Sustainable Intensification of Mixed Farming Systems

CGIAR

Feed Value Chains

Sustainable Intensification of Feed Value Chains in Mixed Crop-Livestock Systems: Towards Improved Forages for Small Ruminants

A Preliminary Report

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The Sustainable Intensification of Mixed Farming Systems Initiative aims to provide equitable, transformative pathways for improved actors' livelihoods 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).

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Abbreviations and Acronyms

DZARC	Debre Zeit Agricultural Research Centre
BoA	Bureau of Agriculture
CSA	Central Statistical Agency
FGD	Focus Group Discussion
FTC	Farmers Training Center
GDP	Gross Domestic Product
HARC	Holetta Agricultural Research Centre
KII	Key Informant Interview
KARC	Kulumsa Agricultural Research Centre
LFSD	Livestock and Fisheries Sector Development
PA	Peasant Association
NGO	Non-Governmental Organization
SARC	Sinana Agricultural Research Centre
WARC	Werer Agricultural Research Centre
WGARC	Wondogenet Agricultural Research Centre

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Summary

The efficiency of livestock production in Ethiopia faces several challenges, of which nutritional issues are the most significant. Population growth and the growing need for food have recently led to a continuous reduction in pasture areas, as these areas are increasingly being converted into agricultural fields for the cultivation of crops. To tackle this problem, better feeding alternatives, including improved forage species and protein-rich browse plants, can supplement crop residues. This not only gives animals more feeding options but also enhances their nutrition. This paper aims to explore the varieties and production methods of improved forage, identify key stakeholders in the value chain, and examine the significant challenges and opportunities present. It provides an overview of improved forage production throughout the value chain.

Data for this study was collected using qualitative methods that included 34 focus group discussions (FGD) and 4 key informant interviews (KII) across two districts of North Shewa Zone, Moretina Jiru and Basona Worena. In addition, secondary data was obtained from published articles, CSA reports, theses, and annual reports. The data was analysed using descriptive statistics and value chain analysis techniques. The study results show that the key actors in the improved forage value chain in the study area are input suppliers, producers, marketers, and consumers. The major input suppliers are the USAID-funded AfricaRising project, the Livestock and Fisheries Sector Development (LFSD) and the respective Bureau of Agriculture.

In the chosen districts, local farmers primarily oversee the processes of production, marketing, and consumption in the value chain. The most common techniques for producing forage in these regions include cultivating forage in backyards, growing forage on contour strips, and planting along roadside. The main challenges encountered are limited land resources, a shortage of high-quality seeds and planting materials for forage, obstacles in securing seed quality certification to ensure forage quality, pest infestation, seasonal fluctuations in the availability of superior forage, and related expenses. This study also underscores considerable opportunities, including the existence of enhanced forage varieties, fertile soil, a favorable climate free from frost, an openness to adopting new technologies, and ample water availability.

The study has several recommendations, including improving the input supply system, creating a market for high-quality forage suitable for small ruminants, enhancing the availability of superior forage types, increasing the production and sale of quality forage, and developing a contractual farming framework for the cultivation of improved forage targeted at small ruminants.

Introduction

In Ethiopia, a significant portion of the population relies extensively on agriculture for their livelihood. The agricultural sector, largely characterized by subsistence smallholder farming, serves as the mainstay of livelihood for most people and is a fundamental pillar of the national economy. In this sector, livestock production is crucial, serving as a key element in the nation's agricultural systems, especially in farming practices. Livestock contributes to over 85% of agricultural income in Ethiopia. Regarding the total GDP, livestock accounts for about 13-16 percent of the country's GDP and approximately 16 percent of all exports (CSA, 2021). Despite the significant role of livestock in the economy, the livestock subsector suffers from low productivity. This is mainly attributed to the poor genetic quality of local animals, substandard veterinary services, and a diet lacking in proper nutrition, which is the primary constraining factor.

