Sustainable Intensification of Mixed Farming Systems

CGIAR

Major challenges and researchable issues of the dairy sector in mixed farming systems of north Shewa and Hadiya zones, Ethiopia

Getnet Assefa[2], Million Gebreyous[1], Kindu Mekonnen[1], and Anthony Whitbread[1]

Author affiliation [1]International Livestock Research Institute and [2]Land O'Lakes

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The Sustainable Intensification of Mixed Farming Systems Initiative aims to provide equitable, transformative pathways for improved livelihoods of actors in mixed farming systems through sustainable intensification within target agroecologies and socio-economic settings.

Through action research and development partnerships, the Initiative will improve smallholder farmers' resilience to weather-induced shocks, provide a more stable income and significant benefits in welfare, and enhance social justice and inclusion for 13 million people by 2030.

Activities will be implemented in six focus countries globally representing diverse mixed farming systems as follows: Ghana (cereal–root crop mixed), Ethiopia (highland mixed), Malawi: (maize mixed), Bangladesh (rice mixed), Nepal (highland mixed), and Lao People's Democratic Republic (upland intensive mixed/ highland extensive mixed).

Contents

Abcronyms

ABC	Alliance of Bioversity International and CIAT
FGD	Focused Group Discussions
TMR	Total Mixed Rations
EM	Effective Microbes
ICARDA	International Center for Agricultural Research in the Dry Areas
R4D	Research for Development
ILRI	International Livestock Research Institute
CIMMYT	International Maize and Wheat Improvement Center
CP	Crude Protein
FMD	Foot and Mouth Disease
NRM	Natural Resource Management
MFS	Mixed Farming Systems
AI	Artificial Insemination
SI	Sustainable intensification
SI-MFS	Sustainable Intensification of Mixed Farming Systems Initiative

1. Introduction

Sustainable Intensification of Mixed Farming Systems (SI-MFS) in Brief

The Sustainable Intensification of Mixed Farming Systems (SI-MFS) initiative is one among the many initiatives of the One CGIAR in Ethiopia. SI-MFS seeks to use systems approaches to characterize mixed farming systems and identify socio-technical innovation packages that maximize system level outputs. The SIMFS Ethiopian team is composed of CG centers including ILRI, ICARDA, CIMMYT and ABC. The team identified two core intervention areas (North-Shewa and Hadia) and two on-demand target areas (Jimma and Meket). As the core representative of the livestock component in the initiative, the ILRI team identified a phased approach to inclusion of dairy, fattening and small ruminant interventions.

The main entry point for the ILRI team would be feed and forage innovations development and scaling. The feed and forage innovations are expected to have a system link, either benefiting from the crop and NRM system or benefit crop and NRM systems. Hence, the current assignment has the following components.

- Desk review: This is to generate quick synthesis of past research on dairy development and feed and forage development in the study areas.
- Dairy sector scoping study: This study aims at generating an overview of the dairy sector in North-Shewa and Hadia zones, with possible additional light work in Jimma and Meket areas. Methodologically, the study will use field work in the study areas, with key informant interviews and focus group discussions with key actors such as experts of government offices, research centers and dairy producers. The outcome of the study is a report comprising of characterization of the dairy sectors, identification of constraints and opportunities in the dairy sector in its linkage with crop production, industrial development and natural resource management in the study areas and co-generation of entry points for R4D and scaling under SIMFS initiative.

Context of dairy production in the highlands

The farming system in the highlands of Ethiopia are crop-livestock mixed. The crop and livestock production is highly integrated. Where most of the crop by products and outputs are inputs as feed for livestock. While livestock is the main form of farm power in the form of traction, threshing and transportation. In addition, livestock provides manure to improve soil fertility. Land is a limited resource where both crop and livestock are depending on. With the current climate change increased degradation and population pressure the land and water resources need to be well managed. Crop production is expanding, and intensification is also slowly coming.

Similarly, livestock production, especially dairy is vigorously emerging with crossbred cows under intensive management. This situation is evident in around North Shewa (Debre Berhan) areas and Hadiya in the southern part of Ethiopia. This calls for identifying appropriate and timely interventions to strengthen the sustainable intensification of the system in the area.

The Ten years agricultural development plan and 'Yelemat Turufat' initiatives

The ministry of agriculture has designed a ten year (2020 to 2030) agricultural development plan. In this plan, a comprehensive livestock development strategy is developed where dairy red meat and poultry are the high priority in the strategy.

The dairy development strategy is to increase milk production and productivity of cattle, camels and goats. The target set is to increase the current total milk production from 4.3 billion liters in 2020 to 11.6 billion liters in 2030. Milk from cattle is about 85% of the total milk production and about 15 % comes from camels while only an insignificant amount from goats. Of the total milk production milk from dairy cows is targeted to increase from 3.6 million liters in 2020 to 10 billion liters in 2030. The major strategies are

- Expansion of family dairy
- Improve productivity of smallholder dairy farmers with local cows through better management
- Increase small scale specialized dairy farms to increase the daily milk productivity from 6 liters in 2020 to 10.7 liters in 2030 and lactation yield of 1620 to 3222 liters
- Increase number and productivity of medium and large-scale dairy producers. In this strategy, the target is to improve the milk productivity of cows from 13 liters in 2020 to 17 liters in 2030, which is to increase the lactation milk yield from 3920 to 5085 liters
- Decrease the number of low producing local dairy cows and increase the proportion of crossbred cows from 2.7% in 2020 to 17.1% in 2030
- Reduce milk loss from 2.6% in 2020 to 1.3% in 2030
- Increase marketable milk of the total production from 46% in 2020 to 67% in 2030
- Targets are set for the different enablers including feed and feeding, animal health, policies, marketing etc.

The strategy in the ten years red meat development plan the productivity of meat from cattle (beef), sheep (mutton), goats (goat meat) and camel (camel meat) will be improved. The set target is to improve the total meat production of 297,000 tons of red meat in 2020 to 1,759,000 tons in 2030. This strategy it is targeted to increase the carcass weight of cattle, sheep, goats, and camels 110, 10.5, 8.4 and 250 kgs in 2020 to 121, 12, 10.1 and 278 kgs in 2030, respectively.

To achieve the targets set for the livestock development plan focusing on dairy, red meat and poultry, the ministry has developed an implementation strategy in the feed components as follows:

1. Improve the productivity and utilization of grazing and rangelands through better management - Among others, over-sowing, weeding, fertilization, improved management, and utilization of communal grazing lands are the main ones. In the rangelands of control of invasive weeds like parthenium and Prosopis are also the priority area. Conservation of seasonally extra forage yields specially by organizing women and youth. Training and extension support will be provided on management, production, conservation, and marketing of feed from grazing lands

2. Increase production of cultivated forage crops. Cultivated forage production will be promoted under conventional methods and through different strategies. Among others cultivated forage production will be promoted under watershed management, backyards, integrated food, and forage production are very important. Cultivated forage production will also be encouraged in enclosure areas and degraded grazing lands for rehabilitation. Forage cultivated under different systems will be promoted for marketing. Women and youth are organized in forage production and forage marketing. These activities will be supported with strong training, extension services and supply of inputs such seed, and fertilizer.

3. Increase supply of forage seeds – Seeds of forage suitable to the different agro-ecologies will be organized to be produced in adequate mount and quality. Researcher centers will produce breeder and pre basic seeds. Basic and certified forage seeds will be produced by the federal and regional seed enterprises, private seed producing enterprises, and innovative farmers to produce forage seeds on a contractual basis. The government and development actors will provide support in training and extension services and facilitate seed distribution in time to all those who demands the forage seeds. Moreover, processing and storage facilities will be established in selected places in the country.

4. Improve conservation and utilization of crop residues - efficient utilization of crop residues will be in place. For this various extension supports will be provided in quality improvement and utilization technologies. This will be enhanced with appropriate theoretical and practical training.

5. Improve management and utilization of agro-industrial by-products – The major available agro-industrial in the different parts of the country are sugar industry, brewery, flour mill and oil mill by products. Strategies will be designed for how these by-products are efficiently utilized as livestock feed in the different parts of the country

6. Efficient feed conservation practices – cultivated forage produced in different strategies and forages produced in the natural pasture and enclosures will be conserved as hay and silage. This will be achieved through provision of theoretical and practical training and extension services.

