Farming Systems Characterization and Analysis in a Mixed Agro-ecology, Somali Region

ENARESS (Enabling Next-generation Researchers **through** Engaging Seasoned Scientists) Project

Farming Systems Characterization and Analysis in a Mixed Agro-ecology, Somali Region

Somali Region Pastoral and Agro-pastoral Research Institute (SoRPARI)

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FOREWORD

Ethiopian Institute of Agricultural Research (EIAR) is the oldest Federal Agricultural Research system responsible for conducting vast research activities in different research areas with the vision to see an improved livelihood of all Ethiopians engaged in agriculture, agro-pastoralism and pastoralism through market competitive agricultural technologies. In the last decades, EIAR has generated thousands of technologies of crops, livestock, natural resources and others which largely contributed to the growth of the sector in the country.

In addition to generating agricultural technologies, EIAR supports Regional Agricultural Research Institutes both financially and technically. One of the projects designed to render such supports was the *Enabling Next-generation Agricultural Researchers through Engaging Seasoned Scientists* (*ENARESS*) Project. The project is a joint venture of EIAR and Agricultural Transformation Institute (ATI) intended to fill the knowledge and skill gaps stifling the youthful research workforce. ENARESS is making all the efforts in building the low experiences and skills of the research force in EIAR, which is dominated by young researchers.

Apart from building its own research capacity, EIAR is also committed to supporting Regional Agricultural Research Institutes in all possible ways. One of the initiatives taken in the direction was to support Somali Region Pastoral and Agro-Pastoral Research Institute (SoRPARI) through the ENARESS Project. Since its inception in March 2019, ENARESS has been supporting SoRPARI to help build the technical capacity of its research-staff through short-term trainings of various

topics. EIAR has particularly been supporting SoRPARI to develop a region-wide plan for conducting participatory farming systems character-ization and analysis study as well as piloting the study in selected woredas of diverse agro-ecologies in the Somali Region by allocating all the necessary financial and technical resources.

The study was piloted in one of the zones of the region with two fundamental objectives; i.e., building the capacity of the research team to conducting farming systems characterization and analysis study; and generating information which can help design agro-ecology-based research and development strategies. In this regard, it is my strong belief that the study team has achieved both objectives.

I would like to appreciate SoRPARI top management and the study team for making relentless efforts towards achieving the goal mutually shared by our partner institutions. I believe adequate lessons and practices have been drawn from the whole processes of piloting the study, which could also be an enormous input for similar studies planned by SoRPARI to be launched region-wide. The report will also serve as a valuable resource to help design pertinent and demand-driven research strategies.

I, on behalf of EIAR, would like at this juncture to thank ATI for its standing support and assure that EIAR will remain dedicated to strengthening collaboration and partnership with SoRPARI.

Feto Esimo (PhD)
Director General, EIAR

Since its establishment in 2002, the Somali Region Pastoral and Agro-pastoral Research Institute (SoRPARI) has been striving to address core pastoral and agro-pastoral development challenges of the Somali Region. The institute endeavored to reach the pastoral and agro-pastoral communities of the region through delivering appropriate, applicable and adoptable research, extension and development inter-ventions. However, as in many other dryland regions of the country, the agricultural production system of the region is threatened by multifaceted challenges including drought, climate variability, soil degradation, rangeland deterioration, widespread human and livestock diseases, rapid expansion of invasive weeds, prevalence of crop pests & diseases, deforestation, poor socioeconomic services and infrastructure, inaccessibility of livestock market, lack of improved farm inputs and farming technologies. Given the wide and very complex set of challenges the sector is facing, there is no single "silver bullet" solution for solving the problems faced by agro-pastoralists. Therefore, the research and development intervention programs that aimed at improving the livelihood of the pastoral and agro-pastoral communities should look for integrated approaches involving multiple sectors, institutes and interest groups.

To address the complex sets of problems that pastoral and agro-pastoral communities are facing in more sensible manner, understanding the existing farming practices, constraints and opportunities is a pre requisite. It is with this motive that this farming system characterization study was initiated. The study mainly employed a combination of qualitative approaches and desk reviews including focus group discussions, key informant

interviews and direct field observations. The study was conducted by multi-disciplinary team of experts who have relentlessly been working in planning and executing the research as well as drafting and refining the report. The report summarizes the major challenges, opportunities and prospects for research and development interventions pertaining to socio-economics, natural resource management, crops and livestock production practices.

