

Promoting the use of home-mixed supplements as alternatives to commercial supplements in smallholder beef production systems in the subhumid region of Zimbabwe

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The economic and performance effect of supplementing smallholder cattle by substituting commercial feed with iso-nitrogenous and iso-energetic diets based on alternative protein sources was investigated in two trials. In trial 1, three diets (commercial concentrate, commercial concentrate partially substituted with mucuna, and commercial concentrate partially substituted with lablab-cowpea) compared with veld grass were allocated to 12 cattle in a complete randomised block design. In trial 2, a double complete randomised block design with 40 cattle assigned to four forage legume-based diets, a poultry-based diet and a commercial beef concentrate was carried out. Diets were offered at 1.5% of body weight daily over 56 d. Average daily weight gain (ADWG) was measured weekly in trial 1 and fortnightly in trial 2. In trial 1, ADWG was significantly ($p < 0.05$) higher for animals on supplements compared with non-supplemented cattle. In trial 2, ADWG was significantly highest on the groundnut stover-based diet and least on the poultry litter diet. Supplementation had a positive effect on ADWG and economic performance of smallholder beef cattle. Substitution of commercial concentrates with alternative protein sources reduced diet costs and significantly improved gross margins.

Keywords: average daily weight gain, beef cattle, feed alternatives, gross margin, Zimbabwe

Introduction

Approximately 70% of the world's rural households derive their livelihoods from agriculture through integrated crop and livestock subsistence farming (World Bank 2008; FAO 2009). In developing countries, cattle play an integral role in the livelihoods of communal smallholder farmers by providing economic, social and food security roles. According to the Second Round Crop and Livestock Forecasting Report (MoAMID 2014) for Zimbabwe, 90% of cattle are owned by smallholder farmers (68% communal, 11% new resettlement, 7% old resettlement, 4% small-scale commercial farming) and 10% are owned by the large-scale commercial farming sector. However, the contribution of livestock to rural livelihoods and household economic food security remains limited owing to various challenges.

Key to smallholder livestock production, which is predominantly extensive and communally based, is rangeland quality and quantity. Inadequate nutritional value of rangeland fodder, particularly during the dry season, reduces rangeland capacity to meet the recommended livestock nutritional requirements, resulting in reduced animal performance. Crude protein content of veld declines from as much as 15% in summer to as low as 3% during

the dry season (Topps and Oliver 1993). Farmers need to supplement their cattle during this period.

However, smallholder farmers rarely provide supplementary feed to their beef cattle during the dry season due to the high cost of commercial supplements, resulting in decline in productivity (Matibvu et al. 2012; Tavirimirwa et al. 2012). Therefore, livestock sold during this period has low market value due to their poor condition. This period also coincides with the lean period in household food security in Zimbabwe, hence livestock is sold to cover household food and related needs. It follows that the contribution of cattle to economic household food security in the dry season is limited.

Studies have indicated the potential of smallholder livestock to fetch better prices and contribute significantly to economic household food security through supplementation. Studies by Prasad et al. (1994) and Israel and Pearson (2000) suggest that supplementing cattle feed, especially during the dry season, improves animal performance, particularly oxen. However, the cost of commercial supplementary feeds is prohibitive for smallholder farmers to supplement their cattle. Most smallholder farmers supplement veld grazing with untreated maize stover, which has low nutritive value, thus limiting performance.

Research has indicated the viability of using alternative locally available feed resources. Groundnut stover has been noted to be a good source of protein (Etela and Dung 2011). Groundnut, being one of the major crops grown by smallholder farmers in Zimbabwe, produces a substantial amount of stover. However, the stover is discarded mostly in smallholder farming systems. Etela and Dung (2011) suggest using groundnut stover as cattle feed, especially during the dry season. Poultry litter has also been suggested as a viable protein source for smallholder cattle, though processing before feeding may be required to control pathogenic micro-organisms (Fontenot and Hancock 2001; Mhaka 2014). A significant number of smallholder farmers in Zimbabwe rear backyard chickens (broilers and layers) for sale and home consumption. Therefore, there is production of significant quantities of poultry litter, which can be used as a cheap source of protein. Utilisation and adoption of these alternative protein sources in smallholder systems has often been limited by lack of (1) information on inclusion levels in cattle rations and (2) demonstration of their feeding value being translated to income from cattle sales.

