Prioritizing feed technologies using TechFit in Horro district, west Oromia, Ethiopia

T. Jembere[1], G. Duguma[1], K. Degefa[1] and A. Tolera[2]

[1]Livestock Research Process, Bako Agricultural Research Center, Ethiopia
[2]Department of Animal and Range Sciences, College of Agriculture, Hawassa University, Ethiopia

Produced by International Livestock Research Institute, International Center for Agricultural Research in the Dry Areas, Ethiopian Institute of Agricultural Research, Oromia Agricultural Research Institute

Published by International Livestock Research Institute

October 31, 2012
www.africarising.net

The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-for-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads an associated project on monitoring, evaluation and impact assessment.

ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE IFPRI IITA Research to Nourish Africa

Introduction

The livestock sector contributes about 45% to the agricultural GDP in Ethiopia (Behnke and Fitaweke, 2011), without considering the contribution of manure and, hides and skins. Livestock plays important roles in providing draught power for traction and transport as well as export commodities in the form of live animals, meat, hides, skins and leather to earn foreign currencies. Moreover, livestock products provide animal proteins that contribute to the improvement of the nutritional status of the people. According to a recent assessment conducted in Horro district (Duguma et al. 2012a, unpublished) the main uses of livestock include provision of traction power, milk production, income generation, means of transport and manure production for fertilizing crop fields. The assessment also showed that cattle, sheep, goats, horses, donkeys, mules and chicken are the animals commonly produced in the district and that the contribution of livestock to household income ranges from 28 to 59%. Cattle, sheep and horses are the most important livestock species raised in the district in that order.

However, livestock production in Horro district is constrained by shortage of feeds, diseases and parasites, and lack of knowledge on improved animal husbandry practices. Shortage of feeds is exacerbated by the increase in human and livestock population and expansion of croplands, resulting in shrinkage of grazing lands (Duguma, 2010). In such a situation, feed technology options that address quantity, quality and seasonality issues are needed. A number of important feed technologies have been generated by the research systems over the last four to five decades, costing substantial amount of efforts and resources. However, adoption rate of the technologies has been very poor due to lack of suitable mechanisms for filtering and prioritizing the available feed technologies for specific locations and situations.

In order to fill this gap, the International Livestock Research Institute (ILRI) has recently developed a simple tool known as TechFit for prioritization of feed technology options to enable better targeted interventions to address livestock feed problems in specific locations. Thus this study was carried out with objectives of prioritizing suitable feed technologies from a basket of options for Gitlo, Lakku, and Oda Buluq kebeles of Horro district using TechFit.

Materials and methods

Description of the study areas

The study was conducted in Gittlo, Lakku and Oda Buluq kebeles in Horro district of the Horro Guduru Wollegga zone of Oromia region, western Ethiopia in July 2012. Horro district is located at about 315 km west of Addis Ababa (9º 34´N latitude and 37º 6´E longitude). The altitude of the district ranges from 1800 to 2835 meters above sea level (masl). Human population of the district is estimated to be 103,707 (61,553 males and 42,154 females). There are 12,805 male and 3,236 female headed households in the district. Total land area of the district is about 77,998 ha of which grazing land accounts for about 8.3%. The proportion of highland, midland and lowland areas in the Horro district are about 49.8%, 49.0% and 1.2%, respectively (Horro District Office of Agriculture). The district has one long rainy season that extends from March to mid-October with mean annual precipitation of about 1800 mm (Olana, 2006). The mean, average maximum and average minimum temperatures of the district were reported to be about 22^0C, 27^0C and 11.7^0C, respectively. Total livestock population of the district was about 346,917 head, which comprises cattle (152,180 head), sheep (59,118 head), goats (29,923 head), horses (29,247 head), donkeys (12,611 head), mules (4,180 head) and chicken (59,568 head).

Selection of kebeles, farmers and context attribute scoring

The three kebeles used in this study were selected by the research team of Bako Agricultural Research Center (BARC) and the staff of the Horro District Office of Agriculture based on sheep production potential and accessibility of the kebeles. Number of households, altitudes and geographical coordinates of the kebeles are indicated in Table 1. About 15 farmers were identified from each kebele to assess feed resource availability using the Feed Resources Assessment Tool (FEAST) (Duguma et al., 2012a) Participatory Rural Appraisal (PRA) group discussions, which preceded the TechFit interview. The participants were selected with the help of the Kebele administration and development workers using the pre-set criteria such as landholding, gender, education status and age. Out of the 15 farmers who participated in the FEAST PRA group discussions in each kebele, 12 farmers were selected for the TechFit group discussions in order to score the context attributes of the area, which focused on availability of attributes such as land, labor, cash/credit, inputs and knowledge.