At this juncture, I would like to express my gratitude to ENSARESS project of EIAR for providing both financial and technical supports. I also express my heartfelt appreciation to all members of the research team for their sincere and dedicated work in conducting the study and preparation of this report. I believe this report will be a valuable source of information for researchers, development workers and policy makers. It will also serve as a baseline document for planning future research and extension interventions, and track the progresses made and impacts achieved.

Mohammed Sharif Ali (PhD)
Director General, SoRPARI

PREFACE

The quality of researchers is a determinant factor of effectiveness and efficiency for the research in fulfilling its mandates of generating and transferring agricultural technologies, knowledge and information. Hence, for the research system to be successful, it should be able to nurture the research workforce through specialized short-term trainings, mentoring and coaching. Providing researchers, especially the young and less experienced ones, with subsequent short-term trainings and mentorship programs would help them build their technical capacity and dexterity. The research also requires to continuously build on the existing knowledge and good practices by creating a system where the knowledge, skill and experiences of senior experts from within as well as outside of research institutions could be tapped into the system by way of coaching and mentoring.

In this regard, the *ENARESS* **(*Enabling Next-generation of Agricultural Researchers through Engaging Seasoned Scientists*)** Project of EIAR has organized and offered a series of short-term trainings for the Somali Region Pastoral and Argo-pastoral Research Institute (SoRPARI) on a range of topics that have been identified and prioritized by the latter. In addition to supporting successful execution of these short-term trainings, ENARESS committed itself to enable SoRPARI to prepare a master plan for conducting region-wide Participatory Farming Systems Diagnosis and Characterization (PFSDC). In due course of preparing the master-plan, it came to light that a pilot FSDC is

necessary to be undertaken at Fafen Zone of the region with ENARESS' budget granted by the ATI in the Amendment of the project agreement.

Accordingly, an expert with acclaimed experience to not only lead the process but also coach SoRPARI-experts in the pilot-FSDC—Ato Agajie Tesfaye, was deployed by *ENARESS* under the auspice of EIAR-HR on contractual basis to deliver the output desired. It is the relentless commitment of his, as a lead executer and coach of the team, as well as that of the SoRPARI-experts involved in the task, that resulted in compilation of this important document. The document will be of fundamental importance not only in describing the circumstances of the community in the pilot area, but equally, if not more, so in serving as a reference material for SoRPARI in general to pursue similar engagements for other areas and recommendation domains too.

I on behalf of *ENARESS*, thus extend my sincere appreciations to the consultant and the SoRPARI team for the job well-done. I would also thank the management of the EIAR for setting a conducive environment to implement the project. With same breadth, I thank ATI, too for its continuous financial support and particularly the guidance of Dr Mandefro Nigussie was instrumental for the successful implementation of the ENARESS Project.

Nigussie Alemayehu (PhD)
Coordinator, ENARESS Project, EIAR

ACRONYMS

AEZ	Agro-Ecological Zones
BOA	Bureau of Agriculture
DA	Development Agents
EDP	Externally Displaced People
EIAR	Ethiopian Institute of Agricultural Research
FCU	Farmers' Cooperative Union
FGD	Focus Group Discussions
FGM	Female Genital Mutilation
FHH	Female Headed Households
FMD	Foot-Mouth-Disease
FS	Farming Systems
FTC	Farmers' Training Centers
IDP	Internally Displaced People
IGA	Income Generating Activities
JJU	Jigjiga University
KII	Key-Informant Interviews
LSD	Lumpy Skin Disease
MFI	Micro-Finance Institutes
MHH	Male Headed Households
PRA	Participatory Rural Appraisal
RD	Recurrent Drought
SFM	Sustainable Forest Management
SORPARI	Somali Region Pastoral and Agro-pastoral Research Institute
SRS	Somali Regional State
SWC	Soil and Water Conservation
SWR-E	Stichting Wageningen Research Ethiopia

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This study would not have been successful without persistent contribution of a number of actors. We would like to render our heartfelt gratitude to EIAR/ENARESS for providing financial and technical supports from beginning to end of the study. We are especially indebted to Dr. Chilot Yirga, DDG for Capacity Building and Administration of EIAR and Dr. Nigussie Alemayehu, Coordinator of ENARESS project, for their persistent advises and follow-up in the course of the study.