Further to the above alternative protein sources, forage legumes have been recognised as alternative cheap sources of feed (Murphy and Colucci 1999), as they are adaptable and produce reasonable quantities of biomass. Research has highlighted the potential of forage legumes in alleviating the dry-season feed shortages. This is despite the fact that forage legumes are known to contain anti-nutritional factors that reduce their utilisability (Matenga et al. 2003). Studies have indicated that supplementation with forage legumes results in weight gain in cattle and goats (Buwu 2014; Gusha et al. 2015a). Irrespective of ample research showing forage legume potential as a livestock feed resource, adoption rates are relatively low in smallholder farming systems (Mapiye et al. 2006). As with groundnut stover and poultry litter, demonstration of the economic feasibility of utilising forage legumes in smallholder systems is lacking. It also follows that lack of demonstration on how supplementation can contribute to improved household income from cattle affects adoption rates. Most smallholder farmers adopt technologies that have been demonstrated to translate into income.

The objectives of this study were to (1) demonstrate the economic and performance effect of supplementing smallholder beef cattle by partially substituting commercial supplements with forage legumes and (2) evaluate the performance of smallholder beef cattle fed forage legumes, groundnut stover and poultry litter as alternative protein sources for livestock feeding with the objective of selling the livestock.

Materials and methods

Study sites

The trials were conducted in Goromonzi (17°29' S, 31°29' E) and Murehwa (17°48' S, 31°35' E) districts. The areas are located in agro-ecological region IIb and have comparatively similar climatic conditions. Annual rainfall of about 750–900 mm is received between October/November and March/April each year with the remaining seven to

eight months being dry. Temperatures average a maximum of 25 °C and a minimum of 10 °C. The main agricultural activities in these districts are crop (maize, groundnuts and cowpea) and livestock (cattle, goats and poultry) production.

Diets

Trial 1 consisted of three iso-nitrogenous and iso-energetic diets (commercial concentrate; commercial concentrate partially substituted with mucuna; and commercial concentrate partially substituted with lablab-cowpea) being compared with veld grazing. Iso-nitrogenous and iso-energetic diets are diets that have the same amount of dietary nitrogen and energy, respectively. The diets are as indicated in Table 1. Trial 2 consisted of five iso-nitrogenous and iso-energetic diets. The diets composition is as indicated in Table 1.

Lablab and mucuna hay were harvested at the early flowering stage, dried for 2–3 d and then baled. Forage seed was harvested dry and included in the diet as crushed bean. Groundnut stover was made from the vegetative groundnut tops after harvesting the pods, consisting of the dry leaf and stem material. Poultry litter (consisting of wheat straw and broiler chicken droppings) was collected and sun-dried for an average of 3 d until completely dry. Commercial concentrate (32% crude protein [CP]) was purchased. Hays, stover and poultry litter were milled using a chopper grinder to approximately 3 cm length before being mixed in the respective diets.

The methods of the Association of Official Analytical Chemists (AOAC 1990) were used to determine the dry matter of the composite samples of the feeds. Crude protein was determined by the standard Kjeldahl procedure (AOAC 1990), and the bomb calorimetric method (AOAC 1995) was used to determine energy content.

Animal management

The trial was conducted over two years. Trial 1 in the 2013 dry season was conducted in Goromonzi district only, and trial 2 in the 2014 dry season was conducted in Goromonzi and Murehwa districts. In trial 1, 12 Mashona crossbred cattle (six male castrates and six multiparous females) were fed three diets over a 56-day feeding period. In trial 2, 40 Mashona crossbred cattle (20 male castrates and 20 multiparous females) were fed five diets over the same period. However, during the progression of trial 2, one animal was disposed of at day 44, hence only 39 animals were fed for the complete period of 56 d. The animals were aged 3 (± 1) years in both trials. The animals were fed for a seven-day adaptation period before data collection commenced. Animals were offered diets at 1.5% of bodyweight in the morning and afternoon by dividing the daily allowance into two equal portions. Clean water and basal untreated maize stover were offered *ad libitum*.

