Characterization of the Farming and Livestock Production Systems and the Potential for Enhancing Livestock Productivity through Improved Feeding in Lemu-Bibilo District, Arsi Highlands, Ethiopia

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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.
The Feed Assessment Tool (FEAST) is a systematic method to assess local feed resource availability and use. It helps in the design of intervention strategies aiming to optimize feed utilization and animal production. More information and the manual can be obtained at www.ilri.org/feast

FEAST is a tool in constant development and improvement. Feedback is welcome and should be directed feast@cgiar.org. The International Livestock Research Institute (ILRI) is not responsible for the quality and validity of results obtained using the FEAST methodology.

1. **Background**

Lemu-Bilbilo district is located in Arsi zone in Oromia regional state of Ethiopia. It is characterized by a crop-livestock mixed farming system where dairy production contributes significantly to livelihoods of the smallholder farmers. Local cattle are the predominant breeds reared in the area. Market-oriented dairy production based on crossbred dairy cows is also practiced in the district. However, economic benefits accruing from the livestock sector are not significant. Livestock production is constrained by ecological, technical and economic limitations which result in severe feed shortages. Thus, the objective of the current study was to assess feed resource availability and utilization using a feed assessment tool (FEAST) within the context of the overall farming and livestock production systems and to determine the potential of site-specific feed interventions in Lemu Bilbilo.

2. **Methodology**

2.1. **Description of the study area**

The survey was conducted in Lemu-Bilbilo district located in Arsi zone, Oromia Regional State of Ethiopia (Figure 1). The district is among the highland areas designated as the “dairy shed” by the Ethiopian Government due to its comparative potential for improved dairy production. Lemu-Bilbilo district is located about 235km South-east of the capital Addis Ababa on the highway towards Bale zone. The area receives an annual rainfall of 1100 mm, of which more than 85% is during the main rainy season (June to November). According to the District Agricultural Office, the altitude of the area is 2567 meters above sea level (m.a.s.l.) and the average annual temperature ranges from 6 to 26°C. The survey was carried out in the kebele (village) of Bokoji Negesso. It lies at an altitude of 2876 m.a.s.l. Approximately 91.8% of the land area is allocated to crop production, 5.8% for grazing and about 2% of the kebele is covered by forest. Bada (highland) and Bada-dare (mid-altitude) are the major agro-ecologies of Bokoji Negesso, which account for 80% and 20% respectively.
2.2. Sampling

Lemu-Bilbilo district was purposively selected based on its dairy potential as well as the district’s inclusion in both the Agricultural Productivity Program (AGP) and Livestock Growth Program (LGP) of the Ethiopian Government. Bokoji Negeso was purposively selected among 27 kebeles based on accessibility and relatively higher dairy potential.

To undertake this survey, farmers were purposively selected based on results from a Sustainable Livelihood Framework (SLF) survey that had been previously carried out in three sub-villages (Cheffa, Mirtilaman and Tulu-Negeso) of Bokoji Negeso. The sub-villages were selected from the three dominant farming zones in the kebele i.e. Cheffa and Tulu-Negeso from livestock and crop dominant areas respectively and Mirtilaman from a mixed farming area. The SLF was conducted in June, 2012. SLF was used to stratify households based on their access to different livelihood assets such as physical, natural, financial, human, and social capital (Figure 2). The SLF outcome categorized farmers into three groups; above average, average and below average. The farmers in the average were not used for this survey due to expected minimum variations within the group.
2.3. Data collection

The Feed Assessment Tool (FEAST) was used for data collection. The purpose of the tool is to offer a systematic and rapid methodology for assessing feed resources at site level with a view to developing a site-specific strategy for improving feed supply and utilization through technical or organizational interventions. The tool comprises two main components, the participatory rural appraisal (PRA) approach which aims to provide an overview of the farming system with particular emphasis on livestock feed aspects and key informant interviews using semi-structured questionnaires. 25 farmers were randomly selected from the three groups outlined by the SLF survey to participate in focus group discussions (FGD) using PRA. Consequently, 9 farmers from the above average groups and 9 farmers from below average were selected as key informants for individual interviews. The assessment was carried out on 11-12 July, 2012. It was conducted by researchers from Kulumsa Agricultural Research Center (KARC) with technical backstopping from the International Livestock Research Institute (ILRI) and the International Centre for Agricultural Research in the Dry Areas (ICARDA).

2.4. Data analysis

The quantitative data from individual interviews of 18 farmers were entered and analyzed using the FEAST excel macro program (www.ilri.org/feast). Narrative responses collected by PRA through FGD were examined and summarized.

