Building Rural Income through Inclusive Dairy Business Growth in Ethiopia (BRIDGE)

Action Research on improved forage and silage making

BRIDGE Practice brief

Introduction

Year-round availability of quality feed is one of the major factors determining dairy productivity in Ethiopia. Given the rapidly increasing cost of concentrate feeds commonly used by dairy farmers, there is a growing need for cultivation of improved forage to meet feed requirements of dairy cows. This makes a transition necessary to dairy farming based on improved forage cultivation and preservation. The growing demands for higher productivity, improved reproduction and reduced seasonal variability of milk (and thus feed) supply necessitates improved forage production. Also, the increasing land scarcity calls for more intensive land use, particularly in peri-urban areas of Ethiopia, for example by cultivating improved forage species. The different agroecological zones of Ethiopia (lowland, midland and highland) and diverse farming systems require variation in forage species and varieties for cultivation. Preservation of forage produced, for example by making silage, is also important to ensure year-round availability of good quality forage for good animal performance. Cultivation of improved forage and silage making are climate smart interventions, as they increase production efficiency and reduce emissions per kg of milk. In line with the aim of the BRIDGE project to contribute to dairy sector transformation, the introduction, evaluation and demonstration of improved forage species for cultivation by dairy farmers, and forage preservation by silage making are key activities being promoted in the BRIDGE project clusters in Amhara, Oromia and Sidama/SNNPR. This research brief presents the highlights of the action research on improved forage and silage making in BRIDGE. It describes the action research approach, studies conducted and main findings, and some case studies illustrating these.

Methodology

Key messages

- The action research approach provided opportunity for participatory problem identification, co-implementation and lesson learning by different stakeholders. It also provided a good platform for scaling of the forage technology.
- Using recently released oat varieties or other improved forage species with high biomass yield is necessary to improve feed availability and milk yield.
- Improved forage silage based feeding for early/mid lactating cows resulted in 28 to 70% increase in milk yield and consequently of income of smallholder dairy farmers.
- Silage making with improved forage reduced the feed gap for dairy cows, offering a new alternative to farmers to have year-round availability of good quality feed.
- The shelf-life of wet brewery spent grain was prolonged by ensiling with crop residues, thereby ensuring availability of good quality feed for dairy cows; this led to increase in milk yield, improvement in quality of butter, improvement in condition of cows and improved the use of crop residues by the animals.

The main approach being used for improved forage and silage evaluation and demonstration is action research. This entails joint identification of problems, co-designing/action planning, co-implementation, participatory evaluation and lesson learning. Stakeholders included researchers, farmers, and extension agents. Figure 1 illustrates the action research approach applied in forage production and silage making activities. Action planning with the stakeholders included design of farmer-and-researcher-managed on-farm trials and demonstration with different improved forage species, such as

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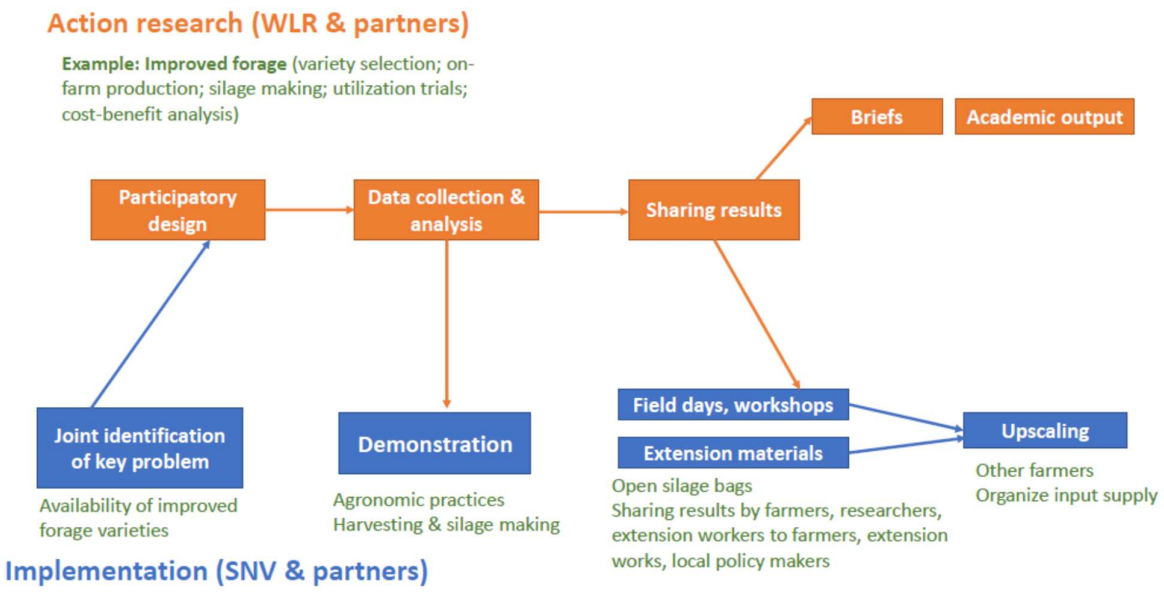