7. Increase supply of formulated concentrated feeds – This will be achieved through increased production of the major ingredients of concentrate feeds, such a, maize, and soybean. This will be achieved through involving private sector in crop production, increasethe number and capacities of feed processing plants and use of the different available agro-industry by-products as major ingredients of the formulated rations.

8. Drinking water – Increase the supply of quality drinking water for livestock especially in areas water is the major problem.

As part of the ten years agricultural development plan of the ministry of agriculture an initiative in transforming wheat production is going on in the country. Recently an initiative called Yelemat Turufat" has been launched in 2022 (2015 EC). The initiative is focusing on transforming productivity of dairy, poultry and honey production in Ethiopia. The goal of 'Yelemat Turufat" are; 1) food and nutrition security, 2) enhancing export marketing, 3) import substitution and 4) job creation in the country. The initiative is planned for 4 years from 2022/2023 to 2025/2026.

The implementation modalities of the dairy development program is improving the milk productivity of the existing crossbred and local dairy animals through better feeding, animal health services and husbandry practices. Feeding would be through production of additional quality cultivated forage crops. The strategy also focuses production of additional crossbred cows. Crossbreeding will be enhanced by using female sexed semen and improved quality semen. Through this process it is targeted to achieve 10 liters of average daily milk and a lactation length of 240 days.

This scheme is to establish several diary villages across the nation. A dairy village will have 120 households each having 4 dairy cows will be established. One of the 4 dairy cows should be a crossbred cow and the number of crossbred cows is planned to be 2 in the project planned time.

The implementation will be led by a technic team structurally organized at different level from kebele, woreda up to Federal level. In addition, the private sector will be involved to play a role in supply of different inputs such as feed and marketing and value addition of different products along the value chain.

Generally, dairy production is an important component of the mixed crop-livestock production system in the highlands. The government development strategy is also well aligned to this scenario. Therefore, it is crucially essential to look deep into the farming system and characterize the existing challenges and opportunities to

provide quick feedbacks to the current development agenda with the following objectives.

Objectives of the study

- Assess the current agricultural production system with specially emphasis on the dairy production practices including feed and feeding, breeding, health, product processing and marketing aligned with crop production and natural resources management efforts and identify the major challenges in the highlands crop-livestock mixed systems.
- Identify researchable issues and interventions to scale in dairy production, particularly in the feed and feeding systems that sustainably intensify the integrated agricultural production system.

2. Study Approaches and Methodology

2.1. Target Locations

The scoping study of sustainable intensification in mixed farming systems has been conducted in two woredas; 1) Lemo woreda in Hadiya Zone of the SNNP region and 2) Basona Worena woreda of North Shewa Zone of the Amhara region. Both the woredas have a cooler highland agroecology and crop livestock mixed farming systems. Detailed assessments were made in Shurmo Kebele of Limo woreda and Abamottie Kebele of Basona Worena Woreda.

This study primarily targets smallholder farmers engaged in mixed crop livestock farming systems and involved in natural resource management practice. The study specifically focuses on dairy producers and their production practices. These producers are highly believed to be affected by the support they get from the different actors. These supporting actors are the input suppliers, service providers, extension workers, regulatory bodies, etc. An effective system needs a platform where the different actors are in a well-integrated, coordinated way, which requires effective policies, guidelines, and regulations in place in a harmonized way.

2. 2. Data Collection Tools and Techniques

Combinations of tools and techniques were used to collect the required information and dataset including desk review, focused group discussions, key informant interview, observations through transect walks and visit to random households. Primary information and data were collected through participatory approaches. In this method checklists were used to generate the information from the different target groups.

2.2.1. Desk review

Intensive desk review focused on generating secondary information to address the main objective of the scoping study was made since the inception of the study. In the desk review published information about the farming systems of the study woredas, dairy production, practices in the highlands, especially in terms of genetic improvement, feed production and feeding strategies, product processing and marketing were reviewed.

2.2.2. Focused group discussions

A total of 9 focused group discussions (FGD) were conducted in this scoping study in five major specific discussion agendas. Every group has a size of 5 to 12 members, which have knowledge and skills on the specific subject matter related to the study agenda. The focused group discussions were categorized in to the following five groups.

1. Woreda and Zone extension experts in dairy (breeding, feeding, health, production), crops, natural resource management (NRM), cooperatives, gender (conducted at Lemo and Bassona Werena)
2. Village level (Kebele) agricultural development workers including livestock, animal health, crop production and natural resources management (conducted at Shurmo and Abamottie kebeles)
3. Dairy farmers (Farmers who keeps crossbred dairy cows and produces milk). These farmers are also producing crops of different types in the crop-livestock mixed systems (conducted at Shurmo and Abamottie kebeles)
4. Farmers who cultivate crops under irrigation and keep dairy cows for milk production in a crop livestock system (conducted Abamottie Kebele)
5. Dairy cooperatives who are organized themselves as group in collection, processing and marketing of milk, milk products and dairy input supplies (conducted at Shurmo and Abamottie kebeles)

The FGD assessment was generally tried to investigate the current scenarios of dairy production in the area, the level of integration among the different components of the farming systems including livestock, crop and natural resources management. Detailed discussions were made in feed resources and utilization, animal health, dairy cows breeding practices, major crops produced and crop residue management and utilization practices and natural resources management practices. The marketing of products like milk and inputs like feed were also focal points of discussion. The farmers were also requested to indicate major challenges, development needs and priorities, and suggest possible interventions to alleviate problems to their respective areas.

Farmers focused group discussion on irrigated agriculture and dairy at Abamottie Kebele

2.2.3. Key informant interviews

Key informant interviews were done with persons who have good experience in the target kebeles/woredas agricultural and dairy production practice. These include individual farmers, extension experts, representatives of research and development institutions, and representatives of cooperatives. Representatives of institutes from Wachamo university, Habebo dairy cooperative, Areka Research center, Lecha feed processing plant and Worrabie research center were in and around Hadiya Zone. In North Shewa Zone, discussions were made with representatives of Debre Berhan University, Debre Berhan Research Center, Project Mercey, and Bisrat dairy cooperative. In addition, farmers and known individuals from the different villages were interviewed.

2.2.4. Observations

During this study, the overall farming areas, the status and setup of individual farms and their practices, different facilities related to dairy production, feed processing, input supplies and service provision around the two target kebele and woreda were visited. Intensive transect walks were made to look into the overall farming systems across the kebele. Places like down the hills including irrigated wheat, barley and faba bean farms, villages up on the hills, water sources, milk collection sites, backyards with forage crops, cabbages, barns and feeding infrastructures, offices of cooperatives were among the visited sites. Evidence was captured through photographs and in some cases a few minute videos. Conversations were also held with the farmers or groups on the issue under observation for better understanding and investigation of the processes of the case that has gone through from commencement to the current status.

3. Results and Discussions

3.1. Overview of the current agroecology and production system of the study areas

The study was conducted in Lemo and Basona Werena woredas. Lemo woreda is found in Hadiya zone of the SNNP region and Basona Worena woreda is located in North Shewa zone of the Amhara region. Shurmo Kebele of Lemo and Abamottie Kebel of Basona Worena woredas were identified as the focal sites for this study. Both the woredas have cooler highland agroecology. The production systems in both the woredas is mixed crop-livestock, where cattle is the main species for dairy production. The major features of the two kebeles agro-ecologies are described in Table 1.

The majority of Lemo woreda has weina dega (1500 to 2300 masl) agro-ecologies, which accounts about 93 % of the total area and the remaining 7% is Dega (2300 to 3200 masl). The rainfall is bimodal and ranges between 700 – 1260 mm annually. The major crops in the woreda are Wheat, teff, barley, maize, faba bean, field pea and vegetables including cabbage of different types, tomato, potato, banana and enset.

The altitude of Basona Worena woreda ranges from 1500 to 3500 masl and agroecologically most of the area in the woreda classified under moist Dega. (Dega, 70%, 22.3% Weina dega and 7.7% Wurchi). The annual rainfall is partly bimodal and ranges between 950 to 1200 mm (Basona Worena woreda agricultural office, 2022). The area is generally mountainous and rugged. The major crops grown in the woreda includes wheat, barley (mainly food barley but also often grows malt barley), faba bean, and chickpea. The importance and productivity of crops varies in the different kebeles within the woreda. The type and acreage of the different crops in the two target kebeles in Lemo and Basona Worena woredas denotes the ecological variations and the relative importance of the crops (Table 2).