At the start of the trials, all cattle were drenched with Benvet®, a broad-spectrum anthelmintic for the treatment and control of liver flukes and gastrointestinal parasites. A vitamin injection was also administered before the onset of the supplementation to boost appetite. The cattle were housed in free-stall pens at the respective farm sites and each animal allocated an individual feeding trough.

Table 1: Nutritional composition (%) and costs of diets fed to beef animals in Goromonzi and Murehwa districts, Zimbabwe

Ingredient	Treatments for trial 1 ¹								Treatments for trial 2 ¹									
	M1		LC1		C1		VG1		M2		L2		GS2		PL2		C2	
	(%)	Cost (US\$)	(%)	Cost (US\$)	(%)	Cost (US\$)	(%)	Cost (US\$)	(%)	Cost (US\$)	(%)	Cost (US\$)	(%)	Cost (US\$)	(%)	Cost (US\$)	(%)	Cost (US\$)
Maize	41	0.11	45	0.12	43	0.11	—	—	40	0.14	40	0.14	40	0.14	40	0.14	79	0.29
Mucuna hay	25	0.06	—	—	—	—	—	—	35	0.05	—	—	—	—	—	—	—	—
Mucuna bean	10	0.05	—	—	—	—	—	—	24	0.09	—	—	—	—	—	—	—	—
Lablab hay	—	—	16	0.03	—	—	—	—	—	—	45	0.08	—	—	—	—	—	—
Cowpea shells	—	—	17	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Soya meal	—	—	—	—	—	—	—	—	—	—	14	0.01	16	0.01	—	—	—	—
Soya hay	10	0.01	4	0.02	36	0.05	—	—	—	—	—	—	—	—	—	—	—	—
Beef concentrate	13	0.04	17	0.05	20	0.07	—	—	—	—	—	—	—	—	—	—	20	0.07
Groundnut stover	—	—	—	—	—	—	—	—	—	—	—	—	43	0.06	—	—	—	—
Poultry litter	—	—	—	—	—	—	—	—	—	—	—	—	—	—	45	0.03	—	—
Maize stover	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14	0.01	—	—
Vitamin + mineral mix	1	0.02	1	0.02	1	0.03	—	—	1	0.01	1	0.01	1	0.01	1	0.01	1	0.01
Veld grazing	—	—	—	—	—	—	100	3.72	—	—	—	—	—	—	—	—	—	—
Dry matter (%)	89.7		89.2		89.3		91.7		89.9		89.4		90.5		91.2		89.3	
Crude protein (%)	13.9		13.7		14.2		5.70		13.8		14.1		13.9		14		14.2	
Energy (MJ kg ⁻¹ DM)	11.5		11.6		11.4		7.90		11.7		11.5		11.5		11.6		11.4	
Feed cost (US\$ kg ⁻¹)	0.29		0.27		0.26		—		0.27		0.33		0.31		0.19		0.37	

¹ Treatment diets: M1 = mucuna, LC1 = lablab–cowpea, C1 = beef concentrate, VG1 = veld grazing, M2 = mucuna, L2 = lablab, GS2 = groundnut stover, PL2 = poultry litter, C2 = beef

Data collection

In trials 1 and 2, data on weight gain, body condition score, feed intake and refusals was recorded every 7 d and fortnightly, respectively. Body condition score was measured on a scale of 1–5 (1 = poor condition and 5 = excellent condition) in both trials.

Data collection was over a 56-day period in both trials. Smallholder farmers normally feed for less than 60 d due to feed availability and cost (Mlote et al. 2013). Feeding period depends on feed availability and coincidence with marketing time for the animals as determined by prevailing market prices (Holness 1998).

Trial design

In trial 1, a randomised complete block design was used. Twelve cattle were ranked using initial live weight and divided into three weight groups of four animals (<200 kg, 201–320 kg and >320 kg). Within each group, the animals were randomly allocated to the four treatments. Offered treatment quantities were adjusted after every 7 d according to the previous weight measurement.