We are also immensely grateful to Fafan Zone Office of Agriculture and Natural Resources for providing the required information and relevant documents for the study team. Our appreciation also goes to Gursum and Awbare Woreda Offices of Agriculture and Natural Resources for their supports in selecting a mix of sample farmers and providing the required information and documents during KII with the study team.

We would also like to appreciate the farmers of Gursum and Awbare woredas for spending their invaluable time with the study team and providing the required data and information. Specifically, we would like to extend our sincere gratitude to Somali Region Bureaus and the President's Office for participation on validation workshop and providing relevant comments which helped enrich the study report. We are also thankful to the contribution of all other actors who have been supportive in the course of the study.

EXECUTIVE SUMMARY

Introduction and Methodology

The Somali Regional State (SRS) is endowed with huge livestock resources with an estimated total population of more than 40 million, making the highest owner of livestock population in the country. Livestock rearing or pastoralism is the dominant and indispensable practice in the region followed by crop production. However, the agricultural sector of the region is constrained by numerous natural, biophysical, socio-economic, and technological challenges, leading to persistent poverty and food insecurity. These constraints need to be addressed to help the region efficiently and effectively utilize its stock of natural resources. The first stage to develop relevant and practical intervention strategies is exploring and understanding of the prevailing farming systems of the region, the reason why this study was initiated. The overall objective of the study was characterizing the farming systems of the target agro-ecology, identifying and prioritizing constraints, and proposing relevant research, development and policy intervention options which help address the constraints and boost the production and productivity of agriculture sector.

During preparation stage, the region was characterized and stratified into five homogenous agro-ecologies: Warm arid lowland embracing six administrative zones (Sitti, Dawa, Jarar, Korahe, Dollo, and Nogob), Hot arid lowland embracing two zones (Shabelle and Afder), Warm moist lowland represented by Liban zone, Mixed agro-ecology represented by Fafan zone, Hot sub-moist lawlands, represented by Erer zone. The stratification exercise was made using scientific information supported with GIS tools and also taking into consideration of farming systems

practices and other parameters. Further sub-stratification was also made based on diversities within each of the agro-ecologies to help select sample zones for in-depth study. Accordingly, three zones (Dollo, Sitti and Jara) were selected for the study from Warm Arid Lowland agro-ecology while Shabelle zone from Hot Arid lowland, Liban from Warm Moist Lowland, Fafan from Mixed Agro-ecology and Erer from Hot sSub-moist lowlands agro-ecology. This means, a total of seven zones (accounting for about 63% of the region) were selected for in-depth farming systems characterization and analysis study.

However, even though the plan was to conduct the study in all the selected zones, resource limitation has made to implement in two phases: the first phase was piloted in Mixed agro-ecology which is represented by Fafan zone while the second phase study will be implemented in the other six zones in four agro-ecologies. The lessons learnt and good practices drawn from Mixed agro-ecology piloting study will be utilized to design the studies of second phase zones in a better way.

The first phase field based study was conducted in early 2023. Multidisciplinary study team comprising of 12 members was drawn from SORPARI and Jigjiga University. This team received intensive skill based trainings on methodologies, tools and techniques of conducting participatory farming systems research. EIAR/ENARESS supported the phase-I study both financially and technically by engaging experienced resource person who has been providing trainings and coaching the whole process of the study from beginning to end.

Fafan zone was in turn sub-stratified into three landscapes: Jigjiga plain, Upper Fafan and Upper Harawo, which are believed to represent diverse agro-ecologies within the zone. The study engaged mixed approaches including desk reviews and primary data collection. Qualitative research approaches, tools and