According to (Fekade, 2019), natural grazing and browsing, crop residues, improved pastures, fodder crops, and agro-industrial by products are the main sources of livestock feed in Ethiopia. Improved forage production brings several benefits, including higher nutritional value, improved digestibility, greater palatability, and increased resistance to pests and diseases. Consequently, the cultivation of improved forage species has gained significant attention from various stakeholders. Species such as Elephant grass, Oats, Rhodes grass, Phalaris, Panicum, Buffel grass, Green leaf Desmodium, fodder beet, pigeon pea, and Sesbania have been introduced as part of an effort to augment the quantity and quality of available forage. Over the past decade, these species have been actively promoted across various regions of the country by the local governments and non-governmental organisations (NGOs). Mokoya *et al*. (2008) notes that over numerous decades, Ethiopia has developed a range of improved forage species, including Sesbania, Leucaena, Calliandra, and Tree Lucerne, for the dual purposes of livestock supplementary feeding and soil enhancement. These improved leguminous forages and browse species offer protein, thereby augmenting the feed resources available for livestock. Nationwide, the total production of animal forage is 3.6 million quintals. Of this, about 396,039 quintal of the country's total animal feed during the 2021/2022 production season consisted of improved forage, representing 0.38% of the overall amount. Grazing contributed to

about 57.7% of the total feed used by farmers, while the rest, amounting to 29.75%, came from crop residues. In the Amhara region, approximately 60,295 quintal of improved forage was produced, accounting for 0.2% of the total national forage production. Meanwhile, in North Shewa zone, about 4590 quintals of improved forage, representing just 0.03% of the country's total forage output. These figures indicate a relatively small percentage (CSA, 2021).

Despite significant development efforts and the clear advantages observed, improved forage production was relatively low, as indicated by the statistics. Among the various types of improved forages available, only vetch, tree Lucerne, sesbania, and desho are planted and utilized by local farmers in the study area. Except for a few significant cases, the practical implementation of improved forage is largely overlooked in the study area. Consequently, this study intends to provide a comprehensive review and analysis of the difficulties encountered and opportunities available in improved forage, including its varieties, production methods, primary functions, and prospects for enhanced forage production with a focus to incorporate them into diets of small ruminants. The study has been structured with the following specific objectives:

- To identify the types and methods of improved forage production in the district, targeted at small ruminants.
- To identify major actors involved in the improved forage value chain,
- To identify the significant constraints and opportunities in improved forage along the value chain.

Methodology

Description of the study areas

The study was conducted in Moretena Jiru and Basona Worena, in the North Shewa Zone of the Amhara Region of Ethiopia.

Moretena Jiru is divided into 11 administrative Peasant Associations (*kebeles*). Moretena Jiru is a central agricultural area, mainly cultivating wheat, barley, teff, and maize. The district also has several important livestock, including cattle, sheep, goats, and poultry. The Basona Worena is characterized by a highland plateau with an average altitude of 2,400 meters above sea level. The climate is temperate, with average temperatures between 15°C to 25°C. The annual average rainfall is about 1,200 mm. Basona Worena study area is home to a diverse range of flora and fauna. The most grown crops in the region are cereals, legumes and oilseeds. Animal husbandry is also essential, with cattle, sheep, goats, and chickens being the most commonly kept animals.

Sampling technique

The study area was selected using a purposive sampling technique. Two districts from the North Shewa zone, Moretina Jiru and Basona Worena, were specifically selected based on their production potential and track record in producing improved forage. Two Peasant Associations (*kebeles*), Gerba and Bolo from Moretina Jiru, and Gudoberet and Debele from Basona Worena district were selected based on their potential and actual production of improved forage, as well as after consultation with local experts found in the district Agricultural Office.