In trial 2, a double randomised block design was used with 20 animals in Goromonzi district and replicated with 20 animals in Murehwa district. In each of the two districts, the 20 animals were divided into four weight groups of five animals (<200 kg, 201–300 kg, 301–400 kg and >400 kg). Within each group, the animals were randomly allocated to the five treatments. Offered treatment quantities were adjusted fortnightly according to the previous weight measurement.

Statistical analysis

Data were subjected to analysis of variance using the Mixed Procedure for repeated measures of SAS 12.1 (SAS Institute 2012) with the initial live weight being used as a

covariate. Comparison of treatment means was done using the Tukey *post-hoc* test.

The model used for the analysis was as follows:

$$Y_{ijkl} = \mu + \beta I_i + T_j + S_k + W_l + e_{ijkl}$$

where Y_{ijkl} is bodyweight, μ is the overall mean common to all observations, β is the linear regression coefficient of initial weight on the response variable, I_i is the initial body weight (covariate), T_j is the fixed effect of treatment ($j = 1, 2, 3, 4, 5$), S_k is the fixed effect of sex ($k = 1, 2$), W_l is the fixed effect of time ($l = 1, 2, 3, 4$) and e_{ijkl} is the normally distributed random error.

One of the animals was sold during the trial, therefore the analysis was adjusted accordingly.

Gross margin analysis

The gross margin of the beef cattle feeding trial was determined by calculating the difference between total income and total variable costs. Total income per treatment was calculated as the summation of the optimum selling price for each animal. This was calculated as an average of the value of animals slaughtered at the abattoir, animals sold on the hoof and those valued at the end of the feeding period. Total variable costs were calculated as a summation of initial live weight price of the animal, feed costs, veterinary costs, labour, transport, slaughter fee, and regulatory costs, such as Rural District Council levy and cattle movement permit issued by the Department of Veterinary Services in association with the Zimbabwe Republic Police.

$$GM_x = \sum_{i=1}^n TI_i - \sum_{i=1}^n TVC_i$$

where GM_x is gross margin (x = treatment diet), $\sum_{i=1}^n TI_i$ is summation of the total income (TI) for each animal

($i = 1, 2, \dots$) and $\sum_{i=1}^n \text{TVC}_i$ is summation of the total variable costs (TVC) for each animal ($i = 1, 2, \dots$).

Results

Animal performance

No significant differences in intake were recorded. Animals consumed and finished the allocated 1.5% of body weight ration. Therefore, there were no refusals observed and recorded in both trials. Supplemented animals had improved body condition compared to animals grazing on veld, from an average body condition score of 2.6 to 3.2. On the other hand, body condition of unsupplemented animals deteriorated from an average of 2.6 to 2.0.

In trial 1, there were no significant differences in average daily weight gain (ADWG) among cattle offered supplementary feed, but ADWG was, however, significantly higher than those grazing on veld. The ADWG of cattle offered supplementary feed (mucuna based diet: $1.04 \text{ kg head}^{-1} \text{ d}^{-1}$; lablab-cowpea based diet: $0.88 \text{ kg head}^{-1} \text{ d}^{-1}$; and commercial concentrate based diet: $0.69 \text{ kg head}^{-1} \text{ d}^{-1}$) was significantly higher ($p < 0.05$) than that of cattle grazing on veld ($0.28 \text{ kg head}^{-1} \text{ d}^{-1}$). For the entire feeding period, while the mean live weight gains for animals offered mucuna substituted diet (60.3 kg) and lablab-cowpea substituted diet (55.0 kg) were not significantly different from each other ($p > 0.05$), they were significantly higher ($p < 0.05$) than those for cattle offered commercial concentrate based diet (34.5 kg) and veld grazing (16.1 kg). The seven-day weight gains increased gradually in the first 28 d, reaching a peak at 35 d and levelling off from 42 d until the end of the trial (Figure 1).

In trial 2, there were significant differences in ADWG of cattle offered supplementary feeding. Mean live weight gain over the feeding period was significantly higher ($p < 0.05$)

for cattle offered groundnut stover diet (42.7 kg), whereas animals offered poultry litter based diet had the least mean live weight gain (28.0 kg) (Figure 2). There were significant differences ($p < 0.05$) in ADWG between the weighing periods (14 d), especially for the first and second weighing periods (Figure 2). Animals grazing on veld lost weight after day 49.