Table 1: Number of households, altitudes and geographical coordinates of the kebeles

Kebeles	№ of households	Altitudes (masl.)	GPS coordinates
Gitlo	501	2758	09^o 33´ N and 37^o 03´ E
Lakku	388	2710	09^o 34´ N and 37^o 03´ E
Oda Buluq	457	2490	09^o 38´ N and 37^o 04´ E

Intensive discussions were conducted between the researchers and farmers on issues that could help for scoring the context attributes of the farmers in the area using a checklist prepared for this purpose (Figure 1). The farmers were encouraged to freely debate on the different attributes to arrive at context scores. Accordingly the farmers scored the five attributes (availability of land, labor, cash/credit, inputs and knowledge) on a 1-5 scale (Table 2) by giving justification. Experts also did their own scoring for the purpose of cross checking the reliability of the scores given by the farmers. The scores (availability) given for each attribute by each Kebele were entered into an Excel template.

Figure 1. Research staff discussing with farmers at Lakku, one of the Kebeles

Pre-filtering of technologies

Technologies which were not applicable to the Kebeles were pre-filtered. Pre-filtering was done based on context relevance and impact potential of the technologies scores (product of the two scores). The context relevance refers to the relevance of the technology to the study area. Relevant technology that can address the identified feed issues within the existing production conditions was given a score of 6 while the one with lowest relevance was given a score of 1. The impact potential of the technologies was about the potential of the identified technology in addressing the feed issue in the area. This was developed by a team of feed experts and the scales ranged from 1-6 (1 least impact, 6 highest impact).

Main-filter of the technologies

Technologies that passed the pre-filtering process were further assessed in main filtering based on context attribute and technology attribute scores and score for scope for improvement. The context attribute scores (scores for availability of land, labour, cash/credit, inputs and knowledge) were given by the selected farmers from each kebele, whereas the technology attribute scores (requirement of each potential feed technology for land, labour, cash/credit, inputs and knowledge) had already been set in the Techfit tool by a group of experts. The context attribute scores were multiplied by the technology attribute scores for each of the five attributes considered. Finally, total scores were determined by adding the scores for the five attributes plus the score for the scope for improvement. The technologies were ranked based on this total score.

Cost benefit analysis

Cost benefit analysis was computed for the top ranked technologies in each kebele. In computing the cost benefit analysis, additional costs incurred to utilize each technology and likely financial benefits from uses of the technology were estimated considering fattening of yearling Horro sheep (Annex 2, 3 and 4 for Gitlo, Lakku and da Buluq, respectively). An initial live weight of 20 kg and total weight gains ranging from 8 – 11 kg were assumed for the fattened rams based on previous works (Duguma et al., 2005). About 0.5 kg more live weight gain was assumed from each feed technology used in Oda Buluq due to its relatively warmer weather condition as compared to the other kebeles. The length of the fattening was assumed to be about three months (115 days including 15 – 20 days of acclimatization period) and timing was assumed to be from February to May. It was assumed that an animal consumed about 3% of its live weight (20 kg in this case) daily on dry matter basis. Maximum contribution to the diet of animals from grazing of natural pasture (roughage) was calculated to be about 60% (Duguma et al., 2012a, unpublished data) when feed is plenty. According to the authors, only about 23% of this amount is available during dry months particularly from February to May when the present work was assumed to be conducted. Thus, it was assumed that the contribution to the diet of animals from the improvement of crop residues, for example, should be about 77% to fill the feed deficit happening during the dry season. Since crop residues are inherently poor in quality, it was assumed that rams assigned to feed technologies related with crop residues be given small amount of supplementary concentrates. Conversely, roughages would be provided for rams assigned to supplementation technology. Additionally, rams would be provided with local mineral (‘*amole*’) to fulfill their mineral requirement and receive some treatments like de-worming. Wage for herding sheep was also considered and made constant across the board. The price of crop residues were assumed to be 0.70 ETB (1USD=17.5 ETB at the exchange rate of July, 2012) per kg of dry matter and, only additional costs pertaining to particular technology were considered.

Partitioning the contribution made by a technology to the weight gain

To partition the contribution made by a given alternative feed technology, previous on-farm sheep fattening study results were used (Abegaz et al., 2004; Duguma et al., 2005). The authors reported that the contribution of concentrate supplements and basal diet (grazing of natural pasture or hay) to the weight gain of a yearling Horro rams were about 52.2% and 47.8%, respectively. Accordingly the contribution of a technology be it basal feed or supplementation was partitioned.

Calculation of the returns

The financial benefit from each technology was calculated as a product of the likely weight gain due to a technology in about three months period and the selling price per kg at export abattoirs. Average selling price at export abattoirs was taken to be 31.00 ETB per kg live weight at export abattoir. According to Duguma et al. (2012b, unpublished data), the producers' share of the final price (the selling price at export abattoirs) was estimated to be 60% at Horro district. Thus, financial benefit from each technology was assumed as 60% of the selling price at export abattoirs. Detailed assumptions of cost benefit analyses are given in Annexes 2 - 4

Results and discussions

Context attributes scores

Farmers' context attribute scores (scores for availability of land, labor, cash/credit, inputs delivery, and knowledge) in the three kebeles is indicated in Table 2 with justification for scores given. The lowest score was given for input delivery in Lakku followed by cash/credit service. Cash/credit, input delivery and knowledge in Oda Buluq, and input delivery in Gitlo were given below average scores.