Figure 1. *Illustration of action research approach for improved forage production and silage making*

Napier, Desho grass, oat, vetch, alfalfa, lablab, desmodium, and stylosanthes. These forage species were planted on farmers' fields with an average area of about 0.125 ha. The average area varied from region to region, the highest land allocation being in Amhara and Oromia, and the lowest in Sidama Region. Data were collected on agronomic characteristics such as herbage yield and plant height. The harvested forage was used partly as green feed and partly for silage making and seed production. In most instances, the quantity of silage prepared for the action research was 800 to 900 kg/farmer. To share results of the forage demonstration plots, fields days and other learning events like study tours, and visits of individuals and groups were organized together with the extension service in each woreda/district for farmers, extension agents, researchers, development practitioners and policy makers, to raise awareness on the benefits of planting improved forage species and to promote adoption by the dairy farmers. The learning events provided opportunity for stakeholders to evaluate the performance of the improved forage species, particularly in terms of herbage yield. Through these learning events and implementation by the extension team, dairy farmers have widely adopted forage technology in all the project clusters. Furthermore, for wider dissemination of the findings, three papers and two posters were presented in conferences of the Ethiopian Society for Animal Production. Generally, the action research approach offers a learning platform to inform implementation by the stakeholders. Other strengths of the approach for forage cultivation included management of the demonstration plots by the farmers, massive participation in farmers' field days and other learning events, support by the extension staff, and facilitation of adoption of forage technology. The main weaknesses were shortage of forage seed and planting materials, over-reliance on farmers' field days as platform for learning by the stakeholders, monitoring and quality of data collected. The challenge with monitoring and data collection on the processes involved in farmers' field school and learning by different stakeholders is common when action research approach is applied to biophysical research. However, the action research approach for forage cultivation provides opportunities for farmers' innovations and attracts strong interest by the public extension service.

Findings

The studies conducted regarding improved forage and silage making are broadly in three areas. (i) Improved forage evaluation and demonstration; (ii) Evaluation and demonstration of fodder silage; (iii) Ensiling wet brewer's spent grain (WBSG) with crop residues. The studies by MSc students broadly covered utilization of non-conventional feed resources as dairy feed; manure production, utilization and evaluation, agronomic practices of improved forage, improvement of crop residues for dairy production. and assessment of milk composition at farm level.

(i) Improved forage evaluation and demonstration. Performance evaluation of different improved forage species was undertaken at Mecha district (Alfalfa, Lablab, Desmodium, Stylosanthes, Napier, Desho, Panicum and Rhodes grasses) and Machakal district (oat and vetch) in West Amhara cluster; Wondo-Genet and Malga districts (Alfalfa, Lablab and Desho grass, maize) in Sidama region; Lemo bilbilu (oat, vetch), Tiyo (oat, vetch), Lode Hitosa (sorghum), Kofle (oat, vetch) and Adaa districts in Adama-Asela cluster (Alfalfa, Lablab and Desho grass) and Wuchale, Debre libanos and Kuyu districts in Sullta-Fitche cluster in Oromia region.

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CASE STUDY 1: Variety selection – Mecha, Amhara

Antigen Tirusew is a dairy farmer living with his family in Enguti Kebele, Mecha district of West Amhara cluster. By the time he decided to allocate land for forage cultivation, he had already bought barley seed to plant. He forgone planting barley and planted various improved forage species. When he took this decision, his neighbors complained that producing 'grass' is equivalent to exposing his family to starvation. Antigen Tirusew ignored the neighbors' comments and planted forage species with technical support in sole cropping, intercropping and grass-legume mixtures. Among the different forages, Antigen chose Napier- Alfalfa intercropping. Before planting forages, Antigen spent 6,000 ETB purchasing crop residues for 2 months. Currently, he has stopped buying crop residues. Antigen said, when he fed crop residues, quality of milk produced was not good and at times rejected by buyers. Now, owing to better feeding with improved forages, quality of milk has improved and acceptable by buyers. Also, Antigen remarked that forage production has reduced the time he and his family spent searching to purchase crop residues.