Data analysis

Primary and secondary data sources were collected in quantitative and qualitative formats. Farmers and agricultural professionals provided qualitative information about improved forage production and the associated challenges. Data was collected using FGD, KII and personal observations were examined using descriptive data analysis. Descriptive statistical analysis techniques were used to analyze qualitative data to identify key players in the improved feed value chain and their associated

primary opportunities and constraints. Since most of the data was qualitative and the collection method was random, descriptive analysis was used. Various techniques were used to triangulate the data. Descriptive statistics (means and percentages) were used to assess the quantitative data, while narratives were used to explain the qualitative data. Tables and graphics are used to convey the information.

Results

Improved forage value chain actors and their functions

Input provision, production, trade (marketing) and consumption are the four main activities in an improved feed value chain. The activities in which the above essential functions were involved are shown in Figure 1.

Input supply: To increase production and productivity, farmers rely heavily on the availability of high-quality inputs at the right time and in the right place. At this stage of the value chain, very few actors are directly or indirectly involved in the supply of agricultural inputs in the study area. The value chain actors in this segment provide the raw materials required for the proper operation of the improved feed value chain. The results of the study showed that non-governmental organizations (AfricaRising Project and LFSD) and extension services are the main sources of significantly improved forages. In 2022, the AfricaRISING project cultivation produced about 5 quintals of vetch, compared to 3 quintals in 2021. The project maintained its annual seed supply, while the LFSD project had previously provided 7 quintals of oats and 5 quintals of vetch in 2020 but has since discontinued this. Both NGOs provided incentives and training to farmers on varieties, applications and related issues of improved forage production and propagation. The improved forage seeds were purchased from the farmers by the Agriculture Bureau office and then delivered back to other farmers. Vetch, whose use in cropping systems has shown potential, is the most well-known improved forage seed offered by the NGOs. It was reported that no improved forage seeds were purchased from seed companies. Other inputs, such fertilizer and crop chemicals, were reportedly supplied through cooperatives. According to the FGD results, even if there is a strong demand for improved forage seed, there is no market for it since the Bureau of Agriculture always provides basic vetch seed to farmers. The AfricaRising project also provided farmers with vetch seed. The actors above provide improved forage seed, variety of planting material, and fertilizer to the farmers in the study area. Since there is no set standard for the purchase price by the government and other stakeholders, the primary cooperatives are not willing to purchase the improved forage seeds produced from the farmers.

Production: The production of improved forage is mainly undertaken by local farmers and the district's Bureau of Agriculture. Therefore, small farmers play an important role in production and marketing in the local markets. According to the study, most farmers sell their forage to other farmers who require livestock feed. Only through barter trade can a farmer in need of improved forage obtain it from another farmer. The lack of improved forage traders is the main reason for the lack of improved forage seed. The main varieties of improved forage seed and planting material in the study area that are widely recognized by local experts are vetch, oat, Sinar, Tree Lucerne, alfalfa, phalaris, sesbania, cowpea, pigeon pea, desho, elephant grass, and Rhodes grass. The most common improved forage and planting material mentioned was vetch, accounting for about 40% of the total, followed by sinar (20%), sesbania (20%), elephant grass (10%) and Tree lucerne (10%) and desho (10%). The seeds and planting material are mainly sourced from Agricultural Research Centers (Table 1).

Table 1: Improved forage production in diverse agro ecologies in Ethiopia

Species	Altitude (m)	Breeder institute	Forage type
Phalaris	2400-3000	BARC	Forage grass
Rhodus grass	1000-2400	HARC	
Oat	1500-3000	SARC	
Elephant grass	700-2400	HARC and WARC	
Desho	1000-2000	DZARC, KARC, WGARC, HARC	
Vetch	1500-3000	HARC	Legumes
Cowpea	1400-1600	MARC	
Sesbania	400-2000	DZARC	Browse trees and shrubs
Pigeon pea	1000-2000	MARC	

DZARC, Debre Zeit Agriculture Research Center (ARC); HARC, Holetta ARC; SARC, Sinana ARC; WARC, Werer ARC; WGARC, Wondogenet ARC; MARC, Melkasss ARC.

