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On farm evaluation of the growth and economic benefit of afar breed rams supplemented with different protein sources: The case of Raya-Alamata District

Tesfay Hagos[1]*, Teshale Teklue[2], Dawit Gebregziabiher[2] and Yohannes Tekie[2]

[1]Tigray Agricultural Research Institute (TARI), P. O. Box 492 Mekelle, Ethiopia.
[2]Alamata Agricultural Research Center (AARC), P.O.Box 56, Alamata, Tigray, Ethiopia.

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On-farm trial was conducted at Raya-Alamata District, Southern Zone of Tigray region, Northern Ethiopia. From the district three representative peasant associations namely Gerjelle, Limate and Harlle was selected based on sheep population and Ziziphus tree availability. The objective of this study was to evaluate the growth performance and economic benefit of Afar breed rams supplemented with different protein sources. Nine farmers were selected per each peasant association. Each farmer had assigned three growing yearly aged Afar breed rams with initial average body weight of 19.33±1.33 kg. The treatments include feeding with traditional practice/free-grazing (T_1), T1+ 277.5 gDM/day/head urea treated teff straw supplementation (T_2), T_1+283.8 gDM/day/head air dried Ziziphus foliages supplementation (T_3) and T_1 + 250 g DM/day/head) concentrate mix of wheat bran and noug cake supplementation (T_4). There was statistically significant difference ($P<0.05$) in daily live weight gain among the control and supplemented groups, except urea treated straw supplemented group. Rams in the control group and urea treated teff straw had showed 67.60 and 71.87 g of daily body weight gain per head, while the air dried Ziziphus leaf and concentrate mix supplemented group had gained 90.47 and 98.70 g/day/head, respectively. Moreover, the concentrate mix supplemented group (T4) had a higher net benefit of Ethiopian Birr 22.93/head over control group and higher profit margin of Birr 0.5/head, followed by the Ziziphus leaf supplemented group (T3) which had a net benefit of Birr 19.85/head and profit margin of Birr 0.4/head over the control group. Assume one US$ is equals to 20 Ethiopian Birr. The results of this study suggested that supplementation of sheep with 283.8 gDM of dried Ziziphus leaf or 250 g DM concentrate mixture is potentially more profitable to the small scale farmers' sheep fattening practice than the other level of supplements.

Key words: Body weight, concentrate mix, profitability, Ziziphus leaf, free grazing, urea treated teff straw.

INTRODUCTION

Tropical ruminant production is basically depending on fibrous feeds like mature pastures and crop residues. These feeds are mostly deficient in protein, energy, minerals and vitamins. Crop residues are the major

*Corresponding author. E-mail eytesfay@yahoo.com, Tel: + 251-34-4407901, +251-914733958.

sources of feed for livestock during dry season, but are low in nitrogen and high in crude fiber and lignin, characteristics that restrict intake and digestibility. With regard their poor CP content they cannot able to meet the rumen microbial requirement when they are feed alone (Van Soest, 1994). Among the nutritional constraints, protein deficiency appears to be the most important. In the face of such scenario, there is a need to integrate trees, crop and livestock production to improve availability of feeds and livestock productivity.

With in Ethiopia in general and Tigray Region in particular, despite the fact that crop residues are the main if not the only feed to livestock, huge amount of crop residues are producing every year. According to the Raya-Alamata district bureau of agricultural and rural development report 452,004 “quintal” teff straws and 473,480 “quintal” stover of sorghum and maize were produced in 2007-2009 years of cropping season. In addition, other possible protein supplements of indigenous browse foliages such as *Ziziphus* tree could be the best alternatives, as they are easily available in the villages and accessible to the smallholder farmers. Browse trees are also among the most feed sources especially in the lowlands of Raya-Alamata District where sheep and goats are important livestock commodities that virtually depend on free grazing and browse foliages throughout the year.