Table 2. Farmers' context attributes score for the different attributes in the three kebeles

№	Attributes (1- 5 scale)‡	Gitlo	Lakku	Oda Buluq	Justifications given by farmers
1.	Land	3	3	3	Sizable farmlands were owned by former elders; young farmers are emerging at alarming rate; parents share to their descendants upon good will
2.	Labor	3	3	3	Young children enroll to school; daily laborer is sometimes unavailable to hire
3.	Cash/credit	3	2	2	Though there is credit service, it is not flexible. Collateral is needed to access it which is actually difficult for farmers suitable collateral
4.	Inputs	2	1	2	Some of the inputs like plastic sheeting are not available to the area; some agricultural inputs lack quality (seeds) and others are becoming too expensive.
5.	Knowledge/skill	3	3	2	Knowledge/skill gap was reported as major issue by farmers in the three kebeles. The present knowledge/skill is too little.

‡1=lowest and 5 = highest

Regarding availability of land, the farmers indicated that many young farmers are emerging although the available land is limited. The shortage of land in the three kebeles resulted in a low context score for the availability of land in the kebeles. This warranted agricultural intensification in the kebeles. Labour availability was reported to be critical during peak agricultural activities such as harvesting as children from each family are enrolled in schools during such times and cannot contribute to farm work. The need of collateral to access the credit service lowered the score given to its availability. Some of the agricultural inputs were either very expensive or not readily available, which resulted in relatively low score. Farmers from the three kebeles noted that they had no tailor made training to fill the knowledge gap they had. This was worst in the case of Oda Buluq, which was not covered by the ICARDA-ILRI-BOKU community-based sheep breeding project. According to Duguma (2010), the ICARDA-ILRI-BOKU community-based sheep breeding project has more than 130 sheep producing households, in Gitlo and Lakku kebeles, as members which have frequently been exposed to several trainings related to improved livestock production and management in general and that of sheep in particular.

Pre-filter of technologies

Lists of technology options, which were categorized into six broad groups, to address the quality, quantity and seasonal issues of feeds are given in Annex 1. The six broad groups were: 1) improvements of crop residues, 2) supplementation, 3) feed conservation, 4) improved forages, 5) feeds from cropping systems, and 6) balanced feeds. Specific technologies unable to be carried forward are indicated with reasons for their failures in Table 3; and the top ranked technologies and reasons for their being ranked as such are depicted in Table 4. In general, the major reason for dropping a technology included was either unsuitability of the technology in the agro-ecology of the area or difficulties in making it available to the area.

Table 3. Feed technologies unable to pass the pre-filtering process and reasons for dropping

№	Technologies	Reason for dropping
I	**Improvement of Crop residues**	
	Feeding of bought in legume residues	In general, purchasing animal feeds is not a common practice in the three kebeles. The home produced legume residues will not reach the level of transaction being surplus from feeding own animals
	Supplementation	
	Supplementation of bought in local brewery wastes	The tradition of home brewing and distilling is significantly decreasing due to change of religion by most of the community members and hence availability of these products for sale and purchase is quite insignificant.
	Use of oats grain and hulls for supplementary feeding	Not known in the areas. Thus it is time demanding to convince farmers to allot the small plots of land they have for a crop that is not known in the area. This technology works better in areas where farmers grow oats and process the grain for human consumption.
	Use of urea molasses block	Molasses is not available in the area and that could be a stumbling block to promote the technology
	Use of poultry litter	Commercial poultry farm is not available in the area
	Feed conservation	
III	Making hay from cultivated perennial fodder with specialist seed (e.g. alfalfa, Rhodes)	Land demanding. Despite their contribution they are not relevant in the areas because they occupy lands for long period which farmers do not prefer and tolerate
	Buying baled hay (e.g. oats/vetch, Rhodes grass, meadow etc.)	Financial demanding and not available in the areas.
	Feed conservation (silage)	Inputs, labor and knowledge intensive
	Improved forages	
IV	Improved forage grasses (Napier grass, Rhodes grass)	Despite their high biomass yield, due to limitation of agro-ecology (not suitable to the areas)
	Improved forage legumes (Alfalfa, Desmodium spp.)	Despite their high biomass yield and suitability of alfalfa to the area, adoption could be a problem as both crops are perennial and occupy the limited land the farmers have
	Fodder trees - dual purpose (Pigeon pea)	Highland agro-ecology is not conducive for dual purpose fodder trees such as pigeon pea
	Use of improved perennial grass-legume mixture (e.g. Rhodes-alfalfa forage or hay)	Difficult and expensive to incorporate a legume every year into perennial grasses. Labor, land and skill demanding
	Feeds from cropping systems	

V	Thinning (e.g. maize and/or sorghum - cutting green at knee height)	Agro-ecological limitation (except for Oda Buluq where maize is grown to some extent, maize and sorghum are not produced in the areas)
	Use of tops, leaf strips (e.g. maize or sorghum)	Agro-ecological limitation; maize and sorghum are not grown in the areas
	Use of enset and/or banana leaves and by-products	Not available in the areas. Enset is not in the culture of the community and it may not be adopted as animal feed when it is not used as human food
	Crop/forage intercropping (sorghum/cowpea for dry areas and maize/lablab for wetter areas)	Agro-ecological limitation (crops are not produced there)
	Root and tubers - use of byproducts	Not available in the areas; except potato root and tuber crops are not grown in the area
	Root and tubers - dedicated use	Not available in the areas; except potato root and tuber crops are not grown in the area
	Vegetable wastes	Not available in the areas; no sufficient waste is found from vegetables