CASE STUDY 2: Desho + Lablab – Wondo genet, Sidama

Sidama Region has a different farming system compared to the other regions or cluster where the BRIDGE project operates. Cash crops like chat, coffee, sugarcane and others are widely grown. In this farming system, farmers can allocate a small amount of land for forage crops (mostly 100 to 200 meter squares) though there are exceptional districts when larger area of land can be allocated. Accordingly, lablab and Desho grass were planted and have shown good yield data. Depending on the rainfall condition, farmers got about 9 to 12 tons of dry matter from Desho grass in one harvest and about 4.5 to 7 tons/ha from lablab. Intercropping is the better approach for this part of the country.

In Mecha district, the suitability of different forage species for the study area was demonstrated and assessed by the farmers based on their perception of the forage crops. Based on the participatory evaluation of different forage species, the potentially suitable forage crops were planted as sole, intercropped with legumes (Napier and Desho grasses with Alfalfa, Stylosanthes, Desmodium), and grass-legume mixtures (Rhodes and Panicum with Alfalfa and Desmodium). The results showed that among grass-legume intercropped species, Napier-Alfalfa yielded a cumulative biomass of 41.0 t DM/ha in four different harvests and Desho-Alfalfa yielded 33.7 t DM/ha from four different harvests. Among grass-legume mixtures, Rhodes-Alfalfa harvested 28.0 t DM/ha from four different harvests. In comparison, natural pastures in enclosed areas in the Ethiopian highlands show annual dry matter yields of 4.5 to 6.0 t/ha, much lower than the yield of the improved forages.

(ii) Evaluation and demonstration of fodder silage. A study on silage making with oat variety 2291 was conducted in three districts in Oromia Region in 2020/2021 and a study on making oat-vetch silage (oat 2291 and 1506 varieties; common vetch) was conducted in 2021/2022 in two districts each in Oromia and Amhara regions, and in one district in Sidama region, making five districts. The objectives were to evaluate and demonstrate silage making with improved forage species, and to assess the physical characteristics and nutritional composition of oat and oat-vetch silage. Fifty-one farmer volunteers participated in the study on silage making with oat and 54 farmers participated in the study on silage making with oat-vetch silage. In preparation, 3 to 5 liters of molasses were diluted in equal volumes of water and uniformly sprinkled on 100 kg of chopped herbage. The herbage material was properly packed, compacted and ensiled for 50-60 days. On average, about 800 to 1,000 kg of silage was prepared to feed a selected cow in early/mid lactation for about 40 days. The physical features and chemical composition of the silages were determined. The results revealed the physical characteristics of the silages to be very good and the silage was found highly palatable to animals. A third study on silage making was conducted at Adaa and Mecha districts in 2021/22, with mixtures of perennial grasses (Napier and Desho grasses), tree forage (Sesbania sesban), and herbaceous legumes (Alfalfa, Lablab, and rejected faba bean) at different levels of inclusion of the legumes (0, 20, 30 and 40%). The results showed that 30% to 40% forage legume inclusion was a good combination.

(iii) Ensiling wet brewer's spent grain (WBSG) with crop residues. A study was conducted on ensiling WBSG with teff straw (in Hawassa) and wheat straw (in Shashemene cluster in Oromia region) with the objectives of prolonging the shelf life of WBSG and improving utilization of crop residues. Forty two farmers were involved in the study at each site. Farmers and relevant partners were trained on the key issues of the research and WBSG preservation. The silage was prepared in PICS sacks and plastic drums in the ratio of 80% WBSG and 20% straw and followed the technique of layer-by-layer filling (crop residues, molasses diluted in water, WBSG) while compacting each layer to exclude air. Salt was added on the top layer. The silage was opened after 37 to 45 days of ensiling (Hawassa) and 44 to 52 days (Shashemene). The color of the silage was yellowish, which resembles the color of the spent grain, and the smell was very pleasant as witnessed by farmers, and participants of the demonstration visits. Average pH of silage was close to 4 while temperatures were 20.6 C and 18.2 C in Hawassa and Shashemene respectively. There was no difference in terms of the physical characteristics of the silage whether it was prepared using plastic drums or PICS sacks. The study showed that shelf-life of WBSG was

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Pictures: *Oat silage preparation and feeding*

CASE STUDY 3: Oat and vetch silage - Adama-Asela

Adama-Asela is the lead BRIDGE cluster in terms of silage making. Before the implementation of the action research, silage making from oat and oat-vetch mixture was unknown to the farmers and the extension services in the area. In 2022, 5,593 farmers in the cluster prepared silages from Desho, Elephant grass, Oat, Oat-Vetch mixture, natural grass and maize in the project areas. Oat and Oat-Vetch were the dominant forage species in terms of silage preparation in the implementation areas of the project. The herbage dry matter yield of oat 2291 and oat-vetch mixture was about 15 tons/ha and 12.02 tons/ha, respectively. Farmers involved from Tiyo district in the action research of oat silage feeding reported: "If we had not prepared this silage, our animals would have died because of the long dry period". Another female farmer remarked: "If it were not for adoption of silage making, I would not have collected any milk from my cows during the extended dry period".