There are two indigenous Ziziphus species (*Ziziphus spina-cristi* and *Ziziphus abyssinica*) growing in many parts of dryland Ethiopia in general and in Tigray region in particular. Out of the two Ziziphus tree species, *Z. spina-cristi* is more dominant in the study area. Ziziphus tree is also drought tolerant and is possible to get good leaf biomass even at times of poor rainfall and dry season; this plant is evergreen, found everywhere, thereby contributing to solving the feed scarcity of small ruminant partially. Traditionally farmers of the study area are observed lop the branches of the trees for the purpose of fence, fire wood and the leaf part is feed to their animals immediate at the field and the remaining leaf are remaining at the ground and decompose or feed by any other browsing animals. Collecting the leaf and stored for the dry season supplementation is not common practice due to lack of awareness of the farmers on browse leaf supplementation for their animals. The nutritional and supplemental values of air dried *Ziziphus* leaf for small ruminant indicated promising results and has crude protein (CP) content of 14.5% (Bruh et al., 2014). Similarly, the Raya-Alamata district has enormous amount of livestock feed resources. However, limited work has been done for maximizing and efficient use of these locally available feed resources. Moreover, for more than 50 years, research work on protein in the nutrition of ruminants has identified urea for treated crop residues due to its ability to increase the nitrogen content of the treated crop residue and due to its readily available in the hand of small scale farmers for the purpose of fertilizer and in this integrated approach multi-purpose trees supplementation, urea treatment and concentrate mix supplementation will have a significant contribution. Hence, utilizing those ample feed resource by identifying the appropriate mix up is quite crucial. Thus, the objective of this study was to evaluate the growth performance and economic benefit of Afar sheep breed supplemented with three different protein sources.

MATERIALS AND METHODS

Study area description

The on-farm experiment was conducted in Raya-Alamata District. It is located at a distance of 600 km North of Addis Ababa and 183 km South of Mekelle. It has an elevation of 1400 to 1600 m above sea level and lies between 39° 35’ East longitude and 12° 15’ North latitude. The area receives a bimodal rainfall distributed from March-May for the short rainy season, and from June - September for the long rainy season with average annual rain fall of 400 to 700 mm. The mean maximum and minimum temperature is 27 and 14.6°C, respectively. Small ruminant production is the main livestock component of the study area followed to cattle production. About 59514 heads of sheep were found in the district (BoARD, 2009; unpublished document).

Peasant association and farmers selection

Three peasant associations (PA) were selected based upon the availability of Ziziphus tree species, teff straw and high population of small ruminant. Farmers who own more than five sheep were selected from each PA in cooperation with agricultural development workers of the area. Twelve participant farmers from each peasant association (PA) were randomly selected from the purposely selected sheep owners, where three farmers were allocated for each feeding regime. Each farmer allocated three growing rams. The growing rams were selected from the herd based on their body weight and allocated to different blocking. Totally the study was participated 36 small scale farmers and 108 Afar breed rams. Farmers and development agents of each PA were given training on project implementation.

Experimental design and feeding management

The treatments were: Traditional practice/free grazing (Control/T_1), T1 + 277.5 gDM/day/head urea treated teff straw(T_2), T1 + 283.8 gDM/day/head air dried Ziziphus foliages (T_3) and T1+ 250 g DM/day/head concentrate mix (T_4) supplementation. The concentrate mix was made from equal proportion of wheat bran and noug cake.

The on farm trial was carried for 90 days following the adaptation period of 15 days. The animals were fed based on the farmers practice. The supplement feeds were offered to the animals after the animals returned from the field at the evening. Farmers cut the branches of their Ziziphus tree for fencing purpose and the fresh leaf was collected, air dried and stored before the execution of the on farm trial. The concentrate is purchased from flour factory and private sector in the study area. The animals in all participant farmers were housed in wooden fenced house and follow up by the farmers with regular visits and monitoring by researchers on house cleaning, health and supplementing of the animals. All participant farmers were trained before the experiment was started on the purpose of the research, how to supplement their animal, housing and sanitation of their animals. All farmers had managed their animals in extensive conditions in the day time and the

experimental animals were separated and supplemented with their respected feed regime at evening. While the control animals had managed with the local practice. The control group in each PA was compensated by paying/kind payment (that is, providing urea molasses block leak for their cattle) for substitution of the contact time, lose of body weight (if any) to maintain the rams till the project termination.

During the study veterinarian researchers had participated and all animals were drenched with broad-spectrum anti-helminthes and vaccinated against common diseases of the area during the adaptation period. Animals were closely followed for the occurrence of any ill health and disorders during the study period.