Table 4. Feed technologies carried forward, scores given to the scope for improvement of the technology attributes and major reasons for scores given

№	Technologies carried out to the main filter	Justifications for promoting for further processing
1.	Hand chopping of crop residues	• Not affected by land and knowledge, but moderately affected by cash (eg. to buy some tools) and labor and slightly by input supply. If practiced it will largely improve the intake of the residues.
2.	Machine chopping of residues	• Though machines which chop residues are not available in area the option can address the problem of residue refusal even more than hand chopping. It would be difficult to be used per farmer but farmers may come together and buy to use it in group.
3.	Generous feeding of crop residues	• Ample crop residues are produced in the areas, but not properly utilized • Not affected by cash/credit, input delivery system and knowledge • Influenced by land (though land is not meant for production of crop residues the availability of land matters) and labor
4.	Treatment of crop residues (e.g. urea treatment)	• This approach would help a lot in improving the inherently poor quality of crop residues. However, the technology is much affected by availability of input and knowledge/skill
5.	Feeding of home grown legume residues	• Same as other crop residues, but has great potential in improving the nutrient contents of feeds (eg. crude protein)
6.	Re-threshing and mixing of crop residues before storage and feeding	• Not influenced by inputs, cash/credit and knowledge, but affected by labor availability • Considering land issue, same as other crop residues
7.	Supplementation of home produced local brewery wastes	• From the beginning the amount of brewers waste produced are reported to be small. However, that amount can be utilized for own animals.
8.	Supplement with oilseed cakes	• The presence oil seed processors in the area favored the promotion of this technology.
9.	Supplement with pulse crop milling by-products (e.g., lentil hulls and/or brans etc.)	• As the crop grinder machines are found in nearby towns and in the villages also the option can be opted
10.	Use of leave/pods of farm trees	• Though not available in the required amount, it does not mean that

		it does not work. In Oda Buluq kebele, for example, it may work well.
11.	Fodder tree leaf meal	• Though not available in the required amount, it does not mean that it does not work. In Oda Buluq kebele, for example, it may work well.
12.	Supplement with agro-industrial by-products	• Not affected by land , but moderately influenced by knowledge • Agro-industries are not available in the areas, other than local oil meals • Dependent on cash/credit and inputs delivery system
13.	Commercial dairy supplements	• These may be obtained through cooperatives and traders to those who can afford.
14.	Fodder beets for cooler highlands	• The Horro district seems an ideal location for the fodder beet as it is quite highland.
15.	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia)	• Requires land. Though they can be planted on crop boundaries and as live fence, usually no impact is expected with few trees • They require a lot of labor for establishment, protection (particularly for young trees) and harvesting – particularly in areas like Horro where animals are left free to roam, their scope for improvement might be low • Some of the technologies are determined by agro-ecologies
16.	Use of weeds, cut grass, tree leaves	• Only slightly influenced by labor, but the use of herbicides for weeds control may influence its future application
17.	Use of improved annual grass-legume mixture (e.g. oat-vetch forage or hay)	• After filling the knowledge gap the farmers have and convincing, farmers could assign part of their land for such alternatives.
18.	Feed conservation of private natural pasture (surplus) (HAY)	• The present initiatives by the community could be more optimized
19.	Making hay from cultivated annual fodder with readily available seed (e.g. oats/vetch)	• The present initiatives by the community could be more optimized
20.	Complete feed-TMR (mash, block, pellet)	• The technology can be tried out though it is capital and knowledge intensive.
21.	Smart feeding (targeted use of bought-in concentrates to target productive animals)	• Affected by cash/credit, input delivery system and knowledge • In relation to the unavailability of feeds processing industries, the scope of improvement for technology might be constrained

Selection of top ranked technologies

Among the promoted technologies for further filtering seven, six and six top ranked feed intervention technologies were identified for Gitlo, Lakku and Oda Buluq, respectively (Tables 5, 6 and 7). The top ranked feed technologies included supplement with home-produced local brewers waste, feeding of home grown legume residues, re-threshing and mixing of crop residues before storage and feeding, use of weeds, cut grass, tree leaves, use leaves and/or pods of farm trees, generous feeding of residues, hand chopping of residues and fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia). In general, these technologies were ranked highly based on the scores given for the technology and context attributes. Some of the feed intervention technologies selected were those related to crop residues and supplementation. Hand chopping of residues was the least ranked in Gitlo whereas the fodder trees were least ranked in Lakku and Oda Buluq. From crop production potential of the areas, one can be sure that feed intervention technologies related to crop residues could reasonably address the feed problem prevailing in the areas. Estimates of annual production of crop residues, based on harvest index of each crop, is around 6.3, 8.7 and 11.7 tons per household for Gitlo, Lakku and Oda Buluq, respectively. In both Gitlo and Lakku kebeles, home grown legume residues received the highest total score followed by re-threshing and mixing of crop residues before storage and feeding (Table 5 and 6). Supplement with home-produced local brewers waste was first ranked in all the three kebeles followed by feeding of home grown legumes. Except for the differences in the scores given for each feed intervention technology, technologies selected for Gitlo and Lakku were almost the same, which indicates their similarity in production system.

