) (%)	9.57	7.61	9.43	9.89	9.33
Consumed* (%)	7.83	6.40	8.04	8.29	7.79
Herd increase (1+2-3-4-5) (%)	6.48 ^a	13.51 ^b	8.06 ^a	2.49 ^c	7.03

Values with different superscripts in row differ significantly (ANOVA; P < 0.05).

* Calculated as: slaughters + 0.614 deaths.

output for milk was realized, mainly because of higher milk prices. In GMS-4, the output of ploughing was less compared to the other GMSs. The low output of herd increase in GMS-4 was explained (and compensated) by higher cattle sales.

Distribution of C&R to the kraal keepers' household

The distribution of C&R to the KKH is summarized in table VI. This should be seen against the ownership of cattle which was 60 % for the KKH. Some of the milk accruing to the KKH (25 %) and most of the meat (75 %) were sold by the KKH.

Other income

The results of this paragraph are per KKH. The crop income of the KKH, calculated from the average of 3.9 ha cultivated land and multiplied by the average cropping pattern and yields, indicated a value of crops of \$ 444. Deducting the cost of labour and seeds estimated at \$ 99 and \$ 24, respectively, resulted in a net return of \$ 320. The interviews gave an average sale of crops amounting to \$ 102 per KKH. Other farm activities such as beer brewing, fishing, keeping shop, sales of crafts, chickens and goats provided \$ 59 on average in cash. Off-farm income through salaries, pension, remittances from elsewhere generated an average of \$ 131 per KKH (table VII). Remittances were received by 38 % of the KKHs, beer brewing generated money in 63 % of the KKHs, the

sale of chickens in 30 % and the other activities mentioned in 2 to 14 %.

■ DISCUSSION

General profile

The tribal composition of the KKHs interviewed indicated that 20 % were Lozi, which are the traditional cattle keepers. This agreed with the findings of a previous study (14).

The population census (20) showed an average number of 1.1 wives per married man in the rural areas of the WP, against 1.4 found among KKHs in our study. Similarly, the KKH (10.2) was larger than the provincial average (4.7). Possibly, labour requirements and/or surplus of food attracted dependents who were taken up in the household.

Costs and returns

Ploughing

The economic returns of ploughing were based on the amount of cultivated land, labour requirements and yields per ha obtained by ploughing as compared with hand-hoeing. This concept was used

Table VI

Distribution of total herd benefits, cost and cash flow to the average kraal keeper's household (KKH)
(SD = standard deviation)

Gross returns	KKH Share (%)	Amount		Cash receipts	
		(US \$)	(%)	(US \$)	(%)
Ploughing	60 (SD = 29)	261	19	5	1
Transport	65 (SD = 35)	40	3	4	1
Manure	59 (SD = 38)	70	5		
Milk	78 (SD = 29)	266	20	66	13
Cattle sales	54 (SD = 40)	298	22	298	60
Local slaughter	85 (SD = 28)	158	12	119	24
Hides	60	6	0	6	1
Births-deaths	60	243	18		
Total return	64	1342	100	497	100
Costs	KKH Share (%)	Amount		Cash spent	
		(US \$)	(%)	(US \$)	(%)
Labour	83	284	50	125	53
Drugs	100	2	0	2	1
Cattle purchases	66	75	13	75	32
Replacem. implements	100	35	6	35	15
Interest	60	173	30	0	0
Total cost	73	569	100	237	100
Net return	58	773		260	

Table VII

Average distribution of benefits and cash income of farm and non-farm activities per kraal keeping household

Source of income Kraal keeping household	Returns		Cash receipts	
	(US \$)	(%)	(US \$)	(%)
Cattle	513	50	173	37
Crops	320	31	102	22
Other farm activities	59	6	59*	13
Off-farm activities	131	13	131*	28
Total	1023	100	464	100

* Household expenditures were not collected during the survey

instead of the concept of "opportunity cost", because the latter was found inappropriate due to the absence of a free market caused by many social obligations and restrictions in hiring out of oxen for ploughing during the time of field preparation.

Data from an animal draught-power survey in Senanga District of the WP (18) estimated an average cultivated area of 5.0 ha (4.2 ha ploughed) for households owning oxen against an average area of 3.0 ha for households without oxen. This implies a smaller effect in area expansion compared to the conclusions from Pingali *et al.* (19) which were applied in our study. The animal draught-power survey (18) indicated a difference of 20 days from hand-hoeing to harvesting compared to ploughing by oxen to harvesting which is similar to the data of Barrett *et al.* (2) which were used in this study.