Data collected and analysis

The initial weight of animals was taken at the beginning of the experiment and was continued at weekly interval. Animals were weighed at morning following the overnight fasting to avoid gut content variation. Body condition score (BCS) of the animals was also recorded at the beginning and ending of the demonstration trial. BCS was assessed using the 5 point scale (1= very thin to 5=obese) following the procedure of Aumount et al. (1994) and Thompson and Meyer (2002). Animals were visually assessed followed by palpation of the lumbar vertebrae area between the back of the ribs and the front of the pelvic bones. Two experienced animal trader farmers and two researchers carried out the BSC assessment with average scores taken to avoid biasness since the exercise is subjective. Each PA was considered as block and the three PA data were pooled for analysis. Analyses of variance (ANOVA) were done by the General Linear Model Procedure of SAS (1998) for data obtained from the experiment. Least squares means were separated using a t-test. The results reported are based on least squares means. The chemical composition data of the feed ingredients used in this on farm trial was taken from previous on station research works with similar feed sources by different authors in the study area.

Partial budget analysis

Data of such as, supplementary feed cost including the urea treatment inputs, initial and final animal selling cost were taken. The labor cost was assumed to be constant for all the treatments in the farming system. Partial budget analysis was performed to evaluate the economic advantage of the different treatments by using the procedure of Upton (1979) and (CIMMYT, 1988; Shapiro et al., 1994 both cited in Legesse et al., 2005). The partial budget analysis was involved in the calculation of the variable costs and benefits. At the beginning of the study, market price of target animals was estimated by three experienced farmers. Similarly at the end of the experiment, the selling price of each experimental animal was estimated. The selling price difference of target animals in each treatment before and after the experiment was considered as gross/total return (*TR*) in the analysis.

For the calculation of the variable costs, the expenditures incurred on various feedstuffs were taken into consideration. Supplementary feed cost including the urea treatment inputs was also taken. The labor cost was found to be constant for all the treatments in the farming system. The cost of the supplementary feeds was computed by multiplying the actual intake for the whole feeding period with the prevailing prices. At the time of feed purchasing, the prevailing price of the feeds was included the labor and transportation cost incurred to move and process them to the participant farmers. The partial budget method measures profit or losses, which are the net benefits or differences between gains and losses for the proposed change and includes calculating net return (NR), that is, the amount of money left when total variable costs (TVC) are subtracted from the total returns (TR): NR = TR-TVC

Total variable costs include the costs of all inputs that change due to the change in production technology. The change in net return (ΔNR) were calculated by the difference between the change in total return (Δ TR) and the change in total variable cost (Δ TVC), and this is to be used as a reference criterion for decision on the adoption of a new technology.

$$\Delta NR = \Delta TR - \Delta TVC$$

The marginal rate of return (*MRR*) measures the increase in net income (*Δ NR*) associated with each additional unit of expenditure (*Δ TVC*). This is expressed by percentage.

$$MRR\% = (\Delta NR / \Delta TVC) \times 100$$

RESULTS AND DISCUSSION

Chemical composition of feeds

This on-farm demonstration trial was undertaken with reference to the on station trials on feeding of air dried Ziziphus leaf and concentrate mix supplementation at different period of time. The chemical composition of the ingredients was taken from the result of different previous research works. The DM and CP content of *Z. spina-christi* as reported by different authors was (89.7 and 14.3) in Solomon et al. (2010) and (94.6 and 14.5) in Bruh et al. (2014) respectively. Tesfay and Solomon (2009) report on Afar ram concentrate supplementation also indicated that the DM and CP composition of noug seed cake and wheat bran was (93.5 and 34.5) and (89.2 and 16.8) respectively.

The DM and CP of urea treated teff straw was 92.5 and 8.4 respectively (Awet and Solomon, 2009). The crude protein of untreated teff straw reported in Raya-Alamata District was 5.75 (Tesfay and Solomon, 2009). The dried leaves of Ziziphus tree have higher CP and lower fiber content to wheat bran. Thus, proper and stratategic use of these feed resources as supplementary feed during the dry season can help minimize seasonal fluctuation in animal productivity. The browse tree supplements are expected to play a catalytic role in feed utilization and are needed in small quantities relatively to the basal roughage (Adugna, 2008).

Body weight change and body condition score

Results of effect of feed types on the live weight and body condition score of rams was shown in Table 1. The average initial live weight of ram's in T1, T2, T3 and T4 was 19.75, 19.88, 19.60 and 18.08 kg, respectively. The final live weight of the rams of the supplement group was 26.34, 27.74 and 26.97 kg for T2, T3 and T4, respectively and the control groups had a final live weight of 25.83 kg. There was a significant difference ($P<0.05$) in daily l ive

Table 1. Body weight change of Afar breed rams maintained on different feed regimes in Alamata district.