Table 5. List of top ranked feed technologies filtered from a basket of options for Gitlo

№	List of feed technologies tope ranked with the TechFit tool	Total score	Rank
1.	Supplement with home-produced local brewers waste	68	1
2.	Feeding of home grown legume residues	67	2
3.	Use of weeds, cut grass, tree leaves	61	3
4.	Re-threshing and mixing of crop residues before storage and feeding	60	4
5.	Use leaves and/or pods of farm trees	59	5
6.	Generous feeding of Crop residues	53	6
7.	Hand chopping of residues	53	6

The lowest total score and hence rank of fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia) and hand chopping was associated with their labor and cash demanding nature. Other technologies like use of weeds, cut grass, tree leaves, re-threshing and mixing of crop residues before storage and feeding, use of leaves and/or pods of farm trees and generous feeding of crop residues were among the top ranking technologies because of their moderate requirement for attributes such as land, cash/credit and inputs.

Table 6. List of top ranked feed technologies filtered from a basket of options for Lakku

№	List of feed technologies tope ranked with the TechFit tool	Total score	Rank
1.	Supplement with home-produced local brewers waste	58	1
2.	Feeding of home grown legume residues	57	2
3.	Re-threshing and mixing of crop residues before storage and feeding	50	3
4.	Use leaves and/or pods of farm trees (e.g. Acacias, Milletia etc)	49	4
5.	Generous feeding of crop residues	44	5
6.	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia etc.)	43	6

Table 7. List of top ranked feed technologies filtered from a basket of options for Oda Buluq

№	List of feed technologies tope ranked with the TechFit tool	Total score	Rank
1	Supplement with home-produced local brewers waste	59	1
2	Feeding of home grown legume residues	58	2
3	Re-threshing and mixing of crop residues before storage and feeding	51	3
4	Use leaves and/or pods of farm trees (e.g. Acacias, Milletia etc)	50	4
5	Generous feeding of crop residues	45	5
6	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia etc.)	44	6

Cost benefit analysis

The economic analyses for the top ranked feed intervention technologies were based on benefit cost ratio (BCR); and, accompanied by net returns (Table 8). If the benefit is higher than cost and the quotient is greater than unity, it means that use of the technology is considered to be economical. All top ranked technologies, except hand chopping of crop residues at Gitlo, were found to be economical at the three kebeles. The BCR value for economically feasible technologies ranged from 1.43 to 1.93 at the three kebeles. As the value of the BCR only indicated the feasibility of a technology, net returns were also presented for respective technologies. The net return per animal in ETB ranged from 20.18 to ETB 38.95 at Gitlo/Lakku. At Oda Buluq the net return ranged from ETB 15.66 from fodder trees to ETB 43.80 from supplement with home-produced local brewers wastes. The higher net return at Oda Buluq kebele was due to the assumption of more weight gain in line with its warmer weather condition compared to the other kebeles.

Table 8: Cost benefit analysis for the technologies top ranked at the three kebeles in terms of benefit cost ratio (BCR)

№	Technology options to address quantity, quality, seasonality issues	Gitlo		Lakku		Oda Buluq	
		BCR	**NRT**	**BCR**	**NRT**	**BCR**	**NRT**
1.	Hand chopping of residues	0.93	-5.15	-	-	-	-
2.	Generous feeding of crop residues	1.81	24.18	1.81	24.18	1.93	28.01
3.	Re-threshing and mixing of crop residues before storage and feeding	1.53	21.43	1.53	21.43	1.72	29.05
4.	Supplement with home-produced local brewers waste	1.62	38.95	1.62	38.95	1.70	43.80
5.	Feeding of home grown legume residues	1.93	28.01	1.93	28.01	1.70	43.80
6.	Use leaves and/or pods of farm trees	1.34	15.66	1.34	15.66	1.34	15.66
7.	Use of weeds, cut grass, tree leaves	1.43	20.18	-	-	-	-
8.	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia)	-	-	1.34	15.66	1.34	15.66

BRC=Benefit cost ratio; NRT=Net return in ETB.

Conclusions and recommendations

Livestock production is one of the major contributors to the livelihood of the smallholder households of the kebeles considered in the present study. They are mainly raised for traction, milk production, income generation and transportation. However, the sector is constrained by different problems; and one of these problems is feed (both quantity and quality). Various feed intervention technologies were generated by research systems of the country during the past three or four decades. Nevertheless, the adoption rate was insignificant probably due to lack of targeting to assess the relevance of the technologies to specific locations.