3. Result and Discussions

3.1. Overview of the farming system

Bokoji Negeso is primarily a smallholder farming system based on mixed crop-livestock system. On the basis of land holding, noticeable differences were observed between farmers in the above and below average groups, whereby 30% of the farmers in the above average group are landless farmers as compared to no landless farmers in the below average group (Figure 3a-b). Land distribution took place in
Bokoji over 20 years ago, thus land owners tend to be of the older generation. The current youth barely own land but may get small plots of land from their families based on the family’s willingness and the family’s total land ownership. In the above average group, most landless farmers are educated and aware of improved agricultural technologies. They rent land for farming purposes. These landless farmers are predominantly educated young farmers. They engage in farming activities with new ideas, knowledge and they have better access to various types of trainings which help them focus more on market-oriented farming.
According to the farmers, the rains begin in the month of March and continue with variable intensity until October. The farmers describe one cropping season (mehare) from March to the end of December in which all farming activities such as land preparation, planting, weeding, harvesting and threshing are carried out. The main crops grown in the study area are barley, faba bean, field pea and wheat (Figure 4). Other crops include linseed and rapeseed.

Barley is the main grown crop by farmers from both above and below average groups (Figure 4a-b). Linseed is grown by farmers of both groups whereas vegetables are only grown by below average farmers. Access to irrigation is minimal. Only 3.5% of the households in the kebele use irrigation from Gonde and Dima rivers. The farmers who use irrigation are those who can afford irrigation pumps from the above average group and those who live near the rivers from the below average group. In general, most crops are grown under rain-fed condition by most farmers.

Farmers use family labor for most farming activities. However, during peak seasons labor is hired. Farmers in both groups use hired labor, but there are differences in the level of utilization of hired labor between the groups. The above average farmers use more hired labor than the below averages due to their engagement in large scale crop production. Activities for peak labor requirement are ploughing, weeding, harvesting and threshing. Cost for hired labor is 45 Ethiopian Birr (ETB; USD 2.5).

There are credit providers like Oromia Credit and saving Institute (OCSI) in the kebele. Farmers tend not to use this service due to many factors. Farmers explained that the credit offered by OCSI is too little to procure dairy animals, it should be repaid within one year and procedures involved such as group formation (5-10 farmers) as a condition to qualify for a loan are prohibitive.

Figure 4a: Crop grown by farmers in the above average group
3.2. Contribution of household income

The major livelihood income sources for the above average group are the sale of cash crops and food crops. Contrary to this, remittances from relatives abroad and in larger cities as well as fattening of sheep and goats are major sources of income for farmers in the below average group (Figure 5a-b). Farmers in the below average group tend to largely diversify their income sources to reduce vulnerability to poverty and food insecurity. On the other hand the above average group confines its involvement to major income generating activities such as the production of market-oriented crops (malt barley, highland pulses, oil crops and wheat) which fetch relatively better income.
3.3. The livestock production system

Every household keeps livestock such as cattle, sheep, goats, horse, donkey and poultry. Cattle are kept for food, cash, draught power and manure production. Local dairy cows in the area provide the households with milk and manure. The dominant livestock species owned by household in the two
groups are shown in Figure 6a-b. Fattening and draft cattle are dominant species for both groups. Contrary to our prior expectations, improved dairy cattle are the second important species for the below average group whereas local cattle are the more dominant dairy cattle for the above average group. Farmers in the below average group own relatively less grazing land, thus they keep fewer local dairy cattle while giving more emphasis to the improved ones so as to reduce herd size to enable them maintain productivity. Both groups keep sheep for home consumption and income generation while horses are kept for transportation and draft purposes.

Figure 6a: Average livestock species holdings per household (TLU) of farmers in the above average group

Figure 6b: Average livestock holding per household (TLU) of farmers in the below average group
3.4. Livestock management

There are two categories of Artificial insemination (A.I) service providers in the district. These are government employees and Community Artificial Insemination (CAI) technicians who are selected and trained by the support of Oromia Livestock Agency and Food and Agriculture Organization (FAO). In the kebele, there is only one government employee who provides the AI services. Those who live in close proximity to the service, get AI service from this source twice a week and pay 6 ETB (USD 0.3). Three repetitions are allowed. In order to expand the AI service to the remote areas of Bokoji Negeso, Arsi zone Bureau of Agriculture with the technical and financial support of FAO, provides AI training to nine secondary school graduate farmers. Four of the graduates are provided with a starter kit that comprises a nitrogen gun, glove and AI container. The community service providers charges 12 ETB (0.67 USD) for one time AI service. An overwhelming number of farmers use AI service for cross breeds, though local breeds weighing 200 kg body weight also receive AI services.