People in the study area, including some who owned oxen, generally complained of a shortage of draught-oxen. However, there are more than 46 days per average herd of 66 animals on which ploughing is possible in the WP (16) and ploughing can be increased to about 5 h per day (21). It can be concluded that oxen ploughed fewer fields than they potentially could and, consequently, there is room to increase the output of draught-power. Reasons for the under-employment of oxen were related to an uneven distribution of oxen, both socially and topographically, the poor quantity and quality of fodder, shortage of cash and absentee ownership.

Manure

The conventional way to assess the economic returns of manure is to convert it into nutrient equivalents of fertilizer. In the WP

fertilizers are only used in part of Kaoma District, on relatively good soils. The soils of the rest of the WP are too sandy to justify use of inorganic fertilizers. Alternatively, the assessment of the economic return of manure was based on its contribution to the farming system. The effect of manure is determined by additions of phosphorus and potassium, in combination with increase in the water holding capacity of the soil (17). The traditional application of manure through kraaling is approximately 15 tons/ha annually, corresponding to 90 kg N, 20 kg P₂O₅, 75 kg K₂O and 75 kg SO₃ (17). These high applications can be used more efficiently if a larger area is manured annually because application of high rates of cattle manure can give rise to leaching of organic carbon, nitrogen and phosphorus, and it is more efficient to apply small amounts of manure frequently than large amounts at longer intervals (5).

Although manure is commonly considered to be one of the main products of cattle-keeping in the WP, it is not in general used fully. The main reasons for not using manure were a shortage of labour, lack of interest or because nearby fields were in cultivation. Even in areas where manuring was common it played a minor role (5 %) in terms of gross returns, because only a limited area was manured annually, and the resultant value of crops was low. This agrees with the results of an economic study on fertilizer equivalents which found that the contribution of manure to the kraal income was low (10 %) (15). However, farmers considered reducing the risk of crop failure as an important reason for the application of manure to be essential. In Sesheke District (GMS-2) manure was used less than in other districts, possibly because the district has more shifting cultivation, is drier, and maize is less common.

Herd increase and meat production

Outbreaks of disease in 1986 in the Southern Province (East Coast fever, foot and mouth disease) led to restrictions of cattle movement. Many private traders from the Southern Province shifted their trade to the WP. Therefore, the sales recorded in this report were higher than in previous years, especially in GMS-4. However, from 1987 to 1992 cattle sales remained at this higher level, a trend which is likely to continue. Despite this increase, the sale of cattle (6.4 % of the animals) was low and there is room to increase it, especially since the natural increase of the herd is large. If culling was more timely, the number of animals for emergency slaughter could be reduced as well. A higher offtake would require farmers to have improved marketing channels and good prices. In return, this could result in a higher income for the rural population and a larger meat supply of the local market.

The gross returns in the form of protein production, i.e. cattle sales, local slaughter and milk together, formed 53 % of the total gross returns.

Cost of land and labour

No land cost has been considered in this study since there is no individual land ownership and all land with good soils for crop cultivation is allocated by the chiefs. The opportunity cost of labour was determined at \$ 0.38 per day. A study of households growing cassava and maize in Kaoma District also found a gross margin of \$ 0.38 per labour day (4).

Distribution of C&R to the kraal keepers' household

The KKs owned 44 % of all animals of the herds in the survey, their wives 3 % and their children 14 %. Together they owned

about 60 % of the cattle (6). This might be a slight underestimate because some KKs or their dependents may have had cattle in other herds. Thirty-two percent of the cattle belonged to relatives and 8 % to others. From table VI it can be observed that 54 to 85 % of the gross returns per kraal went to the KKH. The allocations of milk and meat to the KKH were the highest at 78 and 85 %, though actual consumption was only 62 and 47 % of the kraal production. Meat consumption by the KKH was low because meat usually became available after an emergency slaughter and most was then sold. Slaughter for social purposes was uncommon in village life. Milk gradually became available in small quantities every day. Milk surpluses only occurred in the wet season and scarcely, if at all, in the long dry spell. Moreover, the KK who was also responsible for keeping someone else's cow was often rewarded in milk. Consequently, milk from cows owned by people not living near the kraal was often consumed by the KKH or partly sold. The share of the KKH in the net return at 58 % was similar to the distribution of ownership of cattle (60 %).

