Productivity and profitability of cattle stall-fed for beef on smallholder farms in Malawi*

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SUMMARY

*A*NALYSES WERE *carried out to determine the biological performance of 5483 steers stall fed in the Southern and Central regions of Malawi during 1972–82. The financial returns to steer fattening on smallholder farms in the two regions were also estimated*

In the Southern Region, the mean fattening period was 188 days, with steers gaining 0.59 kg day^{-1} on average. In the Central Region, steers were stall fed for 213 days on average and gained 0.50 kg day^{-1}. The respective mean carcass weights were 210 and 194 kg, with an average dressing percentage of 52.3. Weight gain was influenced by fattening period, breed × month interaction and age. The smaller Malawi Zebu steers had better weight gain rates per metabolic body weight than crossbreds.

Financial returns to fattening were high, implying that most smallholders made profit. About 60% of the net returns were due to changes in beef prices, 18% to weight gains, and 22% to interacting price and weight changes.

INTRODUCTION

Stall-feeding cattle to increase domestic beef production was started in Malawi in 1957. The scheme was first introduced in the Southern Region and was rapidly adopted by smallholders in other parts of the country.

The stall-fed animals were mostly steers obtained on credit from the Ministry of Agriculture (MOA); only in a few cases did smallholders use steers produced from their own herds. Farmers were supplied with two steers from stock purchased at the local markets or from livestock breeding centres, particularly the Chisombezi multiplication centre in the Southern Region and the Dzalanyama ranch in the Central Region.

In the early 1970s, the Ministry of Agriculture started keeping records of animals entering the fattening scheme to control the repayment of credits. In 1984, two ILCA scientists and an official of the Ministry of Agriculture extracted information on the scheme from records kept at the Ministry's Blantyre and Lilongwe offices. The data were then analysed and interpreted by the team, with help from an ILCA economist. This report presents the results of biological and financial analyses performed on a random set of data collected during the 1972–82 period.

STALL-FEEDING OPERATIONS

Environment

The analyses focus on cattle stall-feeding operations in the districts of Blantyre (Southern Region) and Lilongwe (Central Region). Both regions have a predominantly subtropical climate, with a unimodal rainy season from November to April followed by a long dry season from May to October. Figure 1 shows the mean annual rainfall recorded during 1972–81 at four meteorological stations representative of the areas in which smallholders and cattle multiplication centres operate. The mean monthly rainfall for one of the stations, the Chileka station in southern Malawi, is shown in Figure 2.

Figure 1. *Average annual rainfall at Chileka, Chichiri, Lilongwe and Chitedze meteorological stations, Malawi, 1972–81.*

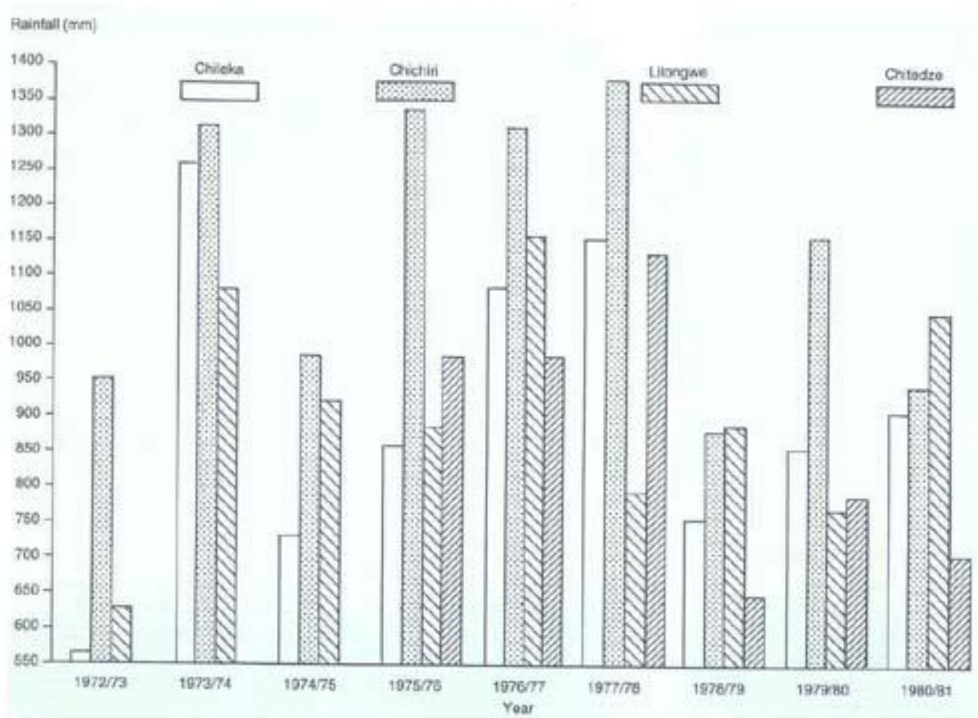
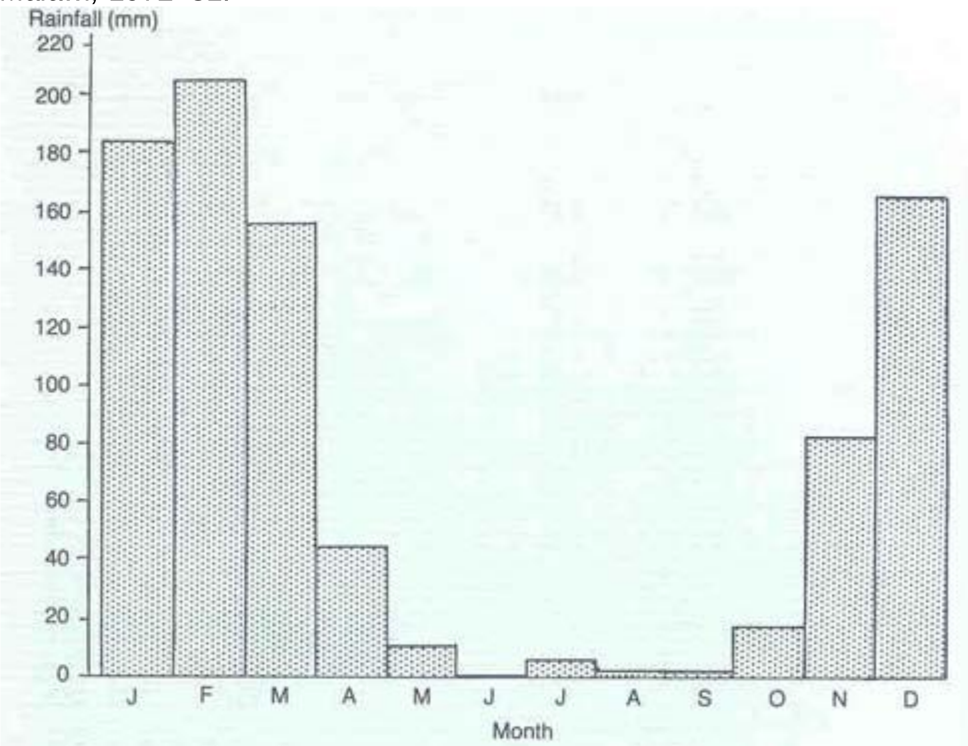


Figure 2. *Average monthly rainfall distribution, Chileka meteorological station, southern Malawi,* 1972–81.