There is one private clinic and three vet drug stores that provide veterinary services for farmers in the district. The prevalent animal diseases mentioned by farmers are mastitis, internal and external parasites such as lung worms, liver flukes and ticks. From the group discussions, it was observed that the problems of AI and animal health service accessibility are faced by both livelihood groups.

Livestock housing varies from farmer to farmer according to livestock type and livestock numbers. Most farmers keep the cattle in open barns in the homestead. Small ruminants like sheep and goats are kept in grass thatched structures. Tethering and hand feeding is practiced throughout the year.

3.5. Feeds and Feeding

3.5.1. Feed availability

Generally, feed scarcity both in terms of quantity and quality is common in Bokoji Negeso. The feed resources in the kebele are primarily natural pasture, crop residue (cereals and legumes), purchased feed, cultivated fodder and naturally occurring and collected fodder. Ever more land is allocated for cropping, thus shrinking land for fodder production. Fodder crop species such as oat, vetch, maize and tree lucerne are grown as shown in Figure 7a-b. Vetch and fodder oats are the most important improved forage crops adopted by both groups of farmers even though the acreage allocated to fodder crops is larger in the above average group compared to the below average group. Crop residue is a major component in the diet of livestock in both groups. Animals rely on crop residues throughout the year especially when grazing pastures are scarce. Farmers who do not have adequate quantity of crop residue from cropping activities purchase additional straw from other farmers who produced cereals in surplus. The straw is usually fed to the animals without any form of processing or manipulation prior to feeding. However, some farmers are aware of mixing straws with linseed cake, wheat bran or salt as a means of improving quality and palatability. Wheat bran and linseed cake are the main concentrate feeds purchased and they are the main protein supplements in the diet.
Industrial by-products available in the nearby Bokoji town are used to supplement the poor quality crop residues. The common industrial by-products in the area are wheat bran, molasses and linseed cake. The farmers purchase these supplementary feeds from the flour factory, oil factory and traders.
Farmers purchase feeds such as wheat bran, molasses, linseed cake, crop residues and salt (Figure 8). Molasses is provided to the farmers by the District Bureau of Agriculture. The farmers in above average group who have closer contact with the Government officers are aware of it and are capable of purchasing the molasses in larger quantity. On the contrary, the less educated, less technology adopters in the below average group purchase less molasses due to communication and awareness gaps as well as financial limitations.

Figure 8: Quantity of purchased feed over the past 12 months by farmers in the above (a) and below (b) average groups

Both groups prefer to purchase wheat bran in greater proportions due to its availability at the nearby flour factories and relatively low price. Barley straw is purchased by the below average group due to its low cost. The amount of linseed cake purchased by both groups is almost similar and farmers get it from the oil factories in Bokoji town.

3.5.2. Feed Quality

Different feed resources contribute differently to the dry matter (DM), metabolizable energy (ME) and crude protein content (CP) as shown in Figure 9, 10 and 11 respectively. Grazing contributes the highest to the dry matter intake of the livestock. Purchased feed, which comprises mainly of barley straw, also contributes highly to the DM and ME of the livestock diets of the below average farmers.
Fig. 9: Contributions (%) made by various feedstuffs to the DM content of total livestock diets of farmers in the above average group (a) and the below average group (b)

Fig. 10: Contributions (%) made by various feedstuffs to the ME content of total livestock diets of farmers in the above average group (a) and the below average group (b)
Fig. 11: Contributions (%) made by various feedstuffs to the CP content of total livestock diets of farmers in the above average group (a) and the below average group (b)

The contribution of grazing to DM, ME and CP is relatively high for the above average group farmers who reserve more land for grazing pasture through land renting. Due to limitations of grazing and crop residue resources, farmers in the below average group are forced to purchase feeds. Purchased feeds thus contribute relatively higher to the DM, ME and CP of their livestock diets compared to that of the above average farmers (Figures 9, 10, 11).