Cognizant of this, the International Livestock Research Institute (ILRI) has recently developed a tool for prioritizing feed technologies (TechFit) for a specific location. The research staff of Bako Agricultural Research Center of the Oromia Agricultural Research Institute (OARI) in collaboration with ILRI and ICARDA used TechFit to prioritize different feed technology options to address the quantity, quality and seasonality issues in Gitlo, Lakku and Oda Buluq kebeles. After filtering the different feed technologies at different levels, six top ranked technologies were identified. The top ranked feed technologies included supplement with home-produced local brewers waste, feeding of home grown legume residues, re-threshing and mixing of crop residues before storage and feeding, use of weeds, cut grass, tree leaves, use of leaves and/or pods of farm trees, generous feeding of residues, hand chopping of residues and fodder trees such asSesbania, Leucaena, Tagasaste, Gliricidia etc. The BCR value for economically feasible technologies ranged from 1.43 for use of leaves and/or pods of farm trees to 1.93 for supplement with home-produced local brewers waste at the three kebeles. Additionally, the returns for economical feed technologies were also computed for each technology which ranged from ETB 20.18 to 38.95 at Gitlo/Lakku and from ETB 15.66 to ETB 43.80 at Oda Buluq. Based on the benefit cost ratio and net return computed, all of the top ranked feed intervention technologies, except hand chopping of residues, were economical.

Based on results of the BCR and net return obtained in the current study, the abundant availability of crop residues in the areas and the ever decreasing grazing lands due to the expansion of crop cultivation, we comfortably recommend the use of generous feeding of crop residues and re-threshing and mixing of crop residues before storing and feeding for the three kebeles.

Challenges, lessons and way forward

Challenges

- Cost benefit analysis was based on a number of assumptions. Verification and feedback from producers was not captured in this regard.
- If cost benefit analysis need to be made for non-monetary impacts, it is difficult to value some traits (e.g. lambing interval, twining, age at first lambing, in the case of sheep).
- Most of the feed technologies make only partial contribution to the total diet of the animal and this poses a challenge in partitioning the contribution of the feed in question to the performance of the animal.

Lessons learned

- The tool has strong power in screening technologies that are not relevant
- The tool saves time and resource in identifying suitable technologies to an area
- **The tool enabled better understanding of why some technologies are not adopted**

The way forward

- A manual has to be prepared for users on how to use the tool
- Validation/verification of the cost-benefit analysis assumptions has to be made
- Technologies related with crop residues have to be accompanied with high quality feeds supplementation.
- Valuation of non-marketable attributes or intangible attributes (eg. reproductive traits) is needed

Acknowledgments

The authors greatly appreciate the support and collaboration of the management of Bako Agricultural Research Center in undertaking the study. Our special gratitude also goes to Alemayeheu Kumsa and Worku Temesgen for their assistance in data collection. We wish to sincerely and greatly thank the smallholder farmers of Gitlo, Lakku and Oda Buluq kebeles for their cooperation in providing necessary information. The financial support of USAID through the Africa RISING Program is gratefully acknowledged.

References

Abegaz, S., Duguma, G., Kumsa, T., Soboka, B., Bacha, D., Dubiso, F., Galmessa, D. and Feleke, B., 2004. On farm verification of sheep finishing technologies in east Wollega zone. *In:* Asfaw Yimegnual and Tamirat Dagafa (eds). Proceedings of the 12th annual conference of the Ethiopian society of animal production (ESAP) held in Addis Ababa, Ethiopia, August 12 – 14, 2004. ESAP, Addis Ababa. Vol. 2: Technical papers.

Ahmad, R., B. Hassan and K. Jabran. 2007. Improving crop harvest index, DAWN Group of Newspapers 2007 on http://archives.dawn.com/copyright.htm (visited on 31-July-2012).

Behnke, Roy and Fitaweke Metaferia, 2011. The Contribution of Livestock to the Ethiopian Economy – Part II, IGAD LPI Working Paper No. 02 – 11.

Berhanu Gebremedhin, Hoekstra D and Samson Jemaneh. 2007. Heading towards commercialization? The case of live animal marketing in Ethiopia. IPMS Working Paper 5. ILRI.

Duguma, G., 2010. Participatory definition of breeding objectives and implementation of community-based sheep breeding programs in Ethiopia. PhD Thesis, University of Natural Resources and Life Sciences, Vienna, Austria.

Duguma, G., Abegaz, S., Kumsa, T., Dubiso, F., Soboka, B., Gojjam, Y., 2005. On farm verification of creep feeding of ram lambs in East Wollega. *In*: Tamirat Dagafa and Fekede Feyisa (eds). Proceedings of the 13th annual conference of the Ethiopian society of animal production (ESAP) held in Addis Ababa, Ethiopia, August 25 – 27, 2005. ESAP, Addis Ababa. Vol. 2: Technical papers.

Duguma, G., Jembere, T., Degefa, K., Temesgen W., Haile A. and Legese, G., 2012b. Value chain analysis of sheep in Horro district of Oromia Region, Ethiopia (Unpublished).

Duguma, G., Jembere, T., Degefa, K., Temesgen W., Kumsa A. and Wamatu, J., 2012a. Characterization of the farming and livestock production systems and the potential for enhancing productivity through improved feeding in Horro District, Ethiopia (unpublished).