Farmers participating in projects produce improved forage on an average of 0.125 to 0.5 hectares of arable land. Due to the high and rising costs, farmers rarely use fertilizers and pesticides, when producing improved forage to increase production. Moretina Jiru district produced vetch on 4 hectares of land from farmers and the Farmer Training Center (FTC) during the 2022-2023 growing season using seeds provided by AfricaRising. From the vetch seeds produced, only 3 quintals of vetch seeds were collected. Pests and frost led to low yields. The main purpose of cultivating

vetch was for seed propagation and as feed for livestock. For dairy and fattening activities, dried vetch is often mixed with oats. In Moretina Jiru district, the major producers of vetch are Gerba and Bolo kebeles. In 2022, Bolo and Gerba harvested 2 quintals and 1 quintal of vetch, respectively. Farmers in the corresponding *kebeles* used, on average, 0.125-0.25 hectares of land to grow vetch. Farms sell vetch to other farmers at any price. Vetch seeds are often sold for 5000 Birr per quintal (5060 Birr per kilo). Annual legumes and cereals provide the best quantity and quality of forage in highland areas. Annual forage legumes yield highest in mid-altitude and lowland areas. Desho is another improved forage grass grown on an average of 0.125 hectares of land in Moretina Jiru district. Desho made its debut in 2019. Farmers with access to water from various sources are the leading producers of desho. In the lowland areas of the district, production of cowpea and pigeon pea seed production was initially started between 2012 and 2013, but it has since been discontinued. Sesbania cultivation began in 2008. Approximately 278,000 sesbania planting materials were produced and distributed to farmers by the Bureau of Agriculture. The FGD discussion revealed that NGOs, zonal specialists, and the FTC demonstration sites provide most of the training to farmers on the use, importance, and associated issues of improved forages. Furthermore, most farmers in Moretina Jiru district reported that wheat cultivation now covers areas previously used for pasture. Vetch is typically grown near wheat fields. The main aim is to prevent cattle from eating wheat.

Marketing: Farmers typically trade the newly propagated forage seeds and planting materials among themselves, rather than selling them. Instead of monetary transactions, they exchange improved seeds for different agricultural products. There is no established central market dedicated to the sale of these improved seeds and planting materials.

Consumption: Customers are mainly farmers groups who buy improved forages, forage seed and planting materials from other farmers and traders for their personal livestock use, as opposed to purchasing for resale purposes.

Core functions of the improved forage value chain

Input supply, production, trading (marketing), and consumption are the key activities in the feed value chain. As shown in Figure 1, these essential functions include various actions.