Parameter	Treatments				SEM	SL
	Control (T_1)	Urea treated teff straw (T_2)	Dried Zizipus leaf foliages (T_3)	Concentrate mix supplementation (T_4)		
Live Body weight change (LBWC)						
Initial LBW	19.75	19.88	19.60	18.08	1.33	NS
Final LBW	25.83	26.34	27.74	26.97	0.97	NS
ADBWG	67.60[b]	71.87[b]	90.47[a]	98.70[a]	5.09	*
Body score condition (BSC)						
Initial BSC	2.17	2.15	2.25	2.32	0.14	NS
Final BSC	2.56	2.81	3.16	3.16	0.19	NS
Difference of BSC	0.39[b]	0.65[b]	0.84[a]	0.91[a]	0.12	*

[a, b]= means within a row not bearing a common superscript letter significantly differ. *= P<0.05; NS = not significant; SEM= standard error of Mean; SL= significant level; BSC= body score condition, ADBWG= average daily body weight gain.

weight gain among the control and supplemented ones, except the group fed on urea treated straw. Rams in the control group and urea treated teff straw supplemented group gained 67.6 and 71.9 g/day of live weight, while the Ziziphus leaf and concentrate mix supplemented group gained 90.5 and 98.7 g/day/head, respectively. Macit et al. (2002) reported higher body weight gain of 148, 155 and 172 g/day for Awassi, Morkaram and Tushin lambs grazed on pasture and supported with concentrate respectively. The daily body weight gain of Ziziphus supplemented animals reported in this study was higher than the report of Bruh et al. (2014) (23.8 g/day) on Abergelle goat and Axum ARC progress report (2012) (30.3 g/day) on Tigray highland sheep supplemented with Ziziphus dried leaf respectively. Similarly, Kaitho et al. (1998) also reported that lower daily body weight gain of 6.5 to 65.2 g/day of sheep supplemented with different level of fodder trees. On the other hand, Tesfay and Solomon (2009) reported that lower daily body weight gain of 43.33 to 67.11 g/day for Afar lambs supplemented with graded level of concentrate supplementation under on-station condition. In this study the concentrate mix supplemented group showed the highest daily body weight gain, while the control group showed the lowest daily body weight gain.

The body score condition (BSC) assessed by taking average estimation of two researchers and two experience animal trader farmers of the study area. The initial body condition score of the treatments were 2.17, 2.15, 2.25 and 2.32 for control (T1), urea treated teff straw (T2), dried Ziziphus leaf (T3) and concentrate mix supplementated groups (T4), respectively (Table 1). There was statistically significance difference at (P<0.05) in total body score condition between control and supplemented groups. The total body score condition difference of T1, T2, T3 and T4 was 0.39, 0.65, 0.84 and 0.91, respectively (Table 1). The highest body score condition was found in the concentrate mix supplemented group followed by dried ziziphus leaf supplemented group.

Partial budget analysis

The partial budget analysis for the feeding trial was reported in Table 2, which involved the evaluation of overall profitability. The result of the partial budget analysis for Afar rams fed on different feed regimes indicated that the concentrate mix supplemented group (T4) returned a higher net benefit of Birr 22.93/head over control group and higher profit margin of Birr 0.5/head, followed by the Ziziphus leaf supplemented group (T3), which recorded net benefit of Birr 19.85/head and profit margin of Birr 0.4/head over the control group. Legesse et al. (2005) reported lower net return of 10.6 ETB per grazed goat supplemented with concentrate as compare to goats managed extensively. The urea treated teff straw supplemented group (T2) were recorded lower net benefit and profit margin. The net return from the supplemented rams was 117.38, 139.29 and 142.37 ETB/head with marginal rate of return (MRR) of 28.7, 42.4, and 49.3 for T2, T3, and T4, respectively. This means each additional unit of 1 birr per lamb cost increment resulted in 1 Birr and additional of 0.4 and 0.5 ETB benefit for T3 and T4, while loss of -0.3 ETB for T2.