Management

The management system used at the stalls depends on the resources available to the smallholder. Fattened animals are housed separately in stalls constructed from eucalyptus poles and thatched with hyparrhenia grass. The stalls are frequently built in a long line to reduce construction costs and facilitate the delivery and collection of steers.

Animals are fattened throughout the year, but stall-feeding during the dry season is more common, particularly in the Lilongwe District. During the wet season, steers are fed cut fodder, mainly improved Napier *(Pennisetum purpureum)* or Rhodes *(Chloris gayana)* grass and such indigenous species as *Hyparrhenia, Panicum; Setaria* and *Digitaria.* The main roughages fed during the dry season are maize stover and groundnut haulms, while maize bran *(madeya)* is given as a supplement.

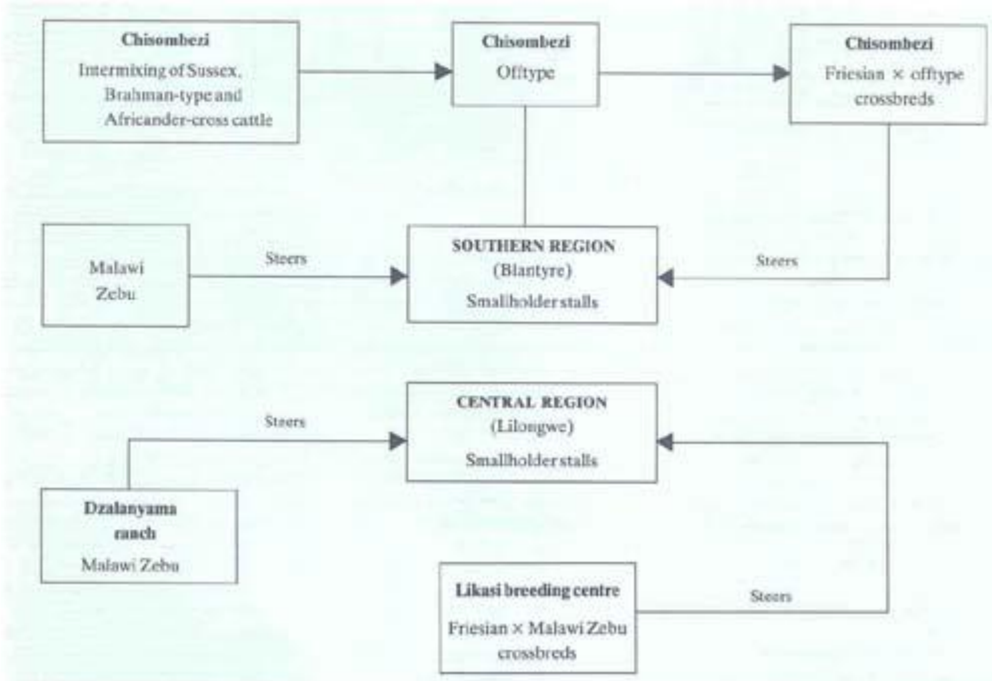
Cattle breeds

Most stall-fed cattle were from the Dzalanyama ranch in central Malawi and the Chisombezi multiplication centre in the south of the country. The Dzalanyama ranch has mainly Malawi Zebu cattle, which is an indigenous *Bos indicus* breed. The Chisombezi animals are of a nondescript 'offtype' breed, which is a composite of Sussex, Brahman-type and Africander crosses.

In addition to these 'pure' forms, crossbred cattle of Malawi Zebu and Friesian *(Bos taurus)* inheritance can be found in the Central Region, where the two breeds are used in a dairy cattle crossbreeding programme. In the Southern Region, Friesian × offtype crossbreds are common (Agyemang and Nkhonjera, 1986).

The steers used for fattening in the Central Region (Lilongwe area) are therefore either pure Malawi Zebu or Friesian × Malawi Zebu crossbreds. In the Southern Region (Blantyre area), three categories of steer are found – pure Malawi Zebu, offtype and Friesian × offtype crossbreds. The steer production schemes used in the two regions are shown in Figure 3.

Figure 3. *Steer production schemes in the Southern and Central regions of Malawi.*



DATA PREPARATION AND ANALYSIS

Data were extracted by random sampling: for Lilongwe, random samples were taken for each year during the 1972–82 period, and for Blantyre during 1974–81. The data were checked for incorrect and inconsistent dates of steer entry and departure from stalls. After editing, the Lilongwe data set comprised 2985 records and that for Blantyre 2498 records.

Since no information was available on the genetic composition of individual steers, their weights at the start of the fattening period were subjected to frequency (10-kg interval) distribution analyses. Histograms based on these analyses indicated a distinct two-peak weight distribution for the Lilongwe steers and a three-peak distribution for those in Blantyre. This suggested that there are two steer subpopulations in the Lilongwe area and three in the Blantyre area.

A truncation point of 250 kg was used to distinguish between the two subpopulations in Lilongwe: steers weighing up to 250 kg at the start of the fattening period were assumed to be Malawi Zebu and those with an initial weight of >250 kg to be Friesian × Malawi Zebu crossbreds. The three subpopulations in the Blantyre area were Malawi Zebu (250 kg), offtype (250—350 kg) and Friesian × offtype steers (>350 kg). These subdivisions correspond to the weights of Malawi cattle reported by Thomas and Addy (1977).

Five age classes were established on the basis of dentition (0, 2, 4, 6 and 8 permanent incisors). There were no 0-tooth steers in the Lilongwe data set and no 8-tooth steers in the Blantyre data set.

For each steer, records were assembled for all performance and economic traits. The individual traits analysed were initial weight, final weight, days on feed, daily weight gain, carcass weight, dressing percentage, grade, price on entering the stall, price on leaving the stall, and gross margin. All characters were analysed by least squares procedures (Harvey, 1977), using fixed-effects models.

All continuous variables which were measured prior to grading the steers (i.e. on leaving the stall or at slaughter) and grade itself (determined on a categorical scale of 1, 2, 3 or 4) were analysed using a fixed-effects model which included breed group, number of teeth on arrival at the stall, month and year of arrival, and breed group × month interaction.

The continuous variables measured at the time of grading or after were cold dressed weight (carcass weight), dressing percentage, total price on leaving the stall, and gross margin. These variables were examined using a fixed-effects model which included grade, breed group, number of teeth, month and year of arrival at the stall, and breed group × month interaction.

The residual mean square was used as the error term to test the significance for each character analysed. Linear contrasts of least squares means were computed to determine the significance of differences between groups.