techniques were intensively employed in the study including: focus group discussions (FGDs), Key Informant Interviews (KII), proportional pilling, direct and pair-wise matrix rankings, T-table, historical analysis, seasonal calendars, observations and transect walk, and visual tools. The target groups of the study were women and men members of a community, Woreda Offices of Agriculture and Natural Resources Staff, Regional BOANR, NGOs and private enterprises. Three kebeles representing diverse features within the woreda were selected from each of the sample woredas. A total of 234 sample households participated in FGD of the study, out of which 25% (59) were women. In each of the kebeles, these households were split into five sub-groups for FGD: Crops, Livestock, NRM, Socio-Economics and Extension, and Gender sub-groups. Each sub-group consisted of 5 – 10 members of the community. A process observer (resource person) has been monitoring and coaching these groups in the field to help in application of relevant tools, provide immediate corrective measures for any gaps observed and make sure that all the group participants are active during FGD discussions. Following the field work, there was evening session of the study team to reflect the progress of the day, identify gaps and provide corrective measures, and revise plans for the next day. Report writing also started at field levels. The key findings have been briefly presented in subsequent paragraphs:

Socio-Economic Circumstances and Nutrition

Among the socio-economic factors, telecommunication services was expanding in the agro-ecologies. Out of the households who owned mobile phones, an estimate of 52% was owned by youths followed by men (about 47%) and women (about 7%). This is a positive feature which helps for designing future digital based interventions. Among labor sources, an estimate of 51% was family, 28% local labor sharing mechanism (*Guus*) and 15% hired labor. The wealth ranking indicates an estimate of 81% in the poor and very poor category, 14% medium and 5% better-off.

Among the income sources, an estimate of 86% is on-farm while 14% off-farm IGAs. Regarding inputs sources, in the range of 68 – 86% was purchases from markets while 14 – 32% was supplied through regional government. Out of road access, an estimate of 85% was seasonal earthen while only 7% asphalt and 8% gravel, which indicates the extent of difficulty to run development activities and inaccessibility of the community to markets. Because of this, they are selling their products at very low prices in village markets.

It was also observed that education service provision was inadequate in the agro-ecology. School attendance of both teachers and students was reported to be less regular, an indication of less monitoring systems and inadequate commitment to support the teaching-learning process from Woereda and Zonal Office of Education. The same holds true for human and animal health services where the community reported lack of the required medical facilities, and personnel. Agricultural Extension Service was also another socio-economic factor which suffered inadequate services for the community. Development Agents were not regularly available and less efficient in most of the kebeles. Because of this, the farmers' extent of awareness and adoption of improved agricultural technologies was still very limited.

Triangulation discussions with Woreda Offices of Agriculture figured out that budget shortages are the major reasons for the limited services at woreda and kebeles levels. They complained that almost no operational budget is allocated from Woreda Administration and the Region to run and provide various services for the community. The community has also reported limited supply of agricultural inputs such as improved varieties, fertilizers, agro-chemicals and farm machineries (tractors and combine harvesters). Establishment and strengthening the

Farmers' Cooperatives was suggested to be one of the options to address problems related to input access. Introduction, promotion and strengthening of digital extension services will be one of the solutions to address problems related to extension services. It is also suggested that the region should strengthen monitoring, evaluation and accountability mechanisms to identify problems early and provide corrective measures timely. The region should also strengthen motivation of development partners, such as NGOs, to support and contribute in various social services, such as education, health, transportation and other services. The regional government should also revise and allocate reasonable budget to help address the identified problems.

Assessment of food consumption preferences indicated that farmers have identified specific varieties of a crop both for consumption and sale. For instance, Cilmi Jama was the sorghum variety preferred for its taste features and cook-ability. Every variety of a crop is produced for some unique features, whether for consumption, marketing, drought tolerance, high-yielding ability, disease tolerance, or others. Knowledge of these features helps crop breeders to take into consideration of these attributes in their breeding programs. Analysis of gender work-burden using T-table also indicated that women worked 16 hours a day compared to 7 hours for men during peak farming seasons.

Natural Resources Management

Agro-ecologies of the study areas are endowed with vertisols, cambisols, luvisols, and leptisols. In upper Fafan zone, about 60% of the land was covered by luvisols, which are slightly fertile. On the other hand, about 50% of the Upper Harawa landscape covered by cambisols, which are moderately fertile while about 35% of was covered by calcaric leptisols, which are infertile. Vertisols, which are fertile soils cover only 18% in Upper Fafan zone while 15% in Upper Harawa. The findings indicate that

close to 80% of the land in Fafan zone is either moderately fertilize or infertile. Factors which contributed to loss of soil fertility included soil erosion, mono-cropping, crop residue removal, poor soil management, and domination of invasive plant species (Barkaakati (*Lantena Camera*), Tiin (*Cactus*)). This means, interventions destined to improve the fertility of the soil are highly required in the study areas and similar agro-ecologies in the region. Hill side terraces, soil bunds and sandbag check-dams were the only SWC measures practiced at community levels in the entire study areas.