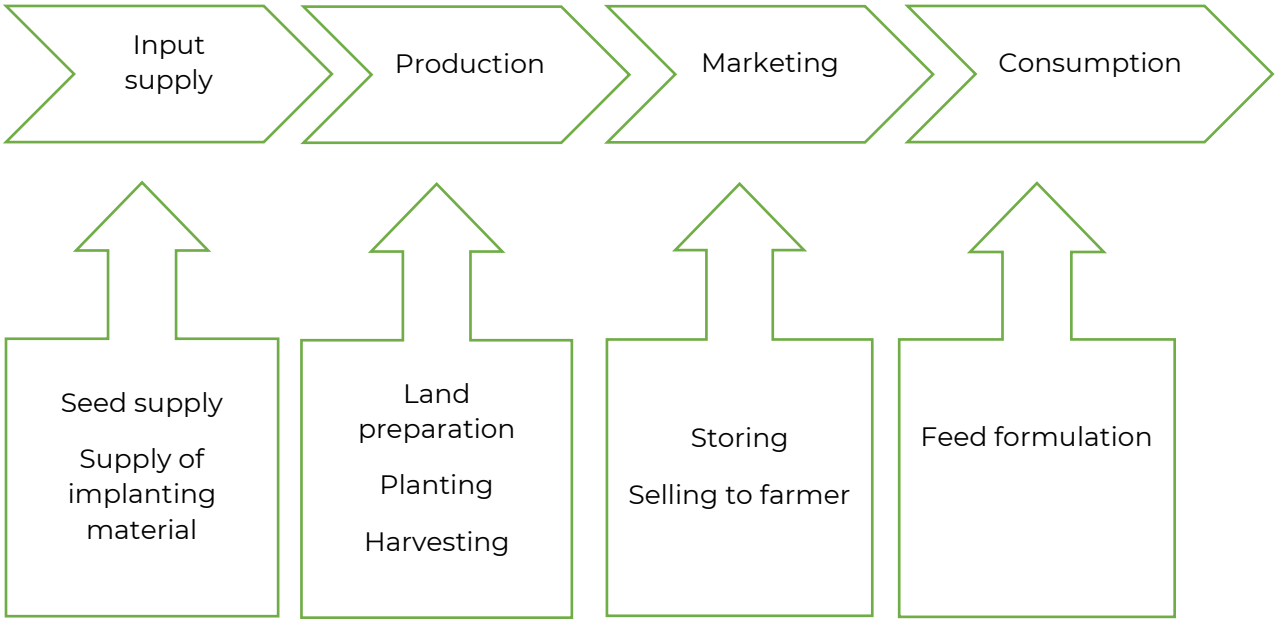

Figure 1: Map of the ore function of the improved forage value chain

Support service institutions and their functions

Bureau of Agriculture and Natural resources

This actor is crucial for the production of improved forages. The main function of support services in the study area is to provide producers with improved forage seed and planting materials. In addition, this actor contributes to forage production by organizing, providing, and coordinating extension or development agents for each *kebele* household under its supervision. The Bureau provides training, new technologies for forage production, provision of inputs to farmers in collaboration with cooperatives, and guidance on field application to increase forage production productivity. It also works with NGOs and Research projects to support farmers in forage production.

Primary cooperatives: In the study region, primary cooperatives play a crucial role in providing inputs to farmers, who mainly cultivate cereals and crops instead of forages. These cooperatives often buy grains, such as wheat and teff, from the farmers, ensuring that they meet high quality and standard requirements for certification. Despite the existence of a standard for buying animal feed, its implementation by cooperatives is lacking. The primary factors for cooperatives not purchasing improved forages produced by farmers include the low yield and productivity of these forages and a focus on agricultural products meant for human consumption rather than animal feed. Furthermore, farmers engaged in producing improved forage seeds and planting materials should collaborate within a cooperative framework to successfully market these forages. In response, the Bureau of Agriculture brought together farmers to form a cooperative consisting of 15 farmer members. This arrangement will enable households that produce forages to maintain consistent production of improved varieties, acquire necessary inputs, and market the forages to other cooperatives. The key reason for organizing farmers into cooperatives for forage production is to facilitate the acquisition of improved forage quality certification. It is challenging for an individual forage producer to obtain this certification. As a result, the Zonal Agriculture Office plans to grant quality certification to organized groups of farmers who can supply improved forages.

Improved forage production strategies

Farmers in the selected district use various methods to enhance forage production. They have selected strategies that would increase fodder production for their households. The most common practices for forage production in these districts include planting along roadsides, creating contour forage strips, and cultivating forage in backyards. Essential to backyard forage production is the establishment of small, efficient areas and hedges for forage and browsing within and surrounding homes. The ideal grasses for backyard forage, such as desho forage, are characterized by their tall growth. Contour forage strips are commonly utilized for growing Tree Lucerne and vetch, but they are less frequently used for phalaris. Typically, farmers plant along contour lines or in slim strips without needing any physical structures. The contour forage strip cultivation technique allows farmers to simultaneously provide

feed, shelter, soil stability, and fuelwood through a versatile approach. Sowing along roadsides is an effective method for implementing this forage production strategy. Its quickness, efficiency, and visually pleasing results can encourage farmer engagement and lead to the formation of pastoral groups or grazing management collectives. In the studied region, this technique was popular for its cost-efficiency. Primarily, this feed production method focuses on using Lucerne from trees. It is estimated that 10 Km of roadside sowing can yield one hectare of enhanced grazing land(Mengistu, 2002).