BIOLOGICAL ANALYSES

The objective of the biological analyses was to identify environmental and genetic factors influencing the biological rate of weight gain in stall-fed steers. The Lilongwe and Blantyre data were analysed separately, but using the same statistical models. Related traits are discussed together for both areas.

Initial and final weights

The mean initial and final weights of 2498 Blantyre steers were 298 ± 20 and 401 ± 48 kg, with coefficients of variation (CV) of 6.8% and 12.0% respectively. The corresponding means for 2985 Lilongwe steers were 271 ± 25 kg (CV = 9.4%) and 370 ± 48 kg (CV = 11.9%).

Analyses of variance for initial and final weights of stall-fed steers are presented in Table 1. In Blantyre, initial weight was significantly ($P<0.01$) influenced by all variables. The results for Lilongwe were similar, except that initial weight was not influenced by number of teeth.

Table 1. *Analyses of variance of initial and final weights of stall-fed steers, Blantyre and Lilongwe areas, Malawi, 1972–82.*

Source of variation	Blantyre			Lilongwe		
	d.f.	Initial weight (MS $\times 10^{-2}$)	Final weight (MS $\times 10^{-2}$)	d.f.	Initial weight (MS $\times 10^{-2}$)	Final weight (MS $\times 10^{-2}$)
Breed group	2	12968**	11709**	1	4438**	4278**
Number of teeth	3	46**	27	3	1	38
Month entered	11	36**	156**	9	75**	294**
Year entered	7	31**	274**	10	270**	409**
Breed ×month	2	91**	252**	9	110**	189**
Remainder	2452	4	23	2952	7	22

** = $P<0.01$

The mean initial weights of Malawi Zebu, offtype and Friesian × offtype steers in Blantyre were respectively 235, 292 and 369 kg. The corresponding mean final weights were 339, 392 and 467 kg. In Lilongwe, Malawi Zebu steers weighed on average 240 kg at the beginning and 342 kg at the end of stall-feeding. The mean initial and final weights of Friesian × Malawi Zebu crossbreds were 293 and 395 kg.

In Blantyre, large differences in initial body weight were indicated by the significant breed group × month interaction: the weight of Friesian x offtype and Malawi Zebu steers which started fattening during the months of October – February, March – May and June – August differed by 124, 140 and 118 kg respectively. The corresponding differences in final weight were 44, 52 and 72 kg. These figures imply that Malawi Zebu steers grew relatively faster during certain periods of the year than crossbreds. Similar breed group × month effects were observed in Lilongwe for Friesian × Malawi Zebu and Malawi Zebu steers.

Age of steer had no significant effect on final weight in either of the study areas. Despite differences in age, the initial weights of Lilongwe steers were similar, indicating that steers were drafted for fattening when they reached the appropriate weight. However, the lack of significant difference in steer weight was also partly due to confounding with breed effects. In Blantyre, the significant differences in initial weight observed for various tooth classes over and above those obscured by possible confounding of age and breed were due to the large difference (124 kg) in initial body weight between the Malawi Zebu and Friesian × offtype steers. The liveweight changes observed in this study were comparable to those reported by Spurling and Spurling (1972), Beale et al (1979) and Butterworth et al (1984), who in their experiments used diets similar to those fed in practice.

Number of days at stall and daily weight gain

The mean stall-feeding period in Blantyre was 188 ± 53 days (CV = 28%) and in Lilongwe 213 ± 54 days (CV = 26%). Analyses of variance for days at stall and daily weight gain are shown in Table 2.

Table 2. *Analyses of variance of days at stall and daily weight gain of stall-fed steers, Blantyre and Lilongwe areas, Malawi, 1972–82.*

Source of variation	Blantyre			Lilongwe		
	d.f.	Days at stall (MS × 10^{-2})	Daily weight gain (MS × 10^{2})	d.f.	Days at Stall (MS × 10^{-2})	Daily weight gain (MS × 10^{2})
Breed group	2	252**	23	1	313*	10
Number of teeth	3	241**	25	3	101**	10
Month entered	11	468**	129**	9	716**	76**
Year entered	7	763**	115**	10	1607**	69**
Breed × month	22	85**	113	9	46	9
Remainder	2452	28	22	2952	30	6

*=P<0.05. **=P<0.01

Fattening period was significantly influenced by all variables except breed × month interaction in Lilongwe. Smaller breeds had a longer fattening period than larger breeds: the average periods for Malawi Zebu steers in Blantyre and Lilongwe were 201 days and 212 days, while the respective means for the Friesian × offtype and Friesian × Malawi Zebu crossbreds were 182 and 198 days. Younger steers tended to stay at the stall longer than older ones: in Blantyre, steers with four permanent incisors at the start of stall-feeding were fattened for 191 days and those with six incisors for 178 days.

The mean daily weight gain for the Blantyre steers was 0.59 ± 0.48 kg (CV = 81%); the corresponding figures for the Lilongwe steers were 0.50 ± 0.22 kg (CV = 43%). Table 2 shows that daily weight gain was significantly influenced by the month and year of the start of stall-feeding, but not by the age of the steer and breed (Friesian × offtype steers gained 0.60 kg day^{-1}, Friesian × Malawi Zebu 0.54 kg day^{-1} and Malawi Zebu 0.52 kg day^{-1}).

When 'pure' breeds and crossbreds were compared[1] on the basis of equal metabolic body weight, breed differences were significant. Lilongwe Malawi Zebus and Friesian × Malawi Zebu crossbreds gained 7.77 and 7.26 g day^{-1} $kg^{-0.73}$ respectively (P< 0.05), while the Blantyre Malawi Zebu, offtype and Friesian × offtype steers gained 8.58, 7.58 and 7.16 g day^{-1} $kg^{-0.73}$.

[1]Comparative figures obtained by dividing daily weight gains by average metabolic body weight (mean of initial plus final weight)$^{0.73}$

In Blantyre, Malawi Zebu steers were significantly (P< 0.01) superior to both the offtype and crossbred steers, but the difference in weight gain between the offtype and crossbred steers was not significant. These results contradict Thomas and Addy (1977) who reported that the liveweight gains of Friesian crossbreds were significantly higher than those of Malawi Zebu steers. Their study, however, did not take into account breed differences in metabolic body weight.

Steers which started stall-feeding in April, May and June had the highest daily weight gains (Figure 4), benefiting probably from the high-quality crop residues available at the end of the dry season and beginning of the rainy season. Increased daily weight gain was indicated for 1977–81 (Table 3), but this trend could not be related to total precipitation for the individual years.