The net return of T4 and T3 was higher than the net return of T2 and T1. The difference in the net return per treatment was due to the difference in live weight change of the animals in each treatment. The higher net return and MRR in T4 and T3 was due to the optimum protein source of the supplemented feeds, which resulted in higher body weight gain of (98.70 and 90.47 g/day) in T4 and T3 respectively, as compared to the other treatments that had relative body weight gain of 67.60 and 71.87

Table 2. Partial budget analysis of Afar breed rams feed different feed regimes in Raya-Alamata District.

Specific Items and their cost	Treatments			
	T1	T2	T3	T4
Initial price of sheep	233.33	226.39	228.15	200.00
Urea consumed (kg/head)	0	0.50	0	0
Plastic sheet used (M2/head)	0	1.00	0	0
Total Concentrate mix consumed (kg/head)	0	0	0	27.00
Zeziphus leaf consumed (kg/head)	0	0	27.00	0
Urea cost (ETH Birr/head)	0	3.15	0	0
Plastic sheet cost (ETH Birr/M2/head)	0	11.00	0	0
Zeziphus Leaf collection cost (ETH Birr/head)	0	0	52.00	
Concentrate mix cost (ETH Birr/head)	0	0	0	79.85
Total feed cost (ETH Birr/head)	0.00	14.15	52.00	79.85
Total Cost (ETH Birr/head)	233.33	240.54	280.15	279.85
Gross Return(ETH Birr/head)	352.78	357.92	419.44	422.22
∆GR		5.14	66.67	69.45
Net Return (ETH Birr/Head)	119.44	117.38	139.29	142.37
∆NR/NROC		-2.07	19.85	22.93
∆TVC		7.21	46.82	46.52
MRR (Ratio)		-0.3	0.4	0.5
MRR (%)		28.7	42.4	49.3

∆NR = change in net return; ∆TVC = change in total variable cost; MRR = marginal rate of revenue, Assume that the conversion rate is 1 US dollar is equals to 20 Ethiopian Birr.

g/day/sheep for T1 and T2 respectively. This indicates that lambs fed with better quality feed performed well and had higher body weight gain and sale at maximum price and earned better net return. Legesse et al. (2005) reported that combining grazing with concentrate supplementation seems potentially more profitable than grazing without supplementation. Lambs fed on Ziziphus leaf supplemented group (T3), had almost similar body weight gain and MRR with the concentrate mix supplemented group (T4), suggesting that Zizphus leaf could be used by local farmers as a good protein source supplement small ruminant.

Even though lambs in T4 showed better performance in live weight gain and MRR as compare to T3, it was not found to be economically feasible as compared to the dried Ziziphus leaf supplemented group. The sheep fed on urea treated tef straw (T2) and control (T1) diet showed lower body weight gain relative to the concentrate and Ziziphus supplemented groups. The supplemented feed item cost taking in this on farm study was 6.3, 2.7, 3.2, 2 and 2.9 Birr/kg for urea, wheat bran, noug cake; dried Ziziphus leaf and concentrate mix respectively.

There was a field day involving researchers, experts, DAs, farmers, woreda and PA administration members. The participant farmers had noticed that the benefit of different supplemental feed was not visible immediately after an adaptation period. Later farmers were very much impressed with the technology being demonstrated. They said that the income generated from the supplemented sheep was higher than that of control group and urea treated groups. Using the strategic supplementation during the dry season farmers could recondition their sheep to an attractive marketing body weight to fetch better price especially during the holidays. Therefore, the study indicated that farmers would readily adopt the technology and disseminate it to other neighboring farmers. However, as farmers had expressed their worries which is less availability of concentrate is the major limitation to the dissemination and wider use of the technology.

Conclusion

The results of this study suggested that supplementation of small ruminant with 283.8 g DM of dried Ziziphus leaf or 250 g DM concentrate mixture consisting of noug seed cake, and wheat bran is potentially more profitable and economically beneficial to the small scale farmers than the other level of supplements. Moreover, the dried Ziziphus leaf feeding technology does not require farm land and can grow in farm boarder waste land and hillsides. The only resource required to utilize it is the labour during harvest/collect and process the leaf until feeding to animals. Nevertheless, it would be important to check whether the Ziziphus leaf harvesting time could not coincide with a seasonal labour peak. In Raya-Alamata

District, Ziziphus leaf harvesting should occur when demand for labor is less.

Conflict of Interest

The authors have not declared any conflict of interest.

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