Both Lemo and Basona worena woredas are rugged and mountainous in which land degradation and erosions are very prevalent. Lemo is warmer than Basona Worena woreda, which is reflected by the crop diversity including forage crops. In both woredas irrigation agriculture is practiced in some of the kebeles. However, Shurmo the selected kebele for this study at Lemo, does not have irrigated agriculture.

An overview of the farming system both under rainfed and irrigation

The major crops grown in the two selected areas are similar. However, the diversity and importance of these crops are different. At Shurmo crop diversity is high, including cereals, legumes, horticultural and forage crops, while the diversity is very low at Abamottie. This might be mainly due to the lower air temperature at abamottie. Table 2 shows the total areas cultivated in 2022 in the two kebeles. The acreage of the major crops wheat, barley and faba bean was about 46.9, 11.6, 12.2% at Shurmo and 30.6, 30.3 and 27.6% at Ababmottie respectively. This clearly shows at shurmo wheat is very important while at Abamottie, wheat, barley and faba bean are almost equally important.

Table 1. Description of major agroecological descriptions and crops grown in Lemo (Hadiya Zone) and Basona Worena (North Shewa zone) woredas

No	Description	Lemo	Basona Worena
1	Major agroecology	Weina dega and Dega	Weina Dega, Deg and Wurchi
2	Altitude ranges	1500 - 3200	1500 to 3500
3	Annual rainfall	700 - 1260	950 - 1250
4	Production system	Crop-livestock mixed	Crop-livestock mixed
5	Main crops	Wheat, barley, tef, maize, faba bean, field pea potato, Enset, cabbage	Wheat, barley, teff, faba bean, field pea, chickpea, lentil, sorghum
6	Main back yard crops	Enset, cabbage, Carrot	Gesho, traditional spices for home use, and fruits (prim)

Table 2. Relative importance of the different major crops grown in Shurmo (Lemo woreda), and Abamottie kebeles (Basona Worena Woreda during), 2022.

No		Shurmo		Abamottie	
	Crop	Area (ha)	%	Area (ha)	%
1	Wheat	384	46.9	331	30.6
2	Barley	95	11.6	328*	30.3
3	Faba bean	100	12.2	299	27.6
4	Field pea	45	5.5	125	11.5
5	Potato	130	15.9	**	-
6	Enset	65	7.9	-	-
	Total	**819**		**1083**	

*(80 ha Malt barley + 248 food barley), ** potato and fenugreek are cultivated, but the area coverage is insignificant

3.2. Livestock production

In Lemo and Basona worena woredas, livestock is a very important component of the farming system. The main species of livestock are cattle, sheep, poultry, and equines. In this highly integrated crop livestock system, cattle is used for dairy, beef and traction (ploughing, planting and threshing). Most of the households have at least an ox, a cow and a donkey. Farmers produce milk and supply to the market and use it for home consumption. The fattening of cattle is practiced in both the studied woredas. However, the practice is different in Lemo. Few farmers in Lemo usually buy oxen around April and May and use for traction during the main rain season. Then they fatten oxen starting from late rain season (September) and sale during Christmas and Easter holidays, and the cycle continues. On the other hand, such practice is rarely practiced in Basona Worena woreda. In this woreda the common practice is fattening old oxen for beef targeting holiday markets. Sheep are reared as an immediate cash source in both the woredas. At Basona Worena Menze sheep breed is the dominant one. It is also crossed with selected Menz rams through the community breeding programs and exotic breeds including Dorper and Awassi breeds. At Lemo the local Deyo Gena sheep is dominant and commonly crossed with Bonga rams selected with community breeding programs. Generally, sheep in both the woredas are prolific and productive and normally used as immediate source of cash.

Farmers in both woredas use cattle for traction as one of the most important functions. Though smallscale market-oriented dairy is boosting, still the overall

management is low. The average herd structure of Abamottie kebele of Basona Worena wereda and Shurmo kebele of Lemo woreda are shown in Tables 3 and 4 respectively. The proportion of crossbreds in the cattle herd is relatively very high at Abamottie (46%) compared to Shurmo (11%). The average holdings per household is about 1.8 oxen 0.9 cows, 9.7 sheep and 1.5 donkeys Abamottie. At shurmo farmers keep almost similar number (2.0) of oxen per household to that of Abamottie, however the cows (1.6) are higher at shurmo. This clearly shows the purpose and focus of cattle in the farming system is crop production. Though keeping oxen is important for crop production, farmers seem to keep large number of oxen compared to cows. Here it should be clearly underlined that the number of crossbred cows needs to be improved primarily to increase farmers income and livelihoods through milk production.

When we consider the scenario at woreda level the picture is different in terms of crop and livestock production. Table 5 shows the livestock population and herd composition. The proportion of crossbred cattle is about 24.3%. which is much lower than Abamottie kebele. The diversity and acreage of crops is also similarly very different.

Poultry production is also a very important income source for many households in the woredas. The dual purpose Sasso chicken is dominantly found in many places. In addition, improved koekoek chicken and local chicken are found here and there. Farmers are interested with the performance of Sasso chicken for egg production and its fast growth for meat. Almost in all the places chicken production is under extensive scavenging system with additional supplements from home leftovers. Few poultry farms under semi-intensive management are produced in and around Hosaena and Debre Berhan towns. Bovans Brown chicken breeds are widely used for egg production and Sasso chicken as a dual chicken in the smallholder scavenging system in both study sites.

Donkeys are very important means of transportation in both the woredas. It was observed that donkeys intensively engaged in transportation of water, goods, and people. In Lemo woreda the landscape is relatively better for using donkey carts, which is very efficient. The donkey carts are mainly transporting water using jerricans. However, in Basoan Worena woreda the area is very rugged, and donkeys are used as pack animals to transport water and goods.

Table 3. Livestock population and herd composition in Abamottie kebele of Basonna Worena woreda, North Shewa Zone, 2021/2022

No	Animal type	Crossbred	Local	Total	% of Crossbreds	Average Number of heads per household
1	**Cattle**					
	Oxen	430	902	1332	32.3	1.8
	Cows	416	278	694	59.9	0.9
	Bull calves	173	185	358	48.3	0.5
	Heifers	193	190	383	50.4	0.5
	Calves	258	187	445	58.0	0.6
	Total	**1470**	**1742**	**3212**	**45.8**	**4.4**
2	Chicken	2519	2281	4800	52.5	6.5
3	Sheep	284	6862	7146	4.0	9.7
4	Goats		942	942	100	1.3
5	Donkeys		1082	1082	100	1.5
6	Horses		462	462	100	0.6

Table 4. Livestock population and herd composition in Shurmo Witbar Kebele of Lemo Woreda Hadiya Zone, 2021/202

No	Animal type	Crossbred	Local	Total	% of Crossbreds	Average Number of heads per household
1	**Cattle**					
	Oxen	54	1753	1807	3.0	2.0
	Cows	164	1309	1473	11.1	1.6
	Bull calves	63	417	480	13.1	0.5
	Heifers	83	512	595	13.9	0.6
	Total	**364**	**3991**	**3212**	**11.3**	**3.5**
2	Sheep	40	1500	1540	2.6	1.7
3	Goats	10	190	200	5.0	0.2
4	Chicken	16626	11600	28226	58.9	30.6
5	Donkeys		1006	1006	100	1.1
6	Horses		583	583	100	0.6
7	Mules		83	83	100	0.1

The major challenge of livestock production in both the woredas is feed shortage. The grazing lands are intensively utilized for production of hay and grazing. They are mostly used in private and also as communal grazing lands. The grazing lands are normally seasonal, and in most of the months the grazing lands are bare. The short rains normally provide good, lush growth of pasture for livestock. It is reported that grazing lands are shrinking due to expansion of cropping lands, construction,

population pressure and other uses. The main source of feed is crop residues, especially straws from barley and wheat, legume whelms from faba bean, field pea and chickpeas. Crop residues are properly conserved and utilizaed traditionally. However, the use of modern quality improvement practices is not well adapted in both the woredas. Enset leaf in Lemo woreda is widely utilized as feed for livestock. In Basona Worena woreda local brewery residues (arekie atela) is important feed supplement to livestock. Cultivated forage crops well adapted in the highlands including Desho grass, Phalaris, tagasaste (tree lucerne), fodder beet and alfalfa are grown in the backyards. Oats and vetch are grown well by many farmers on arable lands. The use of agro-industrial by products and formulated concentrate feeds in both woredas is very limited. Wheat bran produced from the wheat flour mills are used in a limited way by dairy producers in Lemo woreda. While wet brewery spent grain is used by some farmers in Basona worena woredas.