Figure 4. *Average daily weight gains of Blantyre and Lilongwe steers starting stall feeding at different months of the year, Malawi, 1972–82.*

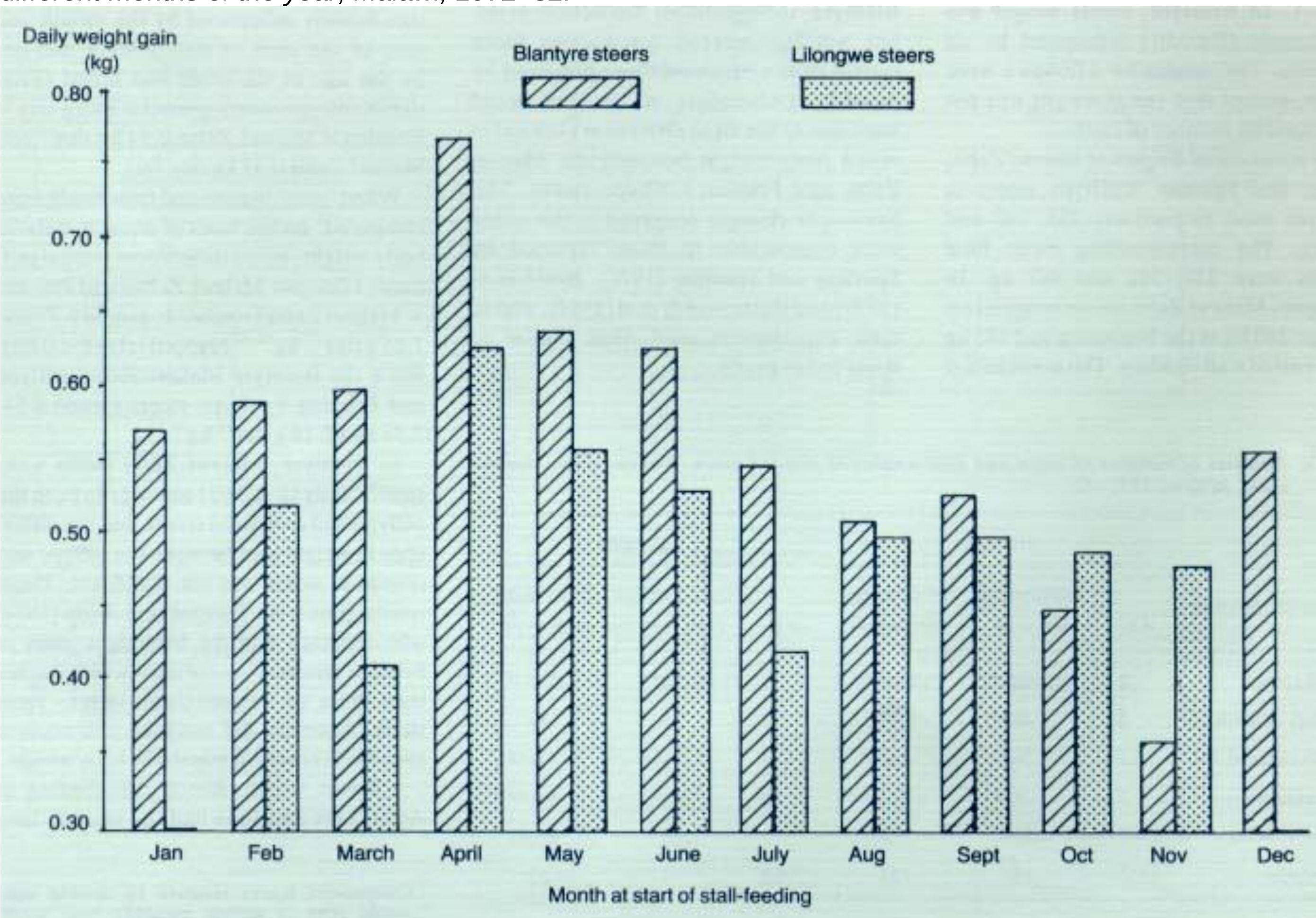


Table 3. *Estimated least squares means[1] for liveweight traits of stall-fed steers, Blantyre and Lilongwe areas, Malawi, 1972–82.*

Year entered	Blantyre				Lilongwe			
	Number of animals	Initial weight (kg)	Final weight (kg)	Daily weight gain (kg)	Number of animals	Initial weight (kg)	Final weight (kg)	Daily weight gain (kg)
Overall	2498	298	399	0.56	2985	266	368	0.50
1972	n.a.[2]	n.a.	n.a.	n.a.	202	265d	366c	0.40a
1973	n.a.	n.a.	n.a.	n.a.	429	254a	365c	0.40a
1974	62	307e	421e	0.61ab	372	261c	374cd	0.44a
1975	715	297bc	393bc	0.54a	314	250a	369cd	0.47b
1976	415	293ab	388ab	0.49a	30	257b	373cd	0.54c
1977	441	299cd	393bc	0.56ab	185	266d	355b	0.43a
1978	389	301de	398c	0.58ab	191	259b	353b	0.44a
1979	189	298cd	414d	0.66d	426	261c	342a	0.41a
1980	40	290ab	372a	0.40a	269	262c	366c	0.55c
1981	247	302de	415d	0.69c	540	279e	379cd	0.46b
1982	n.a.	n.a.	n.a.	n.a.	27	310f	410e	0.54c

[1] Within variable groups, means followed by the same letter do not differ significantly at the 5% level.
[2] n.a. = not applicable.

Carcass weight and dressing percentage

The mean carcass weight of 2498 Blantyre steers was 210 ± 28 kg (CV = 13.1%); in Lilongwe, 2985 steers had a mean carcass weight of 194 ± 23 kg (CV = 12%). The mean dressing percentage was 52.3 for both locations, with coefficients of variation of 4.1% (Blantyre) and 2.6% (Lilongwe).

Analyses of variance of carcass weight and dressing percentage are presented in Table 4. Carcass weight was significantly influenced by breed, grade, month and year of the start of stall-feeding, and breed×month interaction. Dressing percentage varied with grade (in both Blantyre and Lilongwe) and breed×month interaction (in Lilongwe). Age at the start of stall-feeding did not influence the carcass weight and dressing percentage of Blantyre steers, but exerted a significant effect on carcass weight in Lilongwe.

Table 4. *Analyses of variance of carcass weight and dressing percentage of stall-fed steers, Blantyre and Lilongwe areas, Malawi, 1972–82.*

Source of variation	Blantyre			Lilongwe		
	d.f.	Carcass percentage (MS × 10^{-2})	Dressing percentage (MS × 10^{2})	d.f.	Dressing percentage (MS × 10^{-2})	Dressing percentage (MS × 10^{2})
Breed group	2	2008**	307	1	748**	1
Grade	3	2078**	180 518**	2	2012**	1916**
Number of teeth	3	11	510	3	28**	2
Month entered	11	39**	279	9	51**	2
Year entered	7	44**	404	10	98**	7**
Breed × month	22	55**	201	9	47**	2
Remainder	2449	5	242	2950	5	2

**= $p<0.01$.

Estimated least squares means for carcass weight and dressing percentage are given in Table 5. Larger breeds had higher carcass weights than smaller ones: the mean difference in carcass weight between the Friesian× offtype crossbreds and Malawi Zebus was 63 kg. Dressing percentage did not differ among the various breed groups. Better-grade animals had higher carcass weight and dressing percentage than animals with lower grades. This was to be expected since the former carry more 'finish', which is a function of carcass fat and is also closely associated with dressing percentage.