Constraints and opportunities in the improved forage value chain

Constraints along the value chain

Input supply: Due to increasing population growth, pasture areas are increasingly being converted into arable land. Areas for the production of animal feed have now become scarce. Producers in the study area lack access to forage seeds and other planting materials necessary for the production of improved forages. Practical training at the farm level is essential for the production and management of forage and pasture. This is largely lacking at the producer level as only one actor, the AfricaRising project, has been engaged in this area to date. The study findings also reveal that insufficient certification of seed quality for forage, along with a lack of assurance, resulted in reduced production of improved forage. The difficulties in acquiring seed quality and assurance certification were attributed to the quality of the seeds, the geographical location of seed production, and the inability of farmers to present necessary documents to the certification authorities, including records of seed lots and test results.

Production: Farmers cite several issues that contribute to their low production and productivity on better pastures.

- Pest infestations: A major factor in ow production of improved forages is the prevalence of pests. The common pest species in the study area include

nematodes, tiny worms that attack the roots of forage crops, restricting their growth and reducing yields, and insects such as grasshoppers and locusts.

- Land scarcity: The amount of land used for improved forage production was also constrained by lack of land. Farmers in the study area responded that they had very little land available for improved forage production and that their land was almost completely covered by cereal crops. Typically, improved forage is grown on the outskirts of cereal farms to prevent animals from eating the grain.

Marketing: Variations in the availability and costs of enhanced forage based on the season were observed in the research area. During the harvest season, both availability and cost are generally acceptable, but in the dry season, if the supply becomes extremely limited, prices could rise significantly, potentially doubling or more. There's a notable absence of market linkages among producers, traders, and cooperatives.

Opportunities along the value chain

Input supply:

Improved forage species availability: Recognizing the necessity for better forage seeds and planting materials, the district Bureau of Agriculture, in collaboration with various NGOs and research projects, has facilitated the provision of enhanced forage varieties like vetch and alfalfa. The presence of these advanced forage species in the study region represents a significant opportunity for the advancement of forage development.

Production

- **Availability of large and fertile land for forage development**: The regions possess land suitable for cultivation that can be enhanced for better forage growth.
- **Favourable climate with no frost**: The study area has a favorable climate without frost, which is beneficial for the production of improved forage as it allows growth throughout the year. This is important because improved forage crops must be able to grow and regrow quickly to provide a reliable source of feed for livestock. Alfalfa, a legume that is a good source of protein and fiber, is an improved forage

crop that can be grown in favorable areas in the study area without frost. Since it is a perennial crop, the plant can be harvested from the same planting for several years. Additionally, grasses are a good example of improved forage produced in a good climate without frost.

- **Farmers' want to adopt new technology**: Traditional methods of producing forage are often inefficient and not eco-friendly. Farmers have expressed a strong desire to embrace innovative technologies to enhance forage production. This includes adopting advanced forage seed varieties to boost yield. Implementing modern techniques in forage cultivation can lead to higher livestock productivity, better food security, and a smaller environmental footprint. Practices like zero-till planting contribute to soil and water conservation. Farmers are particularly interested in new technologies such as improved forage types, biofertilizers, and silage methods to improve forage production.
- **Availability of water**: Water is crucial for increasing forage crop yields. These improved crops typically require more water because they need to sustain either grazing or harvesting over extended durations. The North Shewa zone is home to various water sources, including rivers and man-made lakes, making it an ideal area for advancing forage cultivation for small-scale farmers, thereby significantly influencing forage yield. In the Moretina Jiru district study area, farmers reported that the scarcity of water resources confines forage cultivation to the rainy season due to the absence of irrigation facilities. Conversely, in the Basona Worena study area, the presence of plentiful water resources allows for year-round cultivation of improved forage crops.