The critical season of feed shortage in Abamottie kebele is during the rainy season as grazing lands are enclosed for livestock grazing and almost all arable lands are cultivated. During this period oats (oats/vetch) mixture green forage is used as the main feed source in addition to the conserved crop residues. Feed is relatively abundant during the months of crop harvesting where aftermath grazing, and grazing lands after hay making are the main source of good quality feed.

Table 5. Livestock population and herd composition of Basona Worena Woreda of North Shewa Zone, 2022.

	Animal type	Crossbred	Local Breed	Total	% Crossbred	% Local
1	Oxen	5996	27311	33307	18.0	82.0
2	Cows	5281	11922	17203	30.7	69.3
3	Heifers	2100	5119	7219	29.1	70.9
4	Bull calves	2607	7637	10244	25.4	74.6
5	Calves	2659	6090	8749	30.4	69.6
	Total	**18643**	**58079**	**76722**	**24.3**	**75.7**
6	Poultry	28281	83826	112107	25.2	74.8
7	Sheep	5150	78910	84060	6.1	93.9
8	Goats	-	57854	57854	100.0	100.0
9	Donkeys	-	29305	29305	100.0	100.0
10	Horses	-	5119	5119	100.0	100.0
11	Mule	-	340	340	100.0	100.0

3.3. Dairy production

According to the woreda and zone extension experts in Lemo and Basona Werena woredas, Dairy is the main form of livestock production practice. In these woredas dairy production is from local and crossbred cows and it is emerging in market-oriented systems at different levels. Some of the kebeles have very good dairy production capacities while others are still low. Shurmo kebel in Lemo woreda and Abamottie Kebele in Basona Worena woreda are currently emerging as dairy producing villages. The existing dairy production practices are described as follows.

3.3.1 Dairy breeding practices.

Use of improved animal genotype especially in dairy and poultry production in Ethiopia is highly encouraged and recommended to transform productivity to meet the increasing demand in the country. Accordingly, efforts are going on here and there to produce more crossbred dairy cows and introduction of commercial layers and dual-purpose chicken in Ethiopia particularly in areas of mixed crop livestock production systems. In Lemo and Basonna worena woredas, cross breeding of local cows using Holstein Friesian breeds is widely practiced. In rare cases it is also common to find Jersey breeds of dairy cows.

Currently farmers are well aware of the importance of crossbred cows. However, acquiring such animals are very difficult due to the high price of crossbred dairy heifers and cows and very difficult situation of accessing or getting AI services. In both the study woredas breeding activity of dairy animals are constrained in many ways 1) the number of AI technicians in the woredas are very few. The number of artificial insemination (AI) technicians in Lemo woreda are 3, similarly Basona Werena weredas has also 3. With the current demand for crossbreeding by farmers the existing AI technicians are inadequate. 2) Beneficiaries are also complaining about the efficiency and skill of AI technicians. They reported animals often do not conceive when inseminated using AI. This could be attributed to the skill of the technician, heat detection, timing of insemination, body condition of the animal and the quality of semen. All of these factors are not equally important, the skill and commitment of the AI technicians, and the quality of the semen are crucially important 3) cost of AI services are reported to be very high. The national and regional AI centers charge around 10 birr per insemination for locally produced semen. While other private semen importers provide the service up to 500 Birr per service. Government AI technicians mostly provide locally produced semen, and they are expected to charge accordingly. However, farmers reported they are paying from 100 to 300 plus birr per service to the technicians. This payment is a direct income for the AI technicians. 4) Poor communication and unwillingness of AI technicians to provide services is also a big problem. When farmers call AIT to provide Ai service for their cows, normally calls do not responding or they are not around and other reasons. It is common to hear farmers cows missed 2 to 3 heats that required

inseminations. 5) Often shortage of Liquid nitrogen for preservation of semen, and shortage of semen are reported to be problems at woreda level.

The main form of breeding practiced by dairy farmers is using bulls. In both the woredas, there are crossbred bulls (mostly Holstein Friesian crosses) owned by farmers or distributed by different organizations are used. In Lemo woreda farmers are not commonly keep bulls and only a few bulls are available for the service. They reported that they are paying 200 and more birrs per service and the bulls are not accessible and often need to travel long distances. At Basona Worena woreda. Many farmers keep bulls and provide services to the surrounding farmers for free. The bulls are usually dual purpose, they are used for traction and breeding. Farmers indicated use of bulls is dependable as they are available at their disposal and conception is usually very high. On the other hand, the limitation in use of bulls is high cost of keeping the bulls, transmission of several reproductive diseases and problems of inbreeding. Despite that the most important observation made in this study is almost all the bulls used by the farmers have little or no record on their pedigree (level of exotic blood level even the breed type), performance especially in terms of milk productivity and ---. In this study, an assessment was made on the type of bull distributed to farmers. In many instances, the bulls do not have adequate information on important parameters including in their genetic background and productivity. Generally, the bulls are not properly selected and hence their expected progeny are commonly expected to be poor in performance. This requires serious attention and intervention.

Photo 3. An example of a herd of a farmer with high proportion of crossbred animals (Abamottie)

Most market oriented dairy farmers prefer to have female calves and when male calves born usually, they cull it at early stage. However, in the study areas specially in Abamottie kebele, farmers do not bother much on the sex of calves born as both sexes have importance in their current farming system. This might also be their interest and demand to have oxen for traction for crop production.

3.3.2. Feed Resources and Management

The feed resources in the studied areas are summarized in Table 6. The main feed resources in both the woredas are grazing lands, crop residues, cultivated forage crops, agro industrial by products, formulated concentrate feeds and other locally available feed resources. The extent and importance of each of the feed resources in the two woredas and withing each of the woredas are different depending on the existing realities on the ground.

Grazing lands - Almost every farmer has small plot of grazing land that usually used for hay making and seasonally for grazing after harvesting the hay in early dry season and the regrowth during the short rains. In these woredas free grazing is generally controlled and seasonal. Farmers use their own grazing lands privately. When the pasture is grazing it will be somehow free for any animal. Most of the areas, however protected from animals. The hay produced from grazing lands are generally small but it is conserved and used during the time of feed scarcity. Grazing lands are enclosed from livestock in most of the months so that it is productive. Few farmers are also irrigate grazing lands to enhance pasture growth during the dry season. Weeding is also common to maximize productivity. The species composition and quality of this species looks poor but farmers harvest in good time to maintain forage quality. In addition to the private owned grazing lands, hay is also produced from different community and government owned compounds such as, schools and churches. The pasture in these compounds are sold to livestock farmers as it stands on the field. The person who purchased will harvest and make hay and transport by his own.

Hay making from natural pasture lands, poor species composition and late harvesting

Crop residues - These the most important feed resources farmers depend on in both the woredas. The main crop residues are barley, wheat, teff and maize from cereal crops, and faba bean and field pea the main legume whelms used as feed for livestock. After harvesting it will be dried and transported to the homestead of farmers, where the threshing grounds are. Transportation is almost entirely made using donkeys as pack animals and in some cases at Lemo using donkey carts. The first threshing is done to separate the straw and grain. Once the grain is separated and collected then there is usually a second-round threshing of the straw. The purpose of the second threshing is just to refine or reduce the size of the straw so that it increases intake by animals. Especially faba bean whelms is hard to be consumed by animals unless and otherwise it is well threshed and chopped into small fine pieces. These crop residues are then stored in a very well protected shed. Hay sheds in Basona Worena woreda is excellently made, denoting the importance and scarcity of feed. In this woreda it is also common that farmers thresh crop residues for the third round where they bring all the crop residues including barley, wheat, and faba bean residues together and mix it thoroughly by threshing and store in mixture. It was indicated also in some places faba bean whelms could be attacked by termites. In places of termite problems farmers different methods to control termites such as use of wood ash, and use of different suspension structures. Generally, farmers' skills and innovations to maximize utilization were found to be excellent. Despite that use of other crop residue treatment techniques like use of urea treatment and effective microbes (EM) is not practiced. Development workers and few farmers in both woredas have been aware of the techniques but it is not generally adopted in either woredas.