Table 5. *Estimated least squares means[1] for carcass weight and dressing percentage of stall-fed steers Blantyre and Lilongwe areas, Malawi, 1972–82*.

Variable	Blantyre			Lilongwe		
	Number of animals	Carcass weight (kg)	Dressing percentage (%)	Number of animals	Carcass weight (kg)	Dressing percentage (%)
Overall	2498	184	49.2	2985	185	51.2
Breed group						
Malawi Zebu	749	158a	49.2	1241	173a	51.2
Offtype	1021	180b	49.3	n.a.2	n.a.	n.a.
Crossbred	728	213c	49.3	1744	196b	51.3
Grade						
Prime	1723	221d	52.8d	1790	205c	53.1c
Choice	573	192c	51.9c	1003	183b	52.1b
Standard	153	169b	48.0b	192	166a	48.3a
Common	49	153a	44.4a	n.a.	n.a.	n.a.
Number of teeth						
0	291	181	49.1	n.a.	n.a.	n.a.
2	195	184	49.4	234	184a	51.1
4	852	183	49.4	192	181a	51.1
6	160	187	49.3	787	184a	51.1
8	n.a.	n.a.	n.a.	38	192b	51.5
Month entered						
January	190	189d	49.0	n.a.	n.a.	n.a.
February	123	184c	49.5	292	184c	51.2
March	445	188d	49.3	79	174a	51.2
April	230	193e	49.3	198	196e	51.0
May	297	180b	49.1	975	189d	51.2
June	380	189d	49.3	735	183bc	51.3
July	125	182b	49.3	727	180b	51.2
August	153	184c	49.3	181	186d	51.3
September	107	178a	49.0	95	192d	51.3
October	261	180b	49.5	92	187d	51.1
November	111	173a	49.3	11	177ab	51.1
December	76	186cd	49.7	n.a.	n.a.	n.a.
Year entered						
1972	n.a.	n.a.	n.a.	202	182bc	51.0ab
1973	n.a.	n.a.	n.a.	429	182bc	51.2bc
1974	62	190	49.2	372	189d	51.0ab
1975	715	182	49.4	34	184c	51.2bc

1976	415	180	49.6	30	184c	52.0f
1977	441	181	49.3	185	181bc	51.2bc
1978	389	182	49.3	191	179ab	51.0ab
1979	189	192	49.4	426	173a	50.8a
1980	40	172	48.7	269	181bc	51.0ab
1981	247	184	49.3	540	190d	51.1ab
1982	n.a.	n.a.	n.a.	27	209e	51.8 e

[1] Within variable groups, row means followed by the same letter do not differ significantly at the 5% level. Means without any letter following did not show a significant difference in the analysis of variance.
[2] n.a. = not applicable.

Grade

At the end of fattening, grade of steers was determined as prime, choice, standard and (in Blantyre) common, coded as 1, 2, 3, and 4.

Table 6 shows that carcass grade was significantly influenced by all variables except breed × month interaction in Lilongwe. Estimated least squares means for carcass grade are presented in Table 7.

Table 6. *Analysis of variance of carcass grade of stall-fed steers, Blantyre and Lilongwe areas, Malawi 1972–82.*

Source of variation	Blantyre		Lilongwe	
	d.f	MS×10^2	d.f.	MS×10^2
Breed group	1	2708**	1	1966**
Number of teeth	3	87**	3	1258**
Month entered	11	351**	9	218**
Year entered	7	311**	10	996**
Breed × month	22	108**	9	12
Remainder	2452	38	2752	31

**=p<0.01.

Table 7. *Estimated least squares means[1] for carcass grade of stall-fed steers, Blantyre and Lilongwe areas, Malawi, 1972–82.*

Variable	Blantyre		Lilongwe	
	No. of animals	Carcass grade	No. of animals	Carcass grade
Overall	2498	1.46	2985	1.52
Breed group				
Malawi Zebu	749	1.75c	1241	1.70a
Offtype	1021	1.16b	n.a.[2]	n.a.
Crossbred	728	1.16a	1744	1.31b
Number of teeth				
0	291	1.48	n.a.	n.a.
2	1195	1.40	234	1.30a
4	852	1.42	1926	1.35a
6	160	1.52	787	1.59b
8	n.a.	n.a.	38	1.86c
Month entered				
January	190	1.35ab	n. a.	n.a.
February	123	1.37ab	292	1.46b
March	445	1.29a	79	1.56c
April	230	1.61de	198	1.42ab
May	297	1.31a	975	1.57bc
June	380	1.59de	735	1.59bc
July	125	1.66f	32	1.75bc

August	153	1.52ef	181	1.49bc
September	107	1.40bc	95	1.57bc
October	261	1.47cd	92	1.32a
November	111	1.72f	11	1.50bc
December	76	1.10a	n.a.	n.a.
Year entered				
1972	n.a.	n.a.	202	1.51c
1973	n.a.	n.a.	429	1.54c
1974	62	1.21a	372	1.69dc
1975	715	1.54c	314	1.43b
1976	415	1.48bc	30	1.16a
1977	441	1.47c	185	1.69de
1978	389	1.35b	191	1.63d
1979	189	1.45c	426	1.70de
1980	40	1.89a	269	1.41b
1981	247	1.27a	540	1.54c
1982	n.a.	n.a.	27	1.44bc

[1] Within variable groups, row means followed by the same letter do not differ significantly at the 5% level. Means without any letter following did not show a significant difference in the analysis of variance.
[2] n.a. = not applicable.

Malawi Zebu steers had a consistently poorer grade than crossbred steers. Younger animals were graded better than older ones because the grading system used gave premium to younger animals. In Lilongwe, steers which went on feed during May through to July were graded better than those that started stall-feeding in other months. In Blantyre, better grades were associated with April to August. The month of starting stall-feeding did not affect final grade, but Thomas and Addy (1977) reported that date of slaughter affected carcass grade, the best months to slaughter being July through to September.

Initial and final steer prices and gross margin

Raw means and standard deviations of price variables are presented in Table 8. Estimated least squares means for initial price, final price and gross margin are laid out in Table 9.

Table 8. *Summary of price variables for stall fed steers, Blantyre and Lilongwe areas, Malawi, 1972–82.*

Variable	Blantyre		Lilongwe	
	Mean ± SD[1] (MK[3])	CV[2] (%)	Mean ± SD (MK)	CV (%)
Initial price	104±9.4	9.0	95±14.4	15.9
Final price	286±46.2	16.2	273±44.1	16.3
Gross margin	182± 43.1	23.7	178±38.9	21.8

[1] SD=standard deviation
[2] CV coefficient of variation
[3] MK = Malawi kwacha (as at October 1986, MK 1=US$1.97)

Table 9. *Estimated least squares means[1] for starting price, final price and gross margin of stall-fed steers, Blantyre and Lilongwe areas, Malawi,* 1972–82.