Other income

Cattle made a sizeable contribution (50 %) to the total income of the KKH. In terms of cash, the direct contribution of cattle was much less: \$ 173 or 37 %. This is because most expenses incurred on cattle are paid in full by the KK. On the other hand, cash from crop sales, partly as a result of the use of animal draught-power and manure, was not credited to cattle. Furthermore, the labour costs were calculated at \$ 0.38 per day but in actual fact amounted to much less, since herdsman were partly paid in kind. Consequently, the cash contribution of cattle was much greater than the results of this study would suggest.

Provincial output

The total provincial net return was \$ 8,479,000 per year. The assessed net income was \$ 1.4/ha/yr and is lower than the income from extensive grazing of \$ 2.4/ha/yr as found in East Africa (7). This is probably due to the low stocking rates found in the WP (1).

■ CONCLUSION

Gathering economic information on cattle kraal management to augment technical production data obtained by the monitoring programme provided an interesting and quantitative insight into the multi-functional contribution of cattle in providing draught-power, cash, milk and meat. The role of cattle as providers of manure appeared minor in economic terms. The study also indicated that there is room to increase draught-power and offtake of the herd. The study further led to the conclusion that cash income from cattle husbandry provided a major part of the total income of the KKH and that the C&R were related to ownership of cattle.

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REFERENCES

1. BAARS R.M.T., JEANES K.W., 1996. The carrying capacity of the Western Province of Zambia. *Trop. Grasslands* (in press)
2. BARRETT V., LASSITER G., WILCOCK D., BAKER D., CRAWFORD E., 1982. Animal traction in Eastern Upper Volta: a technical, economical and institutional analysis. East Lansing, USA, Department of Agricultural Economics/Michigan State University.
3. BESSELL J.E., DAPLYN M.G., 1977. Dairying in Zambia, the traditional sector. Nottingham, United Kingdom, University of Nottingham, 128 p. (Farm Management Investigations for Zambia, Bulletin no. 3)
4. BIJL G. v.d., 1987. Farming systems in a changing policy environment. MSc. thesis, Agricultural University of Wageningen, the Netherlands, 22 p.
5. BROUWER J., POWELL J.M., 1993. Soil aspects of nutrient cycling in a manure application experiment in Niger. In: Powell J.M., Fernández-Rivera S., Williams T.O., Renard C. eds., *Livestock and sustainable nutrient cycling in mixed farming systems of sub-Saharan Africa*, Vol. II: Technical papers. Proc. Int. Conf. ILCA, 22-26 November 1993, Addis Ababa, Ethiopia, p. 211-226.
6. CORTEN J.J.F.M., 1988. Productivity of cattle in Western Province, Zambia. Mongu, Zambia, Department of Veterinary and Tsetse Control Services, 83 p. (Third and final draft report)
7. COSSINS N.J., 1985. The productivity and potential of pastoral systems. *ILCA Bulletin*, 21: 10-15.
8. DE HAAN C., NISSEN N.J., 1985. Animal health services in Subsaharan Africa: Alternative approaches. Washington, USA, World Bank. (Technical Paper No. 44)
9. DE ROOIJ R.C., WOOD A.P., 1989. "Who pays the bill": Towards sustainable cattle development in Western Zambia. In: Proc. 6th Int. Conf. AITVM, Wageningen, the Netherlands, 28th August-1st September 1989.
10. DEPARTMENT OF VETERINARY AND TSETSE CONTROL SERVICES, 1992. Annual report Western Province 1991. Mongu, Zambia, DVTCS, 14 p.
11. EPSTEIN H., 1971. The origin of domestic animals. New York, USA, Africana Publishing Corp.
12. INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA, 1988. Annual report 1987. Addis Ababa, Ethiopia, ILCA.
13. JEANES K.W., BAARS R.M.T., 1991. Vegetation ecology and rangeland resources of Western Province. Western Province, Zambia, Livestock Development Project, Tsetse Control Project Senanga West, DVTCS, Department of Agriculture, 208 p.
14. MACLEAN H.A.M., 1965. An agricultural stocktaking of Barotseiland. Lusaka, Zambia, Government Printer, 49 p.
15. MWAFULIRWA C., MOLL A.J., 1991. Economics of the cattle and crop sub-sectors of Western Province. Western Province, Zambia, DVTCS, LDP, 36 p.
16. NIESTEN M.J., 1984. Sketch of the farm household in Mongu District. Mongu, Zambia, Department of Agriculture.
17. PENNINKHOFF E.P., 1990. Cattle manure in the farming system of Western Province: practices and possibilities. Mongu, Zambia, Adaptive Research Planning Team, Department of Agriculture, 133 p.
18. PHIRI L., 1988. Animal draught-power survey, Senanga District. Mongu, Zambia, Department of Agriculture, Agricultural Engineering Section/Senanga West Agricultural Development Project, 49 p.
19. PINGALI P., BIGOT Y., BINSWANGER H.P., 1987. Agricultural mechanization and the evolution of farming systems in Sub-Saharan Africa. Baltimore, USA, Johns Hopkins University Press.
20. POPULATION CENSUS, 1980. Lusaka, Zambia, Ministry of Statistics, 40 p.
21. SINGH A., SIVANESON S., 1981. Oxen - As a source of farm power. Kabwe, Zambia, Department of Agriculture.
22. WOOD A.P., 1986. Research proposal: Policy implications of socio-economic aspects of cattle keeping in Western Province, Zambia. Huddersfield, United Kingdom, the Polytechnic.