A threshed faba bean whelms (left) to be used as feed for livestock and aftermath grazing (right)

Cultivated forage crops – the most widely used forage crop in both the woredas are oats often in a mixture with vetch. These forage crops are well adapted to the cooler agro-ecologies of the woredas. It is usually very difficult to get different options of well adapted forage species in cooler areas. Oats are grown in arable farms and

utilized in cut and carry or made to hay. In Bassona Worena woreda oats is used most commonly as cut and carry. Hay is usually made when it is extra for the season. In Shurmo kebele of Lemo woreda the weather is relatively wormer than Basona worena and more forage species are grown better than Abamottie including elephant grass, desho grass, phalaris grass, fodder beet, alfalfa and tree lucerne. While in Abamottie area fodder beet, phalaris, fodder beet and tagasaste are grown well. Perennial forage crops are grown in the backyards of farmers' residences. In addition, grasses and tagasaste are also planted on soil bands and field boarders on terraces as soil conservation structures. Farmers are very interested to test any technology that improves feed supply and quality. However, demonstration of improved forage crops, supply of planting materials and seeds and capacity building on efficient utilization is lacking in the kebeles. At Abamottie kebele, oats is widely grown both under rainfed and irrigation conditions and almost all the forage is fed to animals through cut and carry. Farmers are not well aware of varietal distinct differences between oats. Seed is either produced by farmers or usually it is available in the local market.

Desho grass at Shurmo (left) and phalaris grass (On the soil bands) and tree Lucerne (along the fence lines) at Abamottie (right) in the backyards

Supplement feeds – The main supplement feeds used in both the woredas are wheat bran, breweries spent grain and formulated concentrate feeds. At Shurmo kebele, wheat bran is commonly utilized, which is normally produced from the flour mills in Hosaena and found in feed retailer in the town. They also use wet brewery spent grains. It is supplied by agents at Hosaena and distributed to farmers around Hosaena. However, the supply is irregular, and it is most often not available. At Abamottie Kebele, the main supplement is brewery spent grain which is supplied from breweries at Debre Berhan town through the cooperatives. Use of formulated concentrate feeds is very limited in both the kebeles, due mainly to the higher price. According to respondent farmers in both the woredas it is not common to feed grain like barley, wheat or maize to animals.

Table 6. Major feed resources in Shurmo kebele of Lemo woreda and Abamottie kebele of Basonna Worena woredas

No	Major feed categories	Shurmo (Lemo)	Abamottie (Bassona Worena)	Remarks
1	Grazing lands	Grazing Hay making Crop aftermath grazing	Grazing Hay making Crop aftermath grazing	Controlled grazing no free grazing
2	Crop residues			
	Cereal residues	Wheat Barley Tef Maize	Barley Wheat	Finely threshed at Abamottie Finely threshed
	Legumes whelms	Faba bean Field pea	Faba bean Field pea	Finely threshed
	Others	Enset Leaves		
3	Cultivated forage crops			
	Grasses	Oats Phalaris Desho grass Elephant grass	Oats Phalaris	Oats is widely used as cut and carry forage at Abamottie
	Legumes	Vetch	Vetch	Commonly grown in mixture with oats
	Tree legumes	Tree lucerne Vernonia	Tree lucerne	
	Root crop	Fodder beet	Fodder beet	
3	Supplement Feeds	Brewery spent grain Wheat bran	Brewery spent grain Wheat bran Atela and brint	Not easily available at Shurmo
4	Mineral supplements	Common salt Bole (mineral rich soil)	Common salt	Bole is usually fed to animals seasonally

Water – Water is an important resource in both the studied kebeles. At Abamottie Kebele there is water used for irrigation. The sources of irrigation water are the different springs at the foot of the mountains and other permanent rivers. The water is adequate for the existing irrigated agriculture. The irrigation system is flood irrigation. This might not be an efficient way of using water. Despite that the level of evapotranspiration looks very low which helps crops to stay longer under low irrigation frequecies. In this part of the kebele water shortage is not a problem for humans, livestock and other home uses. However, on the other part of the kebele which is around the top of the hill *('Tikurit Bado')*, which has a remarkably large number of households, farmers do not have water for irrigation and other uses. In this part there are no permanent rivers too. Farmers in this area do not have water problems during the rainy season. However, during the dry season, there is a critical

shortage of water for both livestock and human consumption. The main source of water during the dry season is ponds of harvested water during the rainy season. In some seasons these ponds dry out and problems are very critical. In Shurmo kebele of Lemo, water problem is also very serious. There is no any irrigated agriculture, and permanent rivers. Farmers use wells that serve seasonally, and pond water harvested during the dry season. Donkeys are very crucial animals in transporting water that will be used for livestock, human and home consumption in both the kebeles. Dairy animals consume huge amounts of water daily. A dairy cow can consume more than 60 liters of water (3 jerry cans) per day. If animals are not watered properly milk production is significantly reduced.

Harvested water mainly used for livestock drinking, the poor management has resulted with siltation problems

Others – Farmers also use different feed resources available in their surroundings. At Shurmo, Enset leaf is one of the green feeds used for their dairy cows. Enset leaves are good sources of forage with average crude protein (CP) content of 12.3% in dry matter (Agebu *et al*, 2009). At Abamottie and surrounding areas the most commonly available feed supplements are *'atela'* and *'brint'* which are by products of the locally made beverages *'tella'* and *'arekie'* respectively. These byproducts have CP contents comparable to brewery spent grain which is normally above 20% in dry matter (Solomon et al, 2007). In Abamottie area women are producing quite large quantity of arekie (local alcohol) for market. They indicated that the main benefit of alcohol production is to use the byproduct as animal feed, otherwise the profitability of arekie production is not encouraging. On the other hand, tella is normally produced for home consumption and not for market, in which case the quantity is remarkably low compared to arekie brint. During the cropping season weeds from crop fields are used as feed for livestock.

Feed Utilization – The feeding practice of farmers in both the woredas is traditional. Farmers, however, clearly understood dairy cows need to be fed very well so that milk production is increased. The good practice observed in both the woredas is they properly store all available forage (hay and crop residues) and maximize its utilization as feed for livestock. Feed waste from collection to consumption is very low. Farmers try to maximize the intake of poor-quality roughages like wheat straw and other residues in different strategies. 1) they finely thresh crop residues to facilitate intake 2) mix poor quality residues with better quality and palatable residues like legume whelms 3) rinse with salted water, local beverage by produces (atella and brint), and 4) rinse and mix with brewery spent grains and wheat bran.

Though such feeding practices are innovative and will improve the feed intake and nutrient composition of the overall diet, it is not clear with the nutrient content and composition of the feed. The proportion of the mixed feed normally varies depending on the availability of each feed ingredient. Moreover, animals are not fed based on their milk production and physiological requirements such as pregnancy and maintenance. In such feeding systems animals may be under feed and often overfed, in both cases, it will not be economical. Such feeding practice is simulating the practice of total mixed rations (TMR) (Frida, 2018), which is currently innovative dairy farmers are practicing in many countries worldwide.