Variable	Blantyre				Lilongwe			
	Number of animals	Initial price	Final price	Gross margin	Number of animals	Initial price	Final price	Gross margin
	(Malawi Kwacha)				(Malawi Kwacha)			
Overall	2498	106	246	140	2985	91	257	166
Breed group								
Malawi Zebu	749	80a	221a	141a	1241	80a	239a	160a
Offtype	1021	108b	247b	140a	n.a.z	n.a.	n.a.	n.a.
Crossbred	728	132c	271c	150c	1744	103b	275b	174b
Number of teeth								
0	291	108a	246	142a	n.a.	n.a.	n.a.	n.a.
2	1195	110b	246	140a	234	98a	25b	159a
4	852	110b	247	141a	1926	98b	251	158a
6	160	98c	247	153b	787	87b	257	171b
8	n.a.	n.a.	n.a.	n.a.	38	82c	260	178c
Grade								
Prime	1723	n.a.	315a	212a	1790	n.a.	303a	210a
Choice	573	n.a.	254b	153b	1003	n.a.	248b	160b
Standard	153	n.a.	223c	122c	192	n.a.	218c	130c
Common	49	n.a.	193d	89d	n.a.	n.a.	n.a.	n.a.

[1] Within variable groups, row means followed by the same letter do not differ significantly at the 5% level. Means without any letter following did not show a significant difference in the analysis

of variance.
[2] n.a. = not applicable.

As expected, the smaller Malawi Zebu steers were priced lower at the start of stall-feeding than the heavier crossbreds. However, the difference in the final prices of Malawi Zebu and other breed groups was less than in the initial prices, presumably because of the superior growth rate of Malawi Zebu steers.

In both study areas there was a small but significant negative correlation between the rate of weight gain per unit of body weight and grade or quality. Thus, since payments were made on the basis of liveweight and grade, the Malawi Zebus' superior weight gain per unit of body weight was not reflected in the gross margin.

Younger animals were priced higher at the start of stall-feeding than older ones. At the end of the fattening period all age classes attracted equal sale price. Since growth rate was similar for all age groups, the superior final pricing of older animals was due to the pricing system, which was based on unit weight and hence favoured larger animals which were also more likely to be older.

Table 9 shows that carcass grade had a significant effect on both final price and gross margin: prime and choice animals attracted higher final price, and the gross margin for these animals was consequently higher.

Comparison of Blantyre and Lilongwe results

The Blantyre and Lilongwe data sets were not uniform, the major differences occurring in the type and number of cattle breeds studied, the age of steers at the start of stall-feeding and the month in which steers began stall-feeding.

Analyses of variance performed on these data showed that the effects of breed group on growth traits were similar in both areas. Smaller breeds performed as well as, or even better (on a metabolic weight basis) than larger breeds or crossbreds. Age at the start of stall-feeding was not an important factor in terms of growth rates. Starting month and year of stall-feeding significantly influenced growth traits in both areas, but at a different magnitude.

The differences in breed types led to differences in traits determined in absolute terms, such as starting weight, final weight and dressing weight. Higher values were associated with Blantyre where the breeds are heavier. Since total weight gains were similar in both areas, the lower growth rate of Lilongwe steers was related to a longer fattening period.

FINANCIAL ANALYSES

Increasing beef production on smallholder farms was one of the reasons for introducing a cattle stall-feeding scheme in Malawi; the other, equally important, was to raise the cash income of the rural population. Financial analyses were performed to determine whether smallholders in the country's Southern and Central regions benefitted from the scheme.

Rate of return to fattening

The income derived by producers from fattening cattle for beef production can be expressed as the annual financial rate of return to fattening.

Let

R = revenue from selling the animal,

C = purchase cost of the animal, and

T = time (in days) the animal was fattened,

then the annual financial rate of return to fattening (I, %) is:

$$I = [(R - C)/C) \times (365/T)] \times 100 \quad (1)$$

The financial rate of return is thus revenue less purchase cost, expressed as a percentage of purchase cost, and multiplied by the fraction of year the animal was fattened. This is an overestimate because purchase cost does not include some costs, such as of feed and veterinary supplies. The estimate does, however, include the costs of insurance and transport because these are deducted at the slaughterhouse from the sale price.

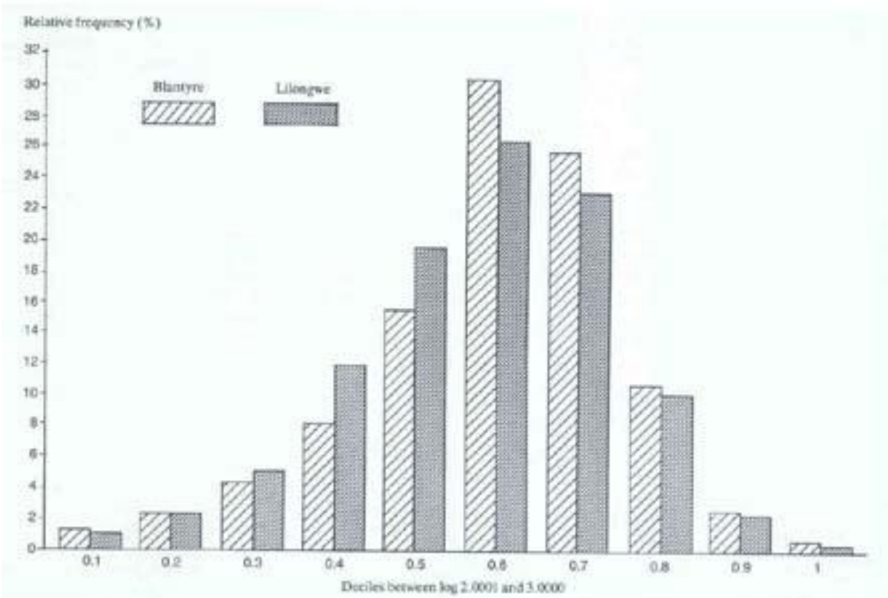
The I variable in equation (1) was computed using the Blantyre and Lilongwe data; summary statistics for the two areas are shown in Table 10. A common log transformation was done, excluding observations with zero or negative returns. Figure 5 gives summary statistics for the transformed frequency distributions. The data show that (a) the average return to fattening was high, (b) the model producer made money, and (c) only very few producers incurred losses.

Table 10. *Distribution of annual financial rates of return to steer fattening in Blantyre and Lilongwe areas, Malawi,* 1972–82.