Haftamu Gebretsadik, Mitiku Haile and Charles F. Yamoah, 2009. Tillage Frequency, Soil Compaction and N-Fertilizer Rate Effects on Yield of Teff (Eragrostis Tef (Zucc) Trotter) in Central Zone of Tigray, Northern Ethiopia, Mekelle University Volume 1 (1): 82 – 94, 2009 (MEJS) Volume 1 (1): 82 – 94.

Netherlands-African Business Council (NABC), 2010. Livestock in Ethiopia and opportunity analyses for Dutch investment: Fact Sheet. NABC.

Olana, B.T., 2006. People and dams: Environmental and socio-economic changes induced by a reservoir in Fincha'a watershed, western Ethiopia. PhD Thesis, Wageningen University, The Netherlands.

Wondimu Fekadu, Habtamu Zeleke and Amsalu Ayana, 2011. Genetic improvement in grain yield potential and associated traits of food barley (Hordeum vulgare L.) in Ethiopia, Ethiop .J. Appl. Sci. Technol. 2(2): 43 -60.

Annex 1: Lists of technologies for pre and main filters

1. **Improvements of crop residues**
    1.1. Machine chopping of residues
    1.2. Hand chopping of residues
    1.3. Generous feeding of crop residues
    1.4. Re-threshing and mixing of crop residues before storage and feeding
    1.5. Treatment of crop residues (e.g. urea treatment)
    1.6. Feeding of home grown legume residues
    1.7. Feeding of bought in legume residues
2. **Supplementation**
    2.1. Supplement with home-produced local brewers waste
    2.2. Supplement with bought in local brewers waste
    2.3. Supplement with UMMB
    2.4. Supplement with oilseed cakes
    2.5. Supplement with agro-industrial by-products (wheat bran, wheat middling etc.)
    2.6. Supplement with pulse crop milling by-products (e.g., lentil hulls and/or bran etc.)
    2.7. Use leaves and/or pods of farm trees (e.g. Acacias, Milletia etc)
    2.8. Commercial dairy supplements
    2.9. Use of oats grain and hulls for supplementary feeding
    2.10. Poultry litter
3. **Feed conservation**
    3.1. Feed conservation of private natural pasture (surplus) (HAY)
    3.2. Making hay from cultivated annual fodder wth readily available seed (e.g. oats/vetch)
    3.3. Making hay from cultivated perennial fodder wth specialist seed (e.g. alfalfa, Rhodes)
    3.4. Buying baled day (e.g. oats/vetch, Rhodes grass)
    3.5. Feed conservation (SILAGE)
    3.6. Fodder tree leaf meal
4. **Improved forages**
    4.1. Fodder beet for cooler highlands
    4.2. Improved forage grasses (Napier grass, Rhodes grass)
    4.3. Improved forage legumes (Alfalfa, Desmodium spp.)
    4.4. Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia)
    4.5. Fodder trees - dual purpose (Pigeon pea)
    4.6. Use of improved annual grass-legume mixture (e.g. oat-vetch forage or hay)
    4.7. Use of improved perennial grass-legume mixture (e.g. oat-vetch forage or hay)
5. **Feeds from cropping systems**
    5.1. Thinning (e.g. maize and/or sorghum - cutting green at knee height)
    5.2. Use of enset and/or banana leaves and by-products
    5.3. crop/forage intercropping (Sorghum/cowpea for dry areas and Maize/lablab for wetter areas)
    5.4. Use of weeds, cut grass, tree leaves
    5.5. Use of tops, leaf strips (e.g. maize or sorghum)
    5.6. Root and tubers - use of byproducts
    5.7. Vegetable waste
    5.8. Root and tubers - dedicated use
6. **Balancing feeds**
    6.1. Smart feeding (targeted use of bought-in concentrates to target productive animals)
    6.2. Complete feed-TMR (mash, block, pellet)

Annex 2.Lists of technologies assumptions for additional costs and benefits for Gitlo

№	Technology options to address quantity, quality, seasonality issues	Assumptions	
		Additional costs	Additional benefit
1.	Hand chopping of residues	Opportunity cost of 43.12 kg of crop residues, price of chopper (ETB 100.00) and wage payment for chopping that amount (ETB 20.00)	Total gain=9.5 kg of which the contribution of the technology is 3.50 kg.
2.	Generous feeding of crop residues	Opportunity cost of 43.12 kg of crop residues	Total gain=8 kg of which the contribution of the technology is 2.944 kg.
3.	Re-threshing and mixing of crop residues before storage and feeding	Opportunity cost of 43.12 kg of crop residues and wage payment for Re-threshing that amount (ETB=10.00)	Total gain=9.0 kg of which the contribution of the technology is 3.31 kg.
4.	Supplement with home-produced local brewers waste	Opportunity cost of 14 kg of home produced local brewery on dry matter basis	Total gain=10.00 kg of which the contribution of the technology is 5.48 kg.
5.	Feeding of home grown legume residues	Opportunity cost of 43.12 kg of crop residues	Total gain=8.5 kg of which the contribution of the technology is 3.13 kg.
6.	Use leaves and/or pods of farm trees	Opportunity cost of 43.12 kg of tree leaves (ETB 35.95), wage payment for collection of tree leaves (ETB 20.00).	Total gain=9.0 kg of which the contribution of the technology is 3.31 kg.
7.	Use of weeds, cut grass, tree leaves	Opportunity cost of 43.12 kg of cut grass and tree leaves (ETB 35.95), wage payment for collection of tree leaves (ETB 20.00).	Total gain=9.0 kg of which the contribution of the technology is 3.31 kg.