3.3.3 Animal Health

Animal health problems are common in the crop livestock mixed farming systems under Ethiopia conditions. Loss of animals due to viral and bacterial infectious diseases is very common. Agricultural development agents and animal health experts at woreda and zonal level indicated high young stock mortality due to poor management, especially in proper feeding. Internal and external parasites are also big complications by directly affecting productivity and transmitting diseases. In every kebele there is at least one animal health worker to provide service for smallholder farmers. The main services provided are periodical vaccinations, treatments, and prophylaxis for sick animals. According to the health development workers at the kebele level. The most common vaccines they are providing are for blackleg, anthrax, lumpy skin disease, cow pox, and PPR (Peste des petits ruminants, which is a highly contagious and economically important viral disease affecting sheep and goats). They also provide periodical deworming for internal and external parasites. These activities are generally planned at woreda level, and it is indicated that irregularities of implementation are common due to several reasons. Most of the vaccines are produced in Ethiopia at the national veterinary institute (NVI), Debre Zeit and are adequately available year-round. Moreover, to avoid budgetary shortages and complications the animal health services are managed by a revolving fund account which remarkably reduces budgetary constraints. At Shurmo kebele, farmers reported livestock health problems are not big problems, however, at Abamottie animal health problems are sometimes critical. There are outbreaks of

some diseases such as Foot and Mouth Disease (FMD) which is a severe, highly contagious viral disease of livestock that has a significant economic impact. The disease affects cattle, sheep, goats, and other cloven-hoofed ruminants. Intensively reared animals are more susceptible to the disease than local breeds. Lemo woreda is located around the Gihbe area where tsetse fly is common. The woreda and zone experts reported problems of trypanosomiasis in the Woreda. However cooler highlands like Shurmo area are not ideal environment to tsetse fly and trypanosomiasis disease.

Livestock health problems are generally critically important from different perspectives. There are important diseases which are not given due attention at village and woreda level. These are mainly zoonotic diseases that affect both humans and animals. These diseases include rabies, anthrax, brucellosis and tuberculosis. With intensification of dairy production proper attention and necessary control measures should be strengthened. With intensification of production problems of mastitis, and reproductive diseases are also very relevant.

Other problems of livestock disease is those caused by a deficiency of minerals. Most farmers in the woredas do not feed minerals to their animals, especially dairy cows. They only provide common salt (NaCl). However, animals require micro and macro nutrients, especially during pregnancy and lactation. These include minerals like calcium, selenium, iron, zinc, sulfur, and others. Deficiency of these minerals could cause abortions, or underweight calves, and may cause lameness of cows that may result loss of life of animals.

3.3.4. Animal husbandry and housing

As a strategy of minimizing risk farmers indicated that they want to continue the mixed crop-livestock production system and have low confidence on specialization of either of them. However, with the changes in land use, population size and the need to increase productivity, intensification of farming practices are emerging. Increase in keeping crossbred cows, use of improved varieties and production packages in crops, expansion of irrigated agriculture, breaking free grazing systems and indoor feeding of dairy animals, and market-oriented production systems are some of the indicators. In this process, farmers could be supported to follow the right and effective way for the envisioned success.

It has been observed that farmers herd size per household especially in Abamottie Kebele is high in relation to the existing available feed resources. It is not only the herd size but also the herd composition that seems poor as farmers keep less productive animals for efficient and productive use of the available feed resources. The herd contains high proportion of male cattle. Productive dairy cows and donkeys are very essential animals in the area.

Farmers keep their animals indoors, especially during the rainy season. This is mainly because of shortage of grazing lands. Hence farmers feed whatever feed available such as green oats, weeds from crop lands, enset leaves, conserved hay or crop

residues, other forage trees, forage from field borders and other sources indoor. Indoor feeding normally boosts productivity, helps efficient utilization of feeds and minimizes physical soil degradation and overgrazing. However, the intensification of dairy production through indoor feeding should be accompanied with proper housing conditions. The area of the barn should fulfill the minimum space requirement of each animal. For example, a dairy cow requires a minimum of about 2.5 sqm area (1m by 2.5 m). The house should be well ventilated and needs to have adequate light (natural light) and the floor should be leveled, not slippery and has adequate slop so that drainage is effective. Feeding and watering troughs should be constructed in such a way that it is convenient for the animals to feed and drink and minimize loss of feed.

The barns of dairy cows in both Shurmo and Abamottie Kebele did not fulfill the major requirements. In most cases the area is adequate for the number of dairy animals in the household. But most of the barns are very dark and do not have proper ventilation. At Abamottie kebele the floors of barns are terribly full of irregular shaped stones and not comfortable to animals to walk or sleep on it, which will have a direct impact on the productivity and health of dairy animals. It is also not suitable for cleaning.

3.3.5. Manure management and utilization

Animal manure is an important resource for farmers in the mixed farming system. In both the study kebeles and woredas it is indicated that the primary purpose of manure is to use as fertilizer in crop production. With the increasing price of chemical fertilizers, farmers give more attention to the use of manure. In Shurmo and Abamottie kebeles and both the woredas at large there is huge area of a eucalyptus plantation, in the backyards and arable lands. These trees are mainly used as source of cash income, construction and firewood. The availability of alternative fire fuel sources reduced the importance of dunk cakes to be used as fuel. Despite that It was observed that in and around Basona Worena woreda women farmers make cow dung cakes and pile in large quantities which are sold in trucks with good prices in Addis Ababa and surrounding towns. It is indicated that selling cow dung has also an attractive income source.

The majority of the farmers make compost, especially during the rainy season as drying dung cakes is also a problem. Cow dungs with roughage wastes and refusals are piled and made into compost. The compost is used in backyards and arable lands. The manure is transported by donkeys to arable lands in the dry season and applied to the field before the first plowing. According to the farmers there is no clear rate of application, they just apply when they feel the soil is poor in fertility. Households in Shurmo kebele have large backyards where most of them grow local cabbage, enset and other garden crops. According to the farmers, cabbage is the mains source of income. They harvest every week and sell to the market. They indicated cabbage performs very well on soils properly fertilized with manure.

3.3.6. Product processing and marketing

In relation to livestock production and specifically to dairy, farmers are highly engaged in production, processing and marketing of feed, milk and milk products. In addition, they also purchased processed feed and also sale animals for breeding, fattening and dairy production.

Feed

Feed production and processing has a direct impact on its quality, intake by the animals and animal performance, which is expressed in terms of milk yield, growth (meat) or work output (traction). Livestock producers in Shurmo and Abamottie process the feed produced at different stages to maximize intake and animal performance. From what is observed, all the efforts made by farmers in feed processing will have an advantage to increase feed intake and animal performance. However, this effort alone will not bring much breakthrough in dairy productivity. The animal to be feed based on their nutrient requirement and amount. The feed processing needs much to work on specially in improving nutrient content beyond the intake by animals. Moreover, the feed processing, especially for supplement feeds like brewery spent grain should also be hygienic for both the animal and the public who are using the product.

Feed is a marketable commodity in both the study kebeles and woreda. Roughage feeds such as straw and hay are marketed usually within the kebele or woreda. Farmers who had extra feed or those who don't have livestock or public and social institutions like schools and churches sell feed for those in need. Natural pasture is mostly sold on the field stand bases and the person who purchased the forage is responsible to harvest and transport it to his place. Similarly, straw is sold on a pile based and the purchaser needs to transport the straw. It is also reported farmers purchase crop residues (usually wheat and barley straw) from other kebeles and woredas and transport by trucks. The price of roughage depends on season, location, and type of roughage (natural pasture hay, wheat straw, barley straw, etc). Green forages such as oats vetch mixtures are also sold in two forms. The harvested green forage is sold to the nearby towns or the green forage is sold on stand bases on the field and arrangements will be made to harvest and use by the person who bought the forage.

Marketing of supplement/concentrate feeds to reach smallholder farmers such as in Shurmo and Abamottie is very difficult. The main problem is its ease of availability, bulkiness like (wet brewery spent grain), and high price. At Shurmo if a farmer wants to buy wheat bran, brewery spent grain or a formulated concentrate, he or she must travel to Hosaena town and need to arrange transportation. Sometimes, the feed may not be available, especially brewery spent grain is rarely available. However, at Abamottie the situation is somehow better, farmers who are members of the cooperative get supplement feeds most wet breweries spent grain on weekly basis to milk collection sites which farmers transport to their residents using donkeys. But

still, other farmers have the same problem of accessibility. Both Shurmo and Abamottie cooperatives are newly established and yet not well organized and strong to provide different services effectively.

Dairy

In both the study kebeles, there are a significant number of market oriented dairy farmers keeping crossbred dairy cows and producing milk. Some of them are organized as cooperatives. The main function of the cooperative is collection of milk and supply to processors, hotels and cafes. Non-members of the cooperatives manage the milk marketing by themselves. Most farmers in both kebeles prefer selling fresh milk to processing. They indicated processing milk is tiresome in many ways. Therefore, farmers process milk for their own consumption or when milk is rejected during collection or if demand in the market is very poor, especially during the fasting periods. The economic benefits of selling fresh milk compared to products after processing depend on several factors. The scale of production, processing capacity and diversity of products, demand of products in the market and related processing costs, determine its profitability. Under the current condition of Ethiopia if the market is not a problem selling fresh milk might be more economical than processing.