Farmers grow diverse crops in these soils. However, soils in the hilly and mountainous agro-ecology (Upper Harawo) were eroded by erosion leaving the farmers at the fate of limited productivity and food insecurity. Farmers of this agro-ecology believed soil erosion is the major factor responsible for their poverty. According to FGD discussants, forest cover of the area used to be 75% in earlier days while currently it was drastically reduced to about 30% because of agricultural land expansion, illegal tree cutting, over grazing, charcoal and fuel wood production, and settlement of internally displaced people (IDPs).

On the aspect of land use, an estimate of 56% of the land was covered by crops in the study areas, while about 30% was covered by woody trees and shrubs while only 10% was left for grazing. The study has also identified about 36 species of trees and shrubs, out of which only nine of them were desirable to livestock feed. However, these tree species are on the challenge of deforestation. Deforestation rate was estimated to be 75% for Upper Fafan zone while 65% for Upper Harawa, which indicates that some strategy is urgently required to save these tree species from disappearance in the agro-ecologies, such as delineating closure areas, enforcing community and government laws on forest use, afforestation, reforestation and introducing improved forage management

practices. Regarding the rains, April–September was identified to be the wet season while the rest of the months are by and large dry.

In the study agro-ecologies, crop production is mainly dependent on rain-fed agriculture while access of the community to irrigation was very limited from seasonal rivers, making agriculture vulnerable to climate change and variability. Traditional irrigation farming is only being practiced in Upper Fafan valley areas. However, the area has ground water potentials at depths of 4 – 6 meters. Farmers required supports to exploit this potential. According to farmers' interview and field observation, soil erosion by water and wind, soil fertility depletion, salinity, rangeland degradation and water logging were identified to be the typical soil degradation problems affecting agricultural production and productivity. Nursery establishment, community-based soil and water conservation technologies and participatory afforestation programs were some of the options suggested to curb the identified problems.

Crop Production Practices

The study agro-ecologies are not only livestock dependent, but also grow diverse crops. Cereals account for 85% of production and 68% of area coverage. In the Upper Fafan agro-ecolgy, maize and sorghum were the major cereal crops grown by the farmers while wheat, barley, and oats were commonly grown cereals in Jigjiga Plain agro-ecology. Moreover, in Upper Harawa agro-ecology, pear millet is the third dominantly grown crop after maize and sorghum. The pulse crops are cash sources for the farmers mainly ground nuts and cowpea, but few farmers also produce haricot bean and chick pea. Farmers also grow diverse varieties under each crop, each of them with their own quality attributes. Some of the varieties are preferred for consumption while others for sale. Even though fruit production is very limited,

vegetables are commonly grown under irrigation, such as tomato, onion, cabbage, and Pepper (green and red). Water melon is also the commonly grown fruit crop.

Among the field crops, the regional government has introduced improved varieties of especially maize, sorghum and wheat. Among horticultural crops, the farmers started growing improved varieties of onion, tomato and watermelon. No improved variety was introduced for other crops. Even to those introduced, improved seed supply was not sustainable. This study was conducted in agro-ecology which is closer to the capital city of the region and most of the improved crop varieties were expected to be introduced, distributed and adopted. However, the reality indicates that many of the improved agricultural technologies were not introduced, promoted and disseminated in Fafan zone. This also implies that technology introduction and dissemination initiative could even be worse in other zones and agro-ecologies of Somali Region. Row planting was also another technology which was not being practiced in the study areas except for ground nuts. None of the farmers were also observed to practice improved crop protection mechanisms for controls of weeds, insects and crop diseases. Application of inorganic fertilizers, such as DAP, Urea or NPS was not also common in Somali Region. Only a few of the farmers applied while most of them depend on organic fertilizers, such as manure.