Economic analysis

Dietary costs

In trial 1, the dietary cost for the mucuna-based substituted ration and the lablab-cowpea substituted ration were higher compared with that of the commercial concentrate. However, in trial 2 dietary cost for the forage legume based diets was lower than for the commercial concentrate (Table 1). Table 1 indicates that the cost of commercial concentrate in trial 1 (US\$0.26 kg^{-1}) was lower than in trial 2 (US\$0.37 kg^{-1}). Table 1 also shows that the cost of the lablab-cowpea substituted diet used in trial 1 was lower than that of the lablab-only diet used in trial 2.

Gross margin analysis

In trial 1, labour costs for the control group (VG1) was higher as they included herding the animals (Table 2). Transport cost was higher for the commercial based diet than the rest of the diets (the cost calculated included the transport cost to ferry feed from the market). The mucuna-based substituted diet had the highest return per head and veld grazing the least.

In trial 1, it can be noted that income from supplemented cattle was higher than that of non-supplemented animals.

In trial 2 (Table 3) gross margin per animal was highest on the mucuna based diet (US\$122), whereas those animals on poultry litter had the least gross margin (US\$51.4). The gross margin from cattle offered poultry

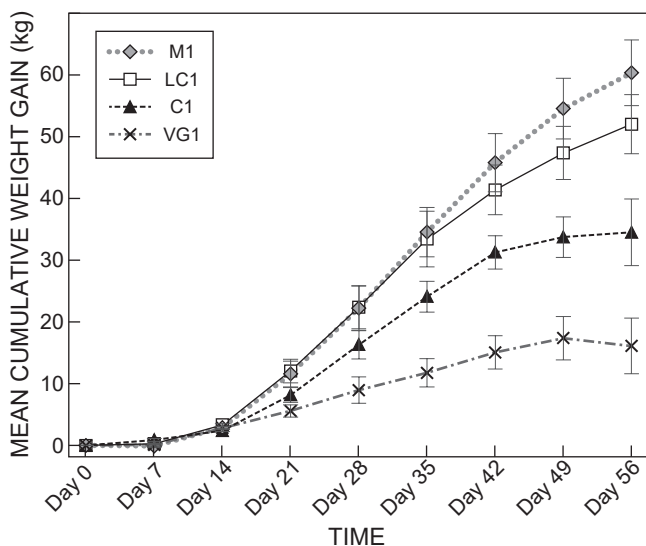


Figure 1: Mean cumulative weight gain of cattle offered different dietary treatments in trial 1 in Goromonzi district, Zimbabwe ($n = 3$). M1 = mucuna based diet, LC1 = lablab-cowpea based diet, C1 = beef concentrate based diet, VG1 = veld grazing

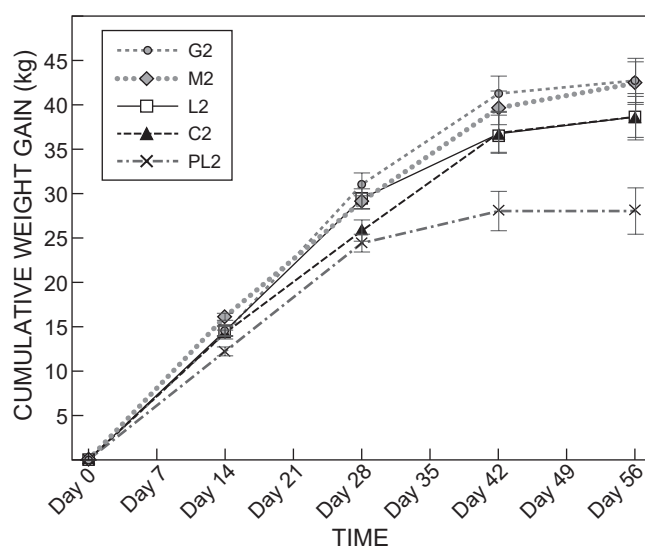


Figure 2: Mean cumulative weight gain of 39 cattle offered different dietary treatments in trial 2 in Goromonzi and Murehwa districts, Zimbabwe ($n = 8$). G2 = groundnut stover, M2 = mucuna, L2 = lablab, C2 = beef, PL2 = poultry litter

litter was less than 50% of the gross margin obtained from cattle offered the other treatment diets.