Recommendations

- Unlike cereals, no established market exists for purchasing and selling improved forage seeds and planting materials. This needs to be addressed.
- Farmers in the study area acknowledge the importance of improved forage production. However, other essential elements for a range of forage seeds, grass varieties and planting materials, remain difficult to obtain. This situation needs to be addressed. Although several different improved forages have been developed, the majority are still not yielding significant results.
- Non-governmental organisations, such as the LFSD and the AfricaRising project, often support farmers by providing them with improved forage seeds. However, the major challenge is maintaining consistency, as the distribution and production of the improved forages halt when projects end, there is disruption in seed supply. This issue needs immediate resolution.
- Once the required seed certification is obtained, seed cooperatives should be encouraged to purchase improved feed and forage seeds at a regulated price. This strategy would motivate farmers to increase their production, thereby reducing the cost of high-quality forage seed and planting material in the study area. Basona Worena and Moretina Jiru are home to cooperatives such as Wedera, Tegulet, and Amhara Region Seed Enterprise. These enterprises, which already buy and sell various types of grains, should be encouraged to venture into the improved forage seed sector.
- Farmers should establish influential marketing units such as cooperatives that can act as bargaining units. These organizations would ensure lower input costs for suppliers of improved feed and potentially ensure a constant supply of it. Small farmers and cooperatives should be encouraged to adopt contract farming to produce high quality seeds. This approach would give farmers greater bargaining power and protect the market in which they sell their high-quality forages. In general, contract farming is used as a strategy to increase the farmer's influence.his approach would give farmers greater bargaining power and protect the market where they sell their high-quality animal feed. Generally, contract farming is employed as a strategy to enhance the influence of the farmer.

- Government authorities should recognize the importance of the improved forage feed subsector and actively support it by creating an enabling environment and incentives. This includes developing comprehensive master plans for the forage sector.

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Appendix

Annex 1: Descriptions of improved forage species in the study area

***Vicia dasycarpa* (Vetch)**

The annual legume vetch is a robust climbing plant with many adaptation options and high acceptance among farmers. It thrives between 1500 and 3000 m above sea level and tolerates a variety of rainfall, usually over 400 mm annually. Vetch can thrive in several soil types but requires adequate drainage for optimal results. It develops quickly on uneven seedbeds and is suitable for underseeding, mixed grazing and backyard food plots. Before planting, the seeds should not be infected. Typical sowing rates are 512 kg/ha as a pioneer component for mixed pastures, 20 kg/ha for pure stands and 12 kg/ha for undersown crops. Expected seed yields are between 400 and 1000 kg/ha, but fragmentation may occur. Up to 1525 kg of seeds can be cleaned and harvested daily by one person (Robertson, 1990).

***Sesbania sesban* (Sesbania)**

Sesbania is a browsing legume that can adapt to its environment and survive for up to 7 years. It can grow in certain conditions where neither leucaena nor alfalfa can grow. It is palatable and is used primarily as forage, but also provides benefits as shelter and nitrogen storage for surrounding crops. Sesbania wood can be used for fences but may be better suited for construction or fuel production. It thrives below 2000 m above sea level, is very frost sensitive and not drought tolerant and requires more than 600 mm annual rainfall to survive. Sesbania can thrive in a variety of soil types, including wet and extremely low-acid sands, and does well with increased fertility. Sesbania is ideal for contour feeders, backyard fences and alley growing. Sesbania produces more than 1 kilogram of seeds per tree, especially from plants that were last cut a year ago. One person can typically collect and clean 3-5kg of pods daily by hand (Robertson, 1990).

***Chamaecytisus palmensis* (Tagasaste/Tree Lucerne)**

The highland regions of Ethiopia are heavily dependent on the temperate, versatile deciduous fruit known as Tree lucerne. It is one of the few pasture species that is highly productive at altitudes above 2000 m. Farmers value it for shelter, bee food, nitrogen fixation, soil protection, and its primary functions as pasture and firewood. The species exhibits a remarkable degree of genetic variability with notable variations in canopy structure, branching habit, leafiness, and flowering ability. It grows best in well-drained fertile soils, but it can even produce infertile acidic sands as long as these are well-drained. Once established, it tolerates drought, but requires more than 400 mm of annual rainfall for optimal productivity. Tree lucerne is a good choice for backyard foraging, contour forage strips, alley cropping, oversowing on self-mulching soils, and soil conservation.