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Résumé

Baars R.M.T., de Jong R., Zwart D. Les coûts et revenus de l'association de l'élevage bovin et de l'agriculture dans la Province de l'Ouest de la Zambie

Une analyse économique a été réalisée sur 50 cheptels afin de déterminer pour chacun la répartition des gains et des dépenses entre les familles, et en quelles proportions il contribuait aux revenus de la famille par rapport aux autres revenus agricoles et à ceux provenant d'autres sources. La vente de bétail, le labour avec les bœufs, l'accroissement du cheptel et la production de lait se sont avérés être les sources de revenus les plus importantes (respectivement 26, 21, 19 et 16 p. 100 des revenus totaux bruts). Les revenus de l'abattage local, du fumier et de l'usage des bœufs pour le transport ne jouaient qu'un rôle mineur. Les coûts calculés représentaient environ le tiers des revenus bruts. L'efficacité économique annuelle nette a été évaluée à 1,4 US\$ par ha. La famille du gérant du cheptel, qui possédait 60 p. 100 du troupeau, avait à son actif environ 64 p. 100 des revenus bruts totaux, 73 p. 100 des dépenses totales et 58 p. 100 des revenus nets. Les revenus nets moyens provenant du bétail, des récoltes, de la vente de produits agricoles et de sources non agricoles représentaient respectivement 50, 31, 6 et 13 p. 100 du revenu total de la maisonnée. Les résultats ont démontré que l'importance de la traction animale et la vente d'animaux pouvait être améliorée.

Mots-clés : Bovin - Analyse économique - Polyculture élevage - Bétail - Economie agricole - Coût - Revenu - Zambie.

Resumen

Baars R.M.T., de Jong R., Zwart D. Costos y beneficios del sistema cultivo-ganado en la Provincia Oeste de Zambia

Se analizaron los costos y los beneficios por hato (N = 50), así como su distribución entre las familias, se estudió también la relación con otros ingresos provenientes de la finca o fuera de ella. Las ventas de ganado, el arado por bueyes, el incremento en el número de cabezas y la producción de leche parecen ser los principales beneficios (26, 21, 19 y 16 p. 100 de los beneficios totales respectivamente). Los matanzas locales, el abono y el transporte con bueyes parecen jugar un menor papel. Los costos calculados fueron de alrededor un tercio de los beneficios brutos. La eficiencia económica neta se calculó en US\$ 1,4 por ha por año. Los pastores "kraal" de los hogares (KKH), propietarios de 60 p. 100 de los hatos, recibieron 64 p. 100 del total de los beneficios brutos, realizaron 73 p. 100 de los gastos totales y recibieron 58 p. 100 de los beneficios netos. El beneficio neto promedio del KKH, a partir del ganado, cultivos, ventas y otros productos derivados de la finca o de productos externos, fue de: 50, 31, 6 y 13 p. 100 del total del ingreso por hogar respectivamente. Existe la posibilidad de aumentar la importancia de la energía por tracción y de las ventas de animales.

Palabras clave : Ganado - Analisis económico - Explotación agrícola combinada - Economía agrícola - Costo - Renta - Zambia.