The most interesting trend observed in Somali region was increased use of agricultural mechanization. The trend of using tractors for land preparation was increasing over time at a service charge of Birr 1000 per hectare on average (Birr 800 – 1200). Combine harvesters were also used for threshing selected cereals (wheat, barely and oats) at a service charge of Birr 600 per quintal. One of the factors driving the farmers to depend on mechanization was recurrent drought which resulted to scarcity of livestock feed resources and consequent inability to feed oxen which are used for land preparation and threshing. The visible

trend happening is that big animals, such as oxen and camels, are finding difficulty of surviving in an environment frequently hit by drought. Because of this, the farmers are changing their farming practices from animals to machinery dependence. In addition to this, labor scarcity is driving the farmers from dependence on hired labor to machine labor especially for harvesting. The reason why row planting was not yet adopted was also associated with an issue of labor, the cost of which is becoming unaffordable (Birr 400 – 600 per day excluding lunch and associated meal services) over time. Because of these key factors, the farmers are realizing the need to depend on agricultural mechanization in Somali Region. The problem in this regard was, however, limited availability of the farm machines and unaffordability of service charges.

Consequent to limited introduction of improved varieties and associated agronomic packages, productivity of crops was very less in the study agro-ecologies. For instance, farmers' productivity per hectare was 24 quintals for wheat, which is lower by 20% than the national average of 30 quintals. In the same way, farmers produced 20 quintals of maize per hectare, which is less by 52% compared to the national average of 42 quintals per hectare. Farmers also produced 38% less yield of sorghum compared to the national average. Farmers' productivities will even be much lower than the potential yields of improved varieties. The findings imply that there is a lot to be done to narrow down the gaps between the farmers' current yield and the national average. Improved varieties along with their associated packages need to be introduced, promoted and disseminated to the farmers. Somali Region Seed Enterprise should also be strengthened to engage in seed production and meet the demands of the farming community.

The key problems farmers' prioritized in crop production were limited access to improved crop technologies, recurrent drought, pest damage and limited access to mechanization services. Recurrent drought, especially, is resulting to decline of area coverage under field crops dependent on rain fall. The study suggested introduction, adaptation and demonstration of improved drought tolerant crop varieties as one of the coping mechanisms to the problem. Establishment and strengthening of seed producer cooperatives could also help to address shortage of improved variety seeds. Introduction and demonstration of solar pumps could be the other option to help farmers adapt to drought related problems through expansion of irrigation-based agriculture.

Livestock Production Practices

The indigenous Somali cattle are mainly kept for the purposes of milk, meat and crop production. The common feature in the study regions was that most of the milk produced was used for sale while only some amount was consumed at home. In all agro-ecologies, goats followed by sheep are mainly kept as source of immediate cash income, in which people consider them as "First aid or emergency response" animals, for they are sold immediately at times of immediate cash needs. Apart from on-farm income sources, sheep and goat are also sources of milk in the study areas. Unlike dairy goat milk, however, sheep milk is confined only to home consumption. Camel milk is used both for sale and home consumption. Apart from transportation services, male camels are used as source of off-farm incomes by renting-out at a rate of Birr 1000 per day especially, to transport goods for off-farm activities.

Even though there is high potential for honeybee production in some areas, the community is not yet effectively practicing bee keeping due to certain constraints, including lack of modern beehive packages, different honey bee diseases and pests.

Furthermore, lack of skills and awareness was a big challenge for the farmers to utilize the potentials in bee keeping and diversify income sources. The yield and lactation length of cattle and camels also depends on feed availability (which is affected by drought occurrence) and their health conditions. Accordingly, farmers reported that camel yielded 5 – 10 liters of milk per day while cattle 2 – 4 liters. Breed improvement of cattle was very limited in the study Agro-ecologies, where only a few farmers practiced artificial insemination (AI) through supports of Jigjiga university.

In the study agro-ecologies, the major feed resources for livestock were natural pasture, green grass, maize, cactus, and crop residues (sorghum and maize Stover). In dry season, cactus, Lantana camera, conserved hay, bush encroachment ("*Haramaha, Waabey, and Xayramad*), wheat bran, and groundnut residues are used as feed resources. Since the majority of the area is shifting to field crops production, the use of crop residues as animal feed is becoming the major feed source, accounting for about 50% of the dry matter of the total diet.