***Vigna unguiculata (*Cow Pea)**

Cowpeas are primarily grown in a wide variety of environments. Scientifically, cowpea is mainly grown in most lowland areas at an altitude of up to 2500 meters. Cowpeas have good drought tolerance and can receive up to 300mm of annual rainfall. It can grow on a rough seedbed with a seed rate of 12-15 kg/ha. Cowpeas can be grown with sorghum and corn. Productivity for cowpea with different cultivation strategies is 500-800 kg/ha.

***Medicago sativa (*Alfalfa)**

When properly managed, alfalfa is a long-lived perennial legume that provides significant amounts of high-quality forage. Typical examples are the varieties Hunter River, Hairy Peruvian, Siriver, Paravivo and Sequel. Alfalfa, also known as lucerne, can withstand a wide range of temperatures and thrives at different altitudes. Once established, the plant tolerates drought due to its deep taproot. With more than 600 mm of rainfall and ideal for irrigation, alfalfa provides good forage. Although alfalfa can grow in a variety of well-drained soil types, alfalfa does best in neutral to slightly alkaline soil. Inoculated seeds should be sown in a well-prepared seedbed at a dosage of 810 kg per hectare for pure stands and 56 kg per hectare for compound feed plots. Alfalfa is generally ready to harvest when 10% of the crop is in flower.

***Chloris gayana* (Rhodes grass)**

A stoloniferous grass called Rhodes Grass is best suited to altitudes below 2400 m and more than 600 mm annual rainfall. It can grow in various soil types, but sufficient fertility is required for optimum harvest Although Rhodes grass is effective at controlling erosion, it should not be used for contour forage stripping techniques as it can become a crop weed. It can withstand intensive grazing and pruning, making stock exclusion areas and reseeding optimal places to apply its erosion control capabilities.

***Phalaris aquatica* (Phalaris)**

The most important grass for soil conservation and pasture development in Ethiopia is Phalaris. Phalaris thrives between 1800 and 3000 m above sea level, tolerates frost and drought and produces well with more than 400 mm annual rainfall. It can survive in poor soils but requires fertile soils for vigorous growth. Phalaris takes time to establish but is ideal for intensive grazing once it establishes. It is appropriate for backyard and forage mixtures, but its soil conservation properties are best utilised in contour forage strips. Phalaris should be lightly grazed or pruned during the early establishment phase. In areas with long growing seasons, where annual seed yields of 300–400 kg/ha are attainable with sufficient fertilization. Phalaris does not set fertile seeds. Contour forage strip techniques benefit from the fact that many locations lack fertility as Phalaris is less likely to become a crop weed.

Sinar

Sinar improved forage has several advantages over other forage varieties, including, it is more productive and yields up to 20% more forage than other varieties, it is more drought and heat tolerant, it is more resistant to pests and diseases, and it has a higher forage quality.

Annex 2: Pictorial - focus group discussions

FGD in Basona worena district, Debele *kebele. Photo credit: Biruk Kemaw*

FGD in Basona worena district, Gudoberet *kebele. Photo credit: Biruk Kemaw*

FGD in Moretina Jiru district, Gerba *kebele. Photo credit: Biruk Kemaw*

FGD in Moretina Jiru district, Bolo *kebele. Photo credit: Biruk Kemaw*

Tree lucerne in Basona worena district, Debele *kebele. Photo credit: Biruk Kemaw*

Tree lucerne in Basona worena district, Bolo *kebele. Photo credit: Biruk Kemaw*

Consent

"Personal information including Name, Business Title, Email, Phones, Images and GPS points included in this report have been authorised in writing or verbally by the data subject." J. Wamatu

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