Annex 3.Lists of technologies assumptions for additional costs and benefits for Lakku

№	Technology options to address quantity, quality, seasonality issues	Assumptions	
		Additional costs	Additional benefit
1.	Hand chopping of residues	Opportunity cost of 43.12 kg of crop residues, price of chopper (ETB 100.00) and wage payment for chopping that amount (ETB 20.00)	Total gain=9.5 kg of which the contribution of the technology is 3.50 kg.
2.	Generous feeding of crop residues	Opportunity cost of 43.12 kg of crop residues	Total gain=8 kg of which the contribution of the technology is 2.944 kg.
3.	Re-threshing and mixing of crop residues before storage and feeding	Opportunity cost of 43.12 kg of crop residues and wage payment for Re-threshing that amount (ETB=10.00)	Total gain=9.0 kg of which the contribution of the technology is 3.31 kg.
4.	Supplement with home-produced local brewers waste	Opportunity cost of 14 kg of home produced local brewery on dry matter basis	Total gain=10.00 kg of which the contribution of the technology is 5.48 kg.
5.	Feeding of home grown legume residues	Opportunity cost of 43.12 kg of crop residues	Total gain=8.5 kg of which the contribution of the technology is 3.13 kg.
6.	Use of weeds, cut grass, tree leaves	Opportunity cost of 43.12 kg of cut grass and tree leaves (ETB 35.95), wage payment for collection of tree leaves (ETB 20.00).	Total gain=9.0 kg of which the contribution of the technology is 3.31 kg.
7.	Use leaves and/or pods of farm trees	Opportunity cost of 43.12 kg of cut grass and tree leaves (ETB 35.95), wage payment for collection of tree leaves (ETB 20.00).	Total gain=9.0 kg of which the contribution of the technology is 3.31 kg.
8.	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia)	Opportunity cost of 43.12 kg of cut grass and tree leaves (ETB 35.95), wage payment for collection of tree leaves (ETB 20.00).	Total gain=9.0 kg of which the contribution of the technology is 3.31 kg.

Annex 4. Lists of technologies assumptions for additional costs and benefits for Oda Buluq kebele

№	Technology options to address quantity, quality, seasonality issues	Assumptions	
		Additional costs	Additional benefit
1.	Hand chopping of residues	Opportunity cost of 43.12 kg of crop residues, price of chopper (ETB 100.00) and wage payment for chopping that amount (ETB 20.00)	Total gain=10.0 kg of which the contribution of the technology is 3.68 kg.
2.	Generous feeding of crop residues	Opportunity cost of 43.12 kg of crop residues	Total gain=8.5 kg of which the contribution of the technology is 3.13 kg.
3.	Re-threshing and mixing of crop residues before storage and feeding	Opportunity cost of 43.12 kg of crop residues and wage payment for Re-threshing that amount (ETB=10.00)	Total gain=9.5 kg of which the contribution of the technology is 3.50 kg.
4.	Supplement with home-produced local brewers waste	Opportunity cost of 14 kg of home produced local brewery on dry matter basis	Total gain=11.0 kg of which the contribution of the technology is 5.74 kg.
5.	Use leaves and/or pods of farm trees	Opportunity cost of 43.12 kg of tree leaves (ETB 35.95), wage payment for collection of tree leaves (ETB 20.00).	Total gain=10.0 kg of which the contribution of the technology is 3.68 kg.
6.	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia)	Opportunity cost of 43.12 kg of cut grass and tree leaves (ETB 35.95), wage payment for collection of tree leaves (ETB 20.00).	Total gain=9.0 kg of which the contribution of the technology is 3.31 kg.

Hypothetical example for calculating the benefit cost ratio: (Say Technology 1- hand chopping of crop residues at Gitlo/Lakku Kebeles):

I. Additional costs: price of 43.12 kg of crop residues (A) + price of chopper (B) + wage payment for chopping that amount (C)
A=43.12 kg*0.7 ETB/kg = ETB 30.184; B=ETB 100/5=ETB 20 (because it is assumed that the tool will serve for five years); C=price of chopping 43.12 =ETB=20.00
Total Additional cost =30.184+20.00+20.00=ETB 70.18

II. Additional benefit=Live weight contributed by the technology*price per kg at export abattoir*60% of the price at export abattoir
=3.50 kg*ETB 31*60% = ETB 65.04

III. Benefit cost ratio= II/I=70.18/65.04=0.93;

Annex 5. Harvest index for different crops

Crop	Harvest index	Source for HI
Wheat	0.45	Ahmad et al., (2007)
Barley	0.32	Wondimu et al., (2011)
Teff	0.28	Haftamu, et al., (2009)
Maize	0.45	Ahmad et al., (2007)