Discussion

Animal performance

No refusals were recorded in trials 1 and 2, indicative of no significant differences in intake. Animals were offered supplement at 1.5% of body weight, in two equal portions daily, which they finished with no observed refusals. According to Madzimure et al. (2011), intake is determined by CP level, form and anti-nutritional factors. The diets contained approximately 14% CP, which was higher than 7% CP, below which it has been documented to affect intake negatively (Milford and Minson 1966). The forages were fed in a dried form, and Madzimure et al. (2011) further assert that dried forages do not affect intake negatively.

Body condition score of the supplemented animals improved and were comparable to those on commercial diet. Supplementation has been noted to improve performance and body condition of the animals. Israel and Pearson (2000) concur that supplementation improves body condition and animal performance significantly.

In trial 1, there were no significant differences in ADWG between animals on the forage legume substituted diets and commercial concentrate, but ADWG was significantly higher than on animals grazing on veld. However, cattle on mucuna-based substituted diet had the highest total weight gain than animals on the other diets. Similar results were observed by other authors where improved performance of cattle fed mucuna was observed (Muinga et al. 2003; Murungweni et al. 2004). In a study by Gwanzura et al. (2011), it was observed that goats fed mucuna had the highest intake and weight gain compared with those on lablab and cowpea treatments. Mucuna has been noted to be an excellent source of fermentable nitrogen and energy, and has an amino acid and mineral profile similar to soya bean (Ayala-Burgos et al. 2003). This could explain the performance in cattle offered the mucuna-based substituted diet. Animals that did not receive any supplementation (animals grazing on veld only) had the least weight gain, with animals losing weight after day 49. Veld condition deteriorates during the drier months, with related poor quantity and quality of grazing, hence reduced performance in animals on veld grass only during the drier months has often been reported. Cattle in the tropics mainly depend

Table 2: Gross margin analysis for treatments in trial 1

Income and expenditure	Treatment ¹			
	M1	LC1	C1	VG1
Total income (US\$)	1 660	1 600	1 590	1 320
Expenditure (US\$)				
Initial livestock costs	878	872	809	888
Feed costs	192	178	183	3.72
Other expenses: Labour costs	40.0	40.0	40.0	60.0
Veterinary costs	6.00	6.06	6.72	7.36
Transport costs	25.0	25.0	37.5	25.0
Slaughter fee	50.0	50.0	50.0	50.0
Regulatory expenses	12.0	12.0	12.0	12.0
Total costs	1 200	1 180	1 140	1 050
Gross margin (US\$)	460	421	448	277
Gross margin (US\$ animal ⁻¹)	153	140	149	92

¹ Treatments: M1 = mucuna based diet, LC1 = Lablab-cowpea based diet, C1 = commercial based diet, VG1 = veld grazing

Table 3: Gross margin analysis for treatment diets/animal for trial 2

Income and expenditure	Treatment ¹				
	M2	L2	GS2	PL2	C2
Income (US\$)	652	654	628	442	657
Expenditure (US\$)					
Initial livestock cost	343	342	325	256	325
Feed costs	75.3	89.2	74.1	23.3	101
Other expenses: Labour costs	40.0	40.0	40.0	40.0	40.0
Veterinary costs	4.00	4.00	4.00	4.00	4.00
Transport	25.0	25.0	25.0	25.0	30.0
Slaughter fee	25.0	25.0	25.0	25.0	25.0
Regulatory expenses	17.5	17.5	17.5	17.5	17.5
Total costs	530	543	511	391	543
Gross margin (US\$ animal ⁻¹)	122	110	117	51	114

¹ Treatments: M2 = mucuna based diet, L2 = lablab based diet, GS2 = groundnut stover based diet, PL2 = poultry litter based diet, C2 = commercial based diet

on feed resources that are low in CP especially in the dry season and addition of protein-rich feed sources would be beneficial (Wanapat 2000). The low weight gains in the animals on veld grazing could have been a result of limited intake coupled with low dry matter digestibility associated with the poor quality of veld forage in the drier months. Digestibility and utilisation of veld grazing material is negatively affected by the low CP content.