There is also the trend of commercializing oat and oat-vetch mixture silages. A farmer and an agro-dealer at Sagure (Digalu Tiyo district) prepared silage from oat-vetch mixture on 2.25 hectares of land. In order to promote his business of sale of forage silage, he gave oat-vetch mixture silage to 9 farmers free and sold silage in PICS sacks to 10 individuals at the price of 400 ETB/PICS sack in addition to feeding his ten dairy cows from the silage prepared. Another farmer produced silage from oat and vetch mixture to sell to dairy owners in the nearby town for 400 ETB/quintal.

CASE STUDY 4: Animal utilization trial - Mukuturi, Selale

It is observed that farmers in the study area have the tradition of owning high grade and better yielding animals than farmers in the other project areas. It is also common to feed grass hay, soyabean cake and wheat bran to their dairy cows. Farmers in the area complain about the rising cost of industrial by-products and commercial feeds and their quality. Accordingly, the action research tried to introduce oat and oat-vetch mixture silages to the study area as this was not known to the farmers and extension staff previously. One of the farmers who was involved in the action research of oat and oat-vetch mixture witnessed that the milk yield of his cow increased by six liters and another farmer reported yield increment of about 9 liters per day when the silages are fed to early lactating dairy cows as part of the dairy ration. The former farmer indicated that he used to buy soyabean cake for about 36 ETB/kg but stopped this following silage preparation, which reduced the cost of feeding his animals.

prolonged by ensiling with crop residues. The participating farmers indicated an increase in milk yield, improvement in quality of butter, improvement in condition of their cows and increased income as benefits of ensiling.

Partners

The key partners involved in this action research on improved forage production and silage making included Southern Agricultural Research Institute, Arsi University, Adami Tulu, Andassa Livestock Research the districts where the studies were undertaken. Andassa Livestock Research Center, livestock experts and Development Agents in the districts where the studies were undertaken. Andassa Livestock Research was involved in the study on evaluation of suitability of different forage species for cultivation in Mecha district of Amhara region. Both Southern Agricultural Research Institute and Adami Tulu Agricultural Research Institute were involved in the study on ensiling wet brewery spent grain (WBSG) with crop residues. The Livestock offices in all the BRIDGE clusters were also involved in the activities on forage production and silage making. The contribution of the smallholder dairy farmers in forage variety selection, establishment and management of the forage demonstration plots, and farmers' field days were indispensable to the implementation of the action research activities. Given that participation of different stakeholders is the key element of action research approach, the partners were involved in every stage of the action research on forage

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production and silage making in the four project clusters.

Pictures: *Ensiled WBSGs with teff and wheat straw*

The action research activities reported in this brief did not include students' activities as their studies require its own practice brief. Studies by the students can be broadly classified under feed resources and farm management. So far, ten students have completed their MSc while three will be completing in the coming months.

Key recommendations

From the action research approach applied to improved forage and silage making, a few key recommendations can be made.

- There is need for focus on few key issues that can have impact on dairy sector transformation. This implies that farm-level activities should be interpreted and communicated with bigger picture of dairy sector transformation. In this regard, documentation of action research activities should also aim at communication with policy makers.
- Concise and timely review can be conducted on emerging key issues to produce practical recommendations for extension, such as done for the lactation curve. This will save cost and time in conducting farmer-and-researcher managed on-farm trials.
- Monitoring of response, adoption and innovation by farmers of improved forage and silage making should be strengthened. This is important for evaluation of the action research activities and for proper documentation of emerging success stories.

Publications

The key publications from the action research on evaluation and/or demonstration of improved forages and silage making included guidelines, extension materials, practice briefs, videos and scientific publications including student thesis. Some key scientific publications are below:

(i) Inclusion levels of tree and herbaceous legumes on nutritive quality of grass silage: Results from on-farm trials.

(ii) Improved forage crops evaluation and demonstration processes in BRIDGE project: Case study in Mecha district, west Amhara cluster (Poster presented at ESAP conference)

(iii) Evaluation/demonstration of ensiling wet brewery spent grain (WBSGs) with crop residues: Silage characteristics, nutrient composition, and perceptions regarding the ensiled feeds. ESAP conference Proceedings. Pages 363-375.

Building Rural Income through Inclusive Dairy Business Growth (BRIDGE) is a five-year (Sep 2018- December 2023) project financed by the EKN and implemented by SNV and Wageningen University & Research. The main objective of the programme is to improve the income of dairy farming on household level and contributing to sector transformation are the core objectives of the project.

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