Statistic	Untransformed data		Transformed data	
	Blantyre	Lilongwe	Blantyre	Lilongwe
Mean	378.3	376.5	2.541	2.525
Standard deviation	227.5	767.95	0.199	0.196
Skewness	15.792	50.595	–3.005	–2.797
Kurtosis	401.996	2681.064	34.433	43.048

Notes. The data were transformed by taking the common logarithm of each observation greater than zero. The mean and standard deviation of the untransformed data are percentages, while those of the transformed data are common logarithms of annual percentages. The skewness and the kurtosis are pure numbers.

Figure 5. *Log-transformed distributions of financial returns to steer fattening in Blantyre and Lilongwe, Malawi, 1972–82.*



Components of the financial return to fattening

What determines the financial rate of return to fattening? In particular, are weight gains or price changes more important in the total returns achieved by producers?

Let

C = purchase cost of the animal,

R =revenue from selling the animal,

p = price per kg of liveweight,

w = liveweight in kg, and

d = the change in C, R, p, or w over the fattening period.

For subscripts, let

o = original (price or liveweight), i.e. at the beginning of the fattening period, and

f = final (price or liveweight), i.e. at the end of the fattening period.

The equations for C, R and d(R) then are:

$C = p_o \times w_o$ (2)

$R = p_f \times w_f$ (3)

$d(R) = R – C$ (4)

Since by definition

$p_f = p_o + d (p)$ (5) and

$w_f = w_o + d (w)$ (6)

it follows that

$d(R) = d (p) \times w_o + d (w) \times p_o + d (p) \times d (w)$ (7)

Dividing equation (7) by d(R) gives:

$100 = \%(d (p) \times w_o) + \%(d (w) \times p_o) + \%(d (p) \times d (w))$ (8)

The right-hand side of equation (7) has three components:

- the price component, which is equal to the change in price multiplied by the original weight;
- the weight component, which is equal to the change in weight multiplied by the original price; and
- the interaction component, which is equal to the change in price multiplied by the change in weight.

The price component is the share of revenue gains from price increases at a constant weight over the fattening period. If the price component were equal to 100%, the animal would have gained no weight during the fattening period; any income gained by the producer would then be due to the higher price paid by the purchasing agency.

The weight component is the share of revenue gains from weight increases at a constant price over the fattening period. If this component were equal to 100%, the price change would have been equal to zero, and any income gained by the producer would have been due to his having fattened the animal.

The interaction component is the share of revenue gains resulting from the interaction of price and weight gains over the fattening period. It cannot be equal to 100%, since that would imply that both the price and the weight component are equal to zero. A positive interaction component means that weight gains are associated with price gains, higher-grade premia presumably being given to fatter animals.

Results

Blantyre. In this area, the distribution of the components of the financial rate of return to fattening was fairly constant across years (Table 11). The price component was between 56 and

65%, the weight component between 17 and 20%, and the interaction component between 18 and 22%. This suggests that most of the returns came from a higher price being paid by the Government for fattened animals. If the animals had gained no weight, the returns would still have been roughly 60% of what they were.

Table 11. *Components of financial returns to steer fattening in Blantyre and Lilongwe areas, Malawi, 1972–82.*

Year	Blantyre				Lilongwe			
	Number of animals	Component of return (%)			Number of animals	Component of return (%)		
		Price	Weight	Interaction		Price	Weight	Interaction
1972	n.a[1]	n.a	n.a	n.a	202	64.3	13.9	23.0
1973	n.a	n.a	n.a	n.a	429	57.5	20.4	22.3
1974	62	60.2	16.8	23.6	372	57.2	19.3	23.9
1975	715	62.9	18.1	20.0	314	56.3	20.3	24.0
1976	415	59.9	20.2	20.6	30	58.2	20.0	22.7
1977	441	64.5	18.2	18.0	185	64.2	17.9	18.6
1978	389	63.2	18.3	19.3	191	62.0	18.8	19.9
1979	189	55.7	19.6	20.5	426	61.0	19.0	20.7
1980	40	64.0	17.7	18.7	269	58.3	20.9	21.0
1981	247	58.2	20.2	21.9	540	62.1	18.9	19.1
1982	n.a	n.a	n.a	n.a	27	64.7	17.7	18.1

[1] n.a. = not applicable.

About one fifth of the returns came from the price/weight interaction component, which suggests that fatter animals were systematically put into higher grades and received higher prices per kg liveweight. In other words, a good producer–one who fattened his animals – received a quantity premium, but the sum of price and weight gains was only about 40% of the total net return to fattening.

Lilongwe. As in Blantyre, the price component was dominant, but there was a slight tendency for the weight component to be higher than in Blantyre (Table 11).

Regression analysis

Total weight gain varied substantially in the two samples analysed: the Blantyre mean for all years was 102.4 kg and the coefficient of variation (CV) was 44.3%, while the Lilongwe mean and CV were 99.5 kg and 41.2% respectively.

The relatively small contribution of weight gain to financial returns suggested the need to investigate this component further. A regression analysis was therefore done on the same data, with total weight gain being the dependent variable. This analysis made it possible to estimate the marginal effects of management practices on weight gain.

Regression results

Blantyre. One equation was estimated with no interaction terms, shown as function 1 in Table 12, and another with four interactions, shown as function 2. In function 1, most of the variables were significantly different from zero at the 1% level. In function 2, the significance levels for the same variables were generally lower, presumably due to the interactions tested. In particular, the effect of crossbreds on total weight gain (function 1) was negative in function 2, even though the absolute values of the coefficients were not very different between the two functions.

Table 12. *Factors determining total weight gain of stall-fed steers in Blantyre, southern Malawi, 1972–82.*

Variable	Function 1		Function 2	
	Regression coefficient	t-statistic	Regression coefficient	t-statistic
Weight in	0.1145	2.8927***	0.2578	1.9336*
Days-at-stall	0.0398	2.4255**	0.3435	1.8371*
Month entered				
February	–22.4603	4.4651***	–20.4741	4.0129***
March	–11.8283	3.1060***	–10.8760	2.8267***
April	–17.1218	4.0546***	–15.8104	3.6669***
May	–9.7030	2.3887***	–8.0634	1.9424*
June	–11.1558	2.8905***	–9.4541	2.3998**
July	–31.7676	6.5060***	–29.9649	6.0240***

August	–27.8749	5.9573***	–26.0859	5.4520***
September	–13.9663	2.6756***	–12.8946	2.4442**
October	–17.7454	4.3663***	–16.8727	4.1344***
November	–32.4820	6.3166***	–31.9454	6.1969***
Year entered				
1975	–17.4023	5.9211***	–17.0086	5.7745***
1976	–16.1442	5.1552***	–16.9712	5.3767***
1977	–19.0915	6.1677***	–19.0292	6.1485***
1978	–17.6759	5.6266***	–17.4928	5.5664***
1980	–31.0685	4.0877***	–30.1012	3.9300***
Breed				
Offtype	–9.6264	3.0381***	13.1383	1.3513
Crossbred	–9.8450	1.8450*	–8.9790	0.4494
Interaction				
Weight in × days-at-stall	not estimated		–0.0008	1.1384
Days-at-stall squared	not estimated		–0.0002	1.5405
Days-at-stall × crossbreds	not estimated		–0.0076	0.0707
Days-at-stall× offtypes	not estimated		–0.0216	0.4626
Adjusted R^2		0.0678		0.0689
F-statistic		10.5540***		9.0384***
Degrees of freedom		19, 2478		23, 2474

Notes. The significance levels are: * = significant at the 10% level, ** = significant at the 5% level, and *** =significant at the 1% level with a two-tailed test. The dummy variables for months are calculated with reference to December and January. The dummy variables for years are calculated with reference to 1974, 1979 and 1981. The dummy variables for breeds are calculated with reference to the Malawi Zebu.