In trial 2, animals on groundnut stover had the highest ADWG. Packard et al. (2007) achieved significantly higher ADWG with goats when fed groundnut stover. The authors concluded that supplementing goats with groundnut stover may improve ADWG when browse is scarce or of poor quality. Studies have indicated that groundnut based feeds have high digestibility (Adamu 2015), which could explain why animals offered groundnut stover based diet performed better than those on the other diets. Francis and Ndlovu (1995) also reported better oxen performance when supplemented with cob sheath groundnut stover. Chakeredza et al. (2002) reported no difference in digestibility when weaner lambs were fed cowpea and groundnut based diets. However, the authors reported higher metabolisable energy intake with cowpea based diet than that of groundnut based diet.

Poultry litter had the least ADWG. Poultry litter has been found to be safe for inclusion in supplementary diets for ruminants (El-Sabban et al. 1970; Tadele and Amha 2015). However, poultry litter quality is variable and is affected by the type and quality of straw used, quality of the feed fed to the poultry and processing method, which invariably affects digestibility. This could explain the lower ADWG recorded in trial 2.

The mean live weight gain increased gradually in the first four weeks, reaching a peak in week five and levelling off from week six until the end of the trials (Figures 1 and 2). This finding concurs with the normal growth curve exhibited by animals.

Economic analysis

In Zimbabwe the unit price of beef depends on grade and weight. Profitability of supplementary feeding is a function of the selling price, input costs and performance factors, such as live weight gain and change in carcass parameters. Animals in the trial improved weight and body condition score, which contributes to the grade. This could explain the higher prices fetched from supplemented cattle.

Most studies have indicated that supplementing with residues, forage legumes or stover reduces the dietary cost. However, in trial 1 where commercial concentrate was substituted by forage legume, the diets were more expensive. This was due to scarcity of the forage seed and resultant hay. In the first year of the trial, forage legume seed was unavailable in the Zimbabwean seed market, hence seed was imported at US\$9.00 kg⁻¹, which drove the production cost for hay and seed prices up at the end of the 2013 growing season. However, in the second year, after seed bulking and redistribution, demand for the seed had dampened, which reduced the price, as evident in the cheaper diets in trial 2.

Feed is one of the major cost drivers in beef cattle feeding and marketing. Feeding of forage legumes as

protein sources is expected to lower variable costs (Gusha et al. 2015a). Gross margins were higher for animals supplemented with forage legume based diets, specifically mucuna based diets in both trials. This was a result of the related lower feed costs and improved animal performance. The results indicate that smallholder farmers can improve economic returns and gross margin by supplementing with low-cost protein alternatives. Partial or complete substitution of feed ingredients with forages or poultry litter as protein sources enabled farmers to source feed locally, utilise what is available at the farm, whilst getting more or less the same animal performance as with commercial feed. Several studies have also concluded with recommending use of alternative protein sources to reduce feed and associated costs, thereby increasing overall profitability (Jokthan et al. 2013; Mhaka 2014; Gusha et al. 2015b). Fluctuations in the pricing of beef in Zimbabwe generally follow seasonal availability of beef quality and quantity. It therefore follows that the price margins for beef are generally high during the dry season when beef of higher grade and quality is in short supply as a result of a decline in feed quality and general lack of supplementary feeding by smallholder farmers.

Conclusion

Supplementing cattle using alternative protein sources, especially in the dry season, has the potential to improve livestock production in the smallholder sector. Supplemented cattle have improved gross margins, increasing the contribution of livestock to household income. While partial substitution of commercial diets with forage-based diets has been demonstrated to reduce feed costs, complete forage-based rations significantly reduce feed costs further. Cattle supplemented with forage-based rations have improved average daily weight gain during the dry season. Smallholder farmers who bridge the dry-season feed shortage gap using on-farm forage-based rations have the potential to improve income from beef due to seasonally higher beef prices, contributing to livelihood resilience.

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