3.5.3. Feed seasonality

Livestock feed is seasonal. There are severe shortages during the dry season and at the start of the rains. Figure 12a-b show that there is no difference in feed availability thought the year for both groups. The most critical periods are from February to May, when all feed resources are virtually depleted and conservation of straw of wheat and barley is inadequate. Whatever has been conserved is preferentially fed to dairy and draft animals as they require additional intake of food during ploughing, planting, lactating and pregnancy. However, the high energy demand of working and dairying animals is not met and their conditions and productivity deteriorate during this period.
Figure 12a: Composition of the livestock diet through the year relative to the rainfall pattern for farmers in the above average group.

Figure 12b: Composition of the livestock diet through the year relative to the rainfall pattern for farmers in the below average group.
4. Problems, issues and opportunities

The major problems and their priority ranking according to farmers are presented in Table 2. Both groups seemed to have similar ranking of their problems. Feed shortage was identified by both groups of farmers as the most important problem in the kebele. Farmers in the below average group are less educated, less trained, resistant to technology adoption than farmers in above average group. These farmers are less aware of the functions of improved technologies due to less contacts with agricultural extension workers, thus they benefit less from new information and technologies. Therefore, priority on trainings should be focused towards this group. Farmers in this group should be encouraged to attend trainings and information gatherings. Other constraints like water problem, inefficient veterinary and AI services are similar and equally important for farmers in both groups. The water problem stems from re-afforestation in Bokoji using eucalyptus trees which are sucking up a lot of ground water.

Table 1: Problems of livestock production in the PA and solutions pointed out by the farmers

<table>
<thead>
<tr>
<th>Problems in order of importance</th>
<th>Problem identified by farmers in both groups</th>
<th>Proposed solution by farmers in both groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feed shortage</td>
<td>Improved forage development and decrease livestock number</td>
</tr>
<tr>
<td>2</td>
<td>Lack of water</td>
<td>Natural water resource development and installation of tap water</td>
</tr>
<tr>
<td>3</td>
<td>Lack of credit/cash</td>
<td>Increase accessibility to credit service</td>
</tr>
<tr>
<td>4</td>
<td>Shortage of veterinary and AI services</td>
<td>Training of farmers in AI service and increase number of veterinarians</td>
</tr>
<tr>
<td>5</td>
<td>Awareness and communication gap (in below average group only)</td>
<td>Frequent capacity building training on general welfares of livelihood, create close communication with livestock production experts through training and regular visits</td>
</tr>
</tbody>
</table>

Opportunities

Opportunities that contribute to the improvement of the sector do exist in the area. These opportunities include:

- The availability of abundant crop residues, especially of wheat and barley, presents opportunities to encourage proper storage and preservation of the residues.
- Farmers in the below average group seek to buy straw, especially barley straw from farmers in the above average group. This presents an opportunity for crop residue markets.
- The availability of adequate industrial by-products from oil and flour factories in the nearby Bokoji town presents an opportunity for supplementation of crop residues to enhance their nutritive value.
Availability of molasses presents an opportunity for molasses/urea supplementation and the production of molasses/urea mineral licks.

Accessibility of all-weather roads in Lemu Bilbilo as well as Bokoji would facilitate functioning of localized residue markets as well as the supply and distribution of livestock inputs and feed supplements.

5 Areas of intervention

Based on the opportunities existing in the area, the following interventions are suggested:

- Abundance of crop residues calls for introduction and encouraging the use of on-farm storage and preservation technologies
- Due to availability of agricultural by-products that can be used as supplements, farmers should be introduced to the formulation of simple rations using these supplements. Demonstrations should be carried out preferably on-farm so as to reach the below average farmers who have lesser contact or may tend to shy away from approaching extension workers or attending training forums.
- Farmers are already growing fodder crops such as vetch and fodder oats. Therefore, integration of forage legumes into the cereal cropping through intercropping, ley farming or other existing methods should be encouraged as such integrations are reported to enhance the nutritive value of crop residues.
- Credit providers to facilitate in giving loans for the creation of fodder and crop residue localized markets.
- Since available crop residues provide feed for various types of animals, studies should be undertaken to determine which crop residues are ideal for which particular livestock species so as to enhance acceptance of crop residues by individual species thereby limiting refusals and avoiding preferential feeding that may lead to unnecessary wastage.

5. Conclusion

This survey emphasizes the need for technology approaches that integrate crop-livestock approaches. The predominant reliance on crop residue requires production of high quantity and quality of the residues that would be nutritionally beneficial to livestock. It also reveals that farmers within a community are not homogenous. The differences may be due to livelihood assets or simply other reasons. This emphasizes the important of the presence of effective extension services that reach out to farmers by particularly carrying out on-farm demonstrations to promote the development of appropriate technology that can be adopted readily at the farm level.