One of the major challenges of marketing milk is fulfilling the minimum quality standards. The milk should not be adulterated and fresh. These parameters are normally tested at collection centers using lactometers and alcohol tests. Milk collection is done once a day. The evening and morning milk is supplied separately for possible rejection of the evening milk in the morning. In these kebeles, there is no any electricity and no cooling systems, which usually condemns milk because of the absence of cooling systems. All milk suppliers also need to bring milk with standard jars, which is usually designed in such a way that it is easy to clean and made of plastic or stainless materials.

Variation in milk price is very huge in different places. At Shurmo a liter of milk costs in the range of 45 and 55 ETB, while at Abamottie it is 30 to 35 ETB. This is mainly due to access to the market and demand. In Shurmo when farmers sell milk to cooperatives the price is a little lower than when they sell to private milk collectors or consumers. On the other hand, at Abamottie Farmers sell milk at a higher price when they supply to cooperatives than when they supply to private milk collectors. In any of the cases, the producers should be at a disadvantage because of a lack of information and other misunderstandings and hence the extension workers need to guide farmers to their benefits. Despite all such price variation in these two locations the price of feed specially the formulated concentrates, wheat bran and wet brewery spent grain, are almost similar.

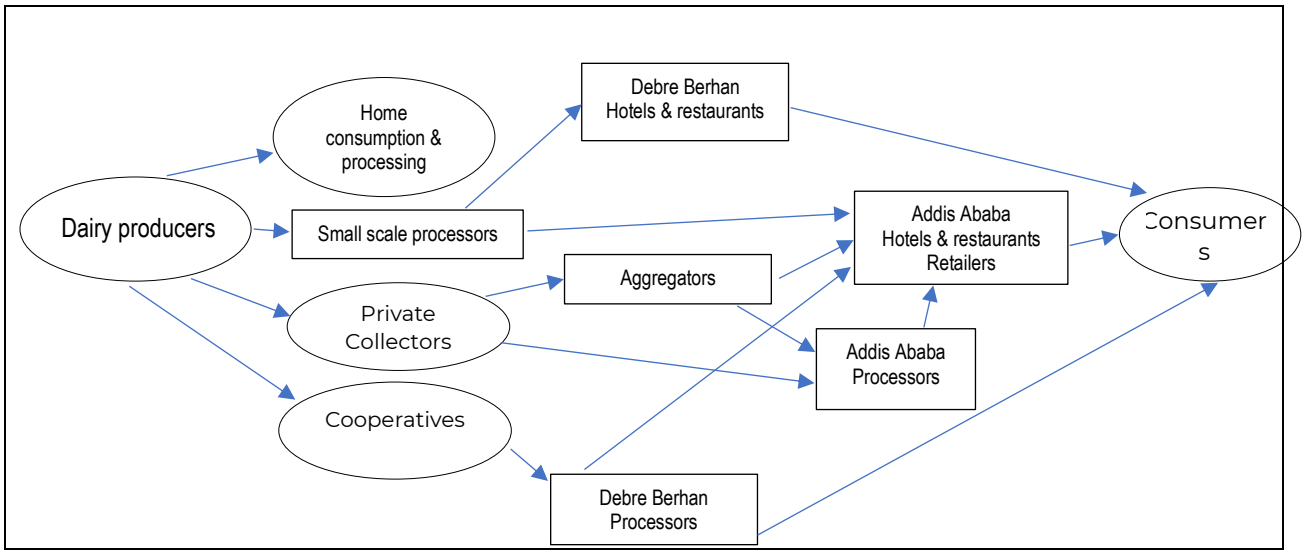

Figure 1 – Milk and milk products market chain at Abamottie diary production area

4 Major challenges

1. Dairy crossbreeding is constrained by poor skill of Artificial Insemination (AI) technicians, very low successes rate of estrous synchronization activities, use of breeding bulls which are not selected based on pedigree and performance and lack of animal identification and data recording schemes

    - Very poor or absence of efficient Artificial Insemination (AI) services for dairy cows due mainly to lack of skilled AI technicians, inputs, facilities, and well-established systems
    - Low success rate AI delivery through synchronization resulting in poor trust of dairy producers on the service and efforts made
    - Lack of animal identification and data recording in dairy animals in the studied woredas. As identification and recording are the bases for sustainable intensification for dairy production.
    - Use of crossbred bulls owned by farmers for breeding in which the bulls do not have any recorded pedigree or performance data and identification. The bull's management are generally poor in terms of feeding and animal health, often used for traction which results in poor performance in breeding. Use of bulls are also believed to transmit several reproductive diseases such as brucellosis and crossbred animals are more susceptible for such diseases relative to local cows
2. Inadequate feed availability which is poor in quality is the major problem for market oriented dairy production in the areas. There is also a very limited level of cultivated forage production through different methods, a lack of information on animal feeding practices based on their requirements, and efficient utilization practices. Use of efficient quality improvement methods for crop residues, poor access, unaffordable price, and poor hygienic feeding practices of concentrate feeding practices.

    - Inadequate availability of feeds of both roughages (hay crop residues, cultivated forage crops) and supplement feeds (wheat bran, formulated feeds, brewery spent grain, local brewery spent grain) in relation to the number of animals farmers keeping and their optimum level of feed requirements.
    - Limited use of well adapted and performing forage crops. Forage crops that would be planted on field borders, soil bands, fence lines and other possible areas are not adequately planted.
    - There is no clear information on the mineral contents of the major feeds available in the study areas. Farmers supplement dairy animals with common salt (NACL). However, it was observed cows with deficiencies of

calcium (Ca). This indicates the need to supplement dairy cows with important micro and macro minerals.

- Even though the number and diversity of forage species and varieties adapted and recommended in color highlands are few, still only few of these species are introduced in these areas. A good example is farmers do not identify or recognize the different varieties of oats, which grows in the cooler areas. However, the national research system recommended more than 15 distinct oats varieties targeted for different functions, production systems, and agro-ecologies
- Lack of using urea, effective microbes (EM), and feed additives like molasses to enhance the quality of cereal crop residues and hay utilization as feed for livestock due to inadequate demonstration and problem of availability and accessibility of these inputs.
- Lack of nutritionally efficient and hygienic use of brewery spent grain. Deterioration of these products due to long distance transportation, long chin of retailing. Long storage time by farmers as farmers are not able to easily access or buy at the required time and place.
- Lack of feeding animals based on the level of productivity and animals physiological requirements. Insufficient information on the quality of mixed roughages feed to dairy animals in the targeted areas
- High and ever-increasing prices of concentrate supplement feeds (agro-industrial byproducts and formulated feeds). Qualities are not usually to the expected standards especially to formulated concentrate feeds, and users lack confidence in the qualities. Moreover, accesses to supplement feed in the required time and place is usually very challenging.

3. Seasonal shortage of water for livestock and human use, which critically affect the efficient utilization of feeds in the rumen of animals that affects milk productivity. Farmers reported that during the dry season dairy cows are supplied with about one third of their normal water requirements.

4. Poor animal disease prevention and health management systems, mainly due to a lack of proper health service practices

    - Lack of strict provision of periodical vaccinations for economically important diseases in the study areas.
    - Poor management of crossbred calves in terms of proper feeding, housing and vaccinations which results in high calf morbidity and mortality.

5. Dairy barns in both the study woredas are poorly constructed. The barns are not well ventilated and most often very dark. The floors are not suitable for cows to walk and sleep and also make the cleaning difficult. The feeding troughs need improvement.
6. The quality of milk supplied to the market is reported to be adulterated usually with water. Quality has also deteriorated due to a lack of cooling systems in the area or collection centers. Moreover, the collection is done only in the morning and the evening milk has to stay at home under room temperature conditions which might lead to fermentation. The recently established cooperative is not fully in place and does not accomplish its full functions. Hence the current milk market chains have many problems that have to be shaped and efficient.