The optimal number of days at stall was calculated using the regression coefficients of function 2. This was done by taking a derivative of function 2 with respect to days at stall, setting it equal to zero, and calculating the optimal value. Because a second derivative for days at stall was negative, the resulting optimum was a maximum. The solution was 317 days, which was almost 70% longer than the Blantyre sample mean of 188.5 days. The optimal value was greater than about 98% of the sample values.

Lilongwe. Table 13 shows that the regressions for Lilongwe had slightly higher R^2 values than in Blantyre, and that the coefficients differed somewhat in terms of sign and significance level.

Table 13. *Factors determining total weight gain of stall-fed steers in Lilongwe, central Malawi, 1972–82.*

Variable	Function 1		Function 2	
	Regression coefficient	t-statistic	Regression coefficient	t-statistic
Weight in	0.0375	1.3831	0.1013	1.0060
Days-at-stall	–0.0330	2.5957***	0.0416	0.3017
Month entered				
February	11.9156	0.9965	11.9835	1.0025
March	–1.2846	0.1000	–1.4060	0.1095
April	25.8942	2.1190**	25.3924	2.0777**
May	12.5342	1.0588	12.0805	1.0203
June	8.7012	0.7314	8.4204	0.0447
July	–0.5467	0.0447	–0.5931	0.0447
August	27.0737	2.2007**	26.7906	2.1772**
September	18.6129	1.4970	18.3517	1.4758
October	31.4282	2.5225**	30.7124	2.4635**
Year entered				

1972	–14.2524	4.0498***	–13.9299	3.9498***
1977	–27.4163	8.4179***	–27.821.4	8.5008***
1978	–21.6162	6.4826***	–21.9414	6.5631***
1979	–33.8007	13.1405***	–33.9424	13.0278***
1980	–14.1093	4.5435***	–14.6602	4.6532***
1981	–18.1030	7.6013***	–18.3017	7.6377***
1982	–17.3670	2.2007**	–18.9123	2.3759**
Breed				
Crossbred	–1.0852	0.5060	3.4736	0.4648
Interaction				
Weight in × days-at-stall	not estimated		–0.0004	0.7543
Days-at-stall squared	not estimated		–0.0001	0.9143
Days-at-stall × crossbreds	not estimated		–0.0178	0.5282
Adjusted R^2		0.1014		0.1018
F-statistic		18.7254***		16.3721***
Degrees of freedom		19, 2965		22, 2962

Notes. The significance levels are:*= significant at the 10% level,**= significant at the 5% level, and***= significant at the 1% level with the two-tailed test. The dummy variables for months are calculated with reference to November, December and January. The dummy variables for years are calculated with reference to 1973, 1974, 1975 and 1976. The dummy variables for breeds are calculated with referenceto the Malawi Zebu.

Comparison of regression results for Blantyre and Lilongwe

Function 1. The regressions for Blantyre and Lilongwe had about the same explanatory power, but the F-statistic of the Lilongwe function was higher because of more error degrees of freedom. Some important differences in coefficients were found: the 'weight in' coefficient for Blantyre was about 3 times larger than the Lilongwe coefficient and was significant at the 1 %

level, whereas the Lilongwe coefficient was not significant at the 10% level. The 'days-at-stall' variable for Blantyre was positive, while that for Lilongwe was negative

The month dummies for Blantyre were all negative and significant at the 1% level; those for Lilongwe were generally positive, though not significant. Because the dummies were for the same months, it was possible to compare their signs and magnitudes. The comparisons showed some very striking differences: for example, the August coefficient for Blantyre was –29.9 and for Lilongwe it was 27.1, while the respective April coefficients were –17.1 and 25.9. These figures suggest that the two areas have different seasonal patterns of feed supply.

The Blantyre regressions showed that the total weight gains of steers starting fattening during December–January were higher than the gains of steers that went on feed in other months of the year. In Lilongwe, the opposite was true: steers entered for stall-feeding in November, December and January gained less than those entered during the other months. These data do not tell us much about the reasons for this difference, but they have important implications for extension work and should be investigated further.

Function 2. The second function also showed some dissimilarities. Although the signs of the 'weight in' and 'days-at-stall' variables for Blantyre and Lilongwe were the same, the magnitudes were much larger for Blantyre. Moreover, the Blantyre coefficients were significant at the 10% level while those for Lilongwe were not.

The Blantyre dummy for crossbreds was negative and the Lilongwe one positive, but neither was significant. The month dummies show that while the sign of the month coefficients did not change between functions 1 and 2 in either data set, the magnitudes were different, although not very much.

'Weight in' × 'days-at-stall' interactions had the same sign in both areas, but neither coefficient was significant and that for Blantyre was twice as large as that for Lilongwe. 'Days-at-stall squared' was negative for Blantyre and positive for Lilongwe, but neither coefficient was significant. The 'days-at-stall' × 'crossbreds' interaction was negative and insignificant for both areas.

CONCLUSIONS

The biological and financial analyses presented in this study show that genetic and environmental factors, particularly breed, age, and month and year entered, influence most biological and economic traits of stall-fed cattle. However, the total contribution of these factors to total variation in some traits (e.g. total weight gain) suggests that other factors (not identified in this study) may be important in stall-feeding operations.

When compared on the basis of metabolic body weight, the indigenous Malawi Zebu steers performed better in terms of several biological characteristics than the Friesian × Malawi Zebu and Friesian × offtype crossbreds. This and the other finding that reasonable weight gains are possible under a low-input management system strongly suggest that the scheme would be suitable for other developing countries where smallholder farmers have access to cattle for fattening and agricultural byproducts.

The financial rate of return to smallholder steer fattening in Malawi was high, but a substantial portion of the return was due to price changes. This implies that if such significant interactions as breed × starting month of feeding were exploited to increase steer weight gain, then it would be possible to pay a smaller price differential to producers and, at the same time, offer a lower beef price to consumers.

Given the substantial differences between Blantyre and Lilongwe in total weight gains of stall-fed steers, a survey of a relatively small subsample of producers from these two areas should be undertaken to gain better knowledge of the seasonal differences in weight gains. This information could be used by agricultural extension workers to improve the share of weight gains in net returns to steer fattening.

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