5 Priority researchable issues and good practices to scale

Dairy Breeding

The use of different options to make the animal breeding service efficient and accessible to smallholder farmers so that animal breed improvement is made more meaningful could be expressed in higher milk productivity.

- Possible methods of efficient Artificial Insemination (AI) service delivery through capacity development including skills of AI technicians, input supply systems, different incentive schemes, and communication systems
- Introduction of animal identification and recording systems as a base for sustainable intensification of dairy production
- Assessing the limitations and constraints of the current synchronization activity and piloting better and alternative packages
- Introduction of Bulls of known information in areas where AI service delivery is critically a problem.

Evaluating and identifying the best combinations of feed production, processing, conservation and utilization methods, which is economically and environmentally feasible and increases productivity.

- Introduction and evaluation of oats varieties with suitable characteristics and higher seed and forage productivities in the target areas. Varieties including late maturing, high grain yield productivity, and high leafiness could be introduced.
- Introduction of different methods of crop residue quality improvement methods and sustainable systems of input supply systems
- Evaluation and piloting of different alternative and best cost ration formulation options using locally available roughage and concentrate feeds in the target area.
- Commercialization of forage and forage seeds (planting materials) under smallholder farmers production systems using different business models
- Study feed supply (value) chains focusing concentrate feeds to identify the constraints and suggest good practice to improve the system
- In Introduction and demonstration of efficient and hygienic feed (including concentrate feeds such as brewery spent grain) conservation practice

Introduction and demonstration of water harvesting systems for home and livestock to be used during the critical seasons of shortage

Epidemiology of important livestock disease in the target areas study on dairy (milk) supply chains in the target areas and identify improvement interventions for the current major challenges facing

Introduction and demonstration of best practice in the functions of cooperatives from similar agro-ecologies and production systems

6. Conclusions and Recommendations

From this study it could be conclude that Basona Worena and Lemo woredas are high dairy production potential areas under the mixed crop-livestock systems. Farmers in the woreda specially in Shurmo and Abamottie kebeles are becoming market oriented dairy producers. They are keeping high proportion of crossbred animals and establishing dairy cooperative which is the base for commercial dairying. Farmeers are very aware of the importance and profitability of improved dairy production. However, the husbandry of dairy animals in terms of feeding, health and milk handling and marketing is still did not develop well. From this study it is also conclude that farmers clearly understood the importance of improved feeding for dairy animals and do their best to maximize the utilization of the available feed resources through timely collection, conservation, and efficient utilization. They start allocation of cultivated land for forage production and started forage production in the backyards and in integration with natural resources conservation activities. However, allocation of land for conventional forage production is very limited. Accessibility, high price and utilization of formulated concentrate and agro-industrial by products such as wheat bran and breweries spent grain needs improvement. Animals are generally not fed based on requirements and calls an intervention in proper formulation of rations. Cooperatives are at infant stage and should be strengthened. Moreover milk marketing has several problems along the value chain. Generally to transform the dairy sector in this area, there should be intervention in terms of capacity building, improvement of feed production and utilization, and input output marketing systems.

Based on the findings of the study the following recommendations are draw

1. There is a high demand of productive crossbred dairy cows due to the attractive milk and heifer market in the country. Moreover, the government policy and strategies are very well aligned to this development needs. Therefore, efforts should be made to make farmers acquire the productive dairy cows through crossbreeding. This calls for establishing effective and sustainable means of crossbreeding activities in the area. The primary activities should be 1) capacity development of AI technicians based on the identified gaps, 2) design an efficient AI delivery systems that address the majority of the farmers, 3) recommend and support how quality inputs such as semen and liquid nitrogen and other supplies are accessible to AI technicians, 4) introduction (strengthening) of animal identification systems and data recording systems 5) design how high grade crossbred bulls of know pedigree and performance recording in place to serve the farmers which are in accessible to AI systems.

2. The main input in dairy production costing the highest proportion of expenses is feed. Improved dairy animals need to be fed nutritionally balanced rations based on their level of productivity and requirements. In this study several challenges and opportunities were identified. The findings lead to the following recommendations; 1) Design techniques and quality improvement practice, including urea EM and urea treatments, choppers etc to improve the quality of roughages including straws, whelms, and hay, 2) identify improved management practice of grazing lands to improve species composition productivity with proper harvesting, conservation and utilization, 3) Participatory evaluation of recommended forage varieties (oats) and species with optimum production packages to diversify and use well performing forages for the target areas 4) Introduction of efficient harvesting hand tools like scythe, which is an ideal for cut and carry systems, hay and silage making to harvest in short time to keep forage quality which otherwise deteriorates due to long harvesting time, 5) capacity development in proper and efficient and safe means of transportation, conservations and utilization of concentrate feeds through engaging cooperatives and other farmers groups, 6) establish best cost ration formulation practice to the target areas based on the locally available feed resources including minerals. 7) Piloting forage and forage seed (planting material) production for market and study on economic feasibility of forage production compared to food crop productions in the target areas.
3. Identification and demonstrations of appropriate water harvesting methods from rain, capacity development in efficient and hygienic water utilizations for irrigation and other uses in the target areas.
4. Investigation and monitoring of epidemiology of major and economically important major livestock diseases, and zoonotic diseases from one health perspective to design sustainable interventions.
5. Design proper model barn prototypes for cattle dairy farms, which best fits to the local circumstances of the target areas and to be made from local materials, with the basic structures including feeding and watering troughs to be demonstrated to selected innovative dairy farmers.
6. Capacity developments to cooperatives, farmers and milk market chain actors on effective and safe milk marketing and supply chains and establishing a model and successful milk producers system

7. Potential Partners in Lemo and Basona Worena woredas

In view of sustainable intensification of the different interventions made to a given target area, it is crucially important to involve the different stakeholders engaged along the value chain. In this study it was recognized several private and public organizations working in and around Lemo and Basona Worena Woredas. During the course of this study, it was possible to meet and discuss the objectives of Sustainable intensification in the crop livestock mixed farming systems. It was possible to visit some of the facilities, dairy farms, forage fields, etc. In this discussion and visit we have got an overview of what these organizations are doing and scrutinize the potential areas of collaborations. Table 7 shows the list of organizations we have made discussions and visits. But it should be noted that there are many other private and public organizations to be considered further. Some of them was planned to be communicated but was not possible to make it due to different inconveniences.

Table 7. List of private and public organizations communicated and visited during the study, which would be potential partners in the initiative

No	Name of potential partner	Woreda	Potential Area of partnership
1	Lemo woreda of agricultural office	Lemo	All planned activities in the woreda
2	Wachamo University	Lemo (Hosaena)	Forage crops, seed production, and bull selection
3	Areka Research Center	Areka	Forage and pasture crops, Enset as feed for livestock
4	Habiebo Dairy cooperative	Lemo (Hosena)	Dairy input and output marketing and more
5	Lecha animal feed processing	(Hosaena	Dairy Ration Formulation
6	Basona Worena woreda of agricultural office	Basona Worena (Debre Berhan)	All planned activities in the woreda
7	Debre Berhan University	Basona Worena (Debre Berhan)	Dairy and Bull selection
8	Debre Berhan Agricultural Research Center	Basona Worena (Debre Berhan)	Forage varieties, seed and planting materials, dairy bull selection, AI and animal health
9	Bisrat Dairy cooperative	Basona Worena	Dairy input and output marketing and more
10	Project Mercy	Chacha	Jersey Crossbred heifers, AI service delivery and Jersey bull selection and dissemination

References

Agebu Nurfeta, Adugna Tolera, L. O. Eik and F. Sundstøl, 2009. Feeding value of enset (*Ensete ventricosum*), *Desmodium intortum* hay and untreated or urea and calcium oxide treated wheat straw for sheep. Journal of Animal Physiology and Animal Nutrition 93: 94–10

Solomon Demeke, 2007. Comparative nutritive value of Atella and industrial brewers grains in chicken starter ration in Ethiopia Solomon Demeke. Livestock Research for Rural Development, 19 (1)

Frida Petters, 2018, Compact total mixed ration to dairy cows: effects on feed hygiene, feed intake, rumen environment and milk production. Swedish University of Agricultural Sciences, Uppsala, Sweden.

Ministry of Agriculture (MOA), 2020, The Agricultural Sector Ten Years Development Plan. Ministry of Agriculture, Addis Ababa Ethiopia

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