The study has also identified a number of economically important infectious and parasitic livestock diseases which affected their productivity. Among the identified diseases of goats, CCPP (*Sambabka riyaha*) was the major one while sheep and goat pox, and Listeriosis were reported to be highly prevalent viral and bacterial diseases of small ruminants. Worm parasite "***Suus***" was the one and only common honey bee disease that was identified in Aadaale kebele of Gursum district. On the other hand, black leg, botulism, foot and mouth diseases (FMD) and lumpy skin diseases (LSD) were the most frequently occurring diseases affecting cattle in all livestock production systems of the study areas. Camels are relatively better tolerant to different diseases compared to cattle and shoat, except a few diseases, such as Pneumonia, Anthrax and Abscess.

Among the livestock technologies, it was almost only improved forage crops, such as Sudan grass, which were introduced and utilized with a few households in the study agro-ecologies. Farmers reasoned out lack of forage seeds, inadequate extension services, shortage of water, and lack of awareness as the factors responsible for limited adoption of improved forages. Inadequate focus paid by Woreda Office of Agriculture and regional government was also blamed for either none or very limited introduction of livestock technologies in the region.

The findings also indicated that livestock population has declined by an estimate of 40% since the last decade due to recurrent droughts, shortage of feed, animal diseases, a lack of vet services, the shrinking of range land which shifted into crop production, rangeland degradation, expansion of poisonous plants, and lack of government support. Destocking of animals due to the current drought and the sale of young livestock have contributed to decline of local livestock population. The species particularly affected were cattle and sheep, which are grazers and less tolerant to harsh environments. Among the solutions included digging out underground water and providing motor pumps to enable the community produce forages for their livestock. In addition, providing training and creating awareness about proper utilization of existing feed resources and conservation techniques is essential. Introducing, demonstrating, and cultivating improved forages and, cultivating sorghum and maize for purposes of animal feed can also help address feed shortage problems. To manage livestock diseases, field studies of veterinary vaccine effectiveness that are in use including controlled clinical evaluation of veterinary vaccines are highly needed to assess the performance of livestock vaccination programs. Cooperatives and unions should also be strengthened to produce and distribute forage seeds, and also supply the required inputs for livestock.

Conclusion and Ways Forward

Overall, the study has revealed a number of findings on the farming systems practices of the pastoral and agro-pastoral community. Even though the study was piloted in diverse agro-ecologies of Fafan zone, the findings could apply to all the similar agro-ecologies in Somali Region.

A lot of dynamism is taking place in the agro-ecologies including increased frequency of drought occurrence, decline of rangelands, increasing expansion of agricultural lands, and declining of livestock population. Apart from this introduction of some agricultural technologies is a new dynamism taking place in the farming systems, such as improved crop varieties, and increased use of agricultural mechanization. There are also challenges observed in the farming systems, such as inadequate introduction and distribution of agricultural technologies in both quantity and area coverage, limited use of agricultural inputs, such as fertilizers and agro-chemicals, inadequate availability of farm machineries, such as tractors and combine harvesters, unavailability of either animal drawn or tractor mounted row planters, and increased loss of crop diversity, such as long-maturing varieties. More than 80% the farming community is not yet using improved agricultural technologies. The other noticeable finding also includes limited socio-economic services including insufficient extension, education, health and transportation services, which were largely attributed to limited focus of Woreda Administration and regional governments in resource allocation, follow-up and accountability.

As a way-forward, we suggest the regional government and development partners operating in the region to focus their development strategies based on priority problems identified for agriculture sector. It is also essential to establish and strengthen strong commitment and accountability mechanism of the regional

government. Since all the problems identified cannot be addressed by regional government, integration and collaboration of other development partners is highly essential. To reinforce integration, it is suggested to establish agriculture sector stakeholder platform which embraces various Bureaus of regional government, NGOs, university, international organizations, private sectors, associations and unions. The platform members will jointly set plans and monitor implementation of projects, jointly evaluate achievements and, share experiences and good practices. It is also helpful to introduce motivation and reward mechanisms to those actors with exemplary performances to induce positive competition.

1. INTRODUCTION

According to Dixon *et al*. (2001), a farming system implies a population of farm households that broadly share similar agro-ecological and market access conditions, generally of mixed types and sizes, that as a group have broadly similar patterns of resources, livelihoods, consumption, constraints and opportunities, and for which similar bundles of development strategies and interventions would be appropriate. Farming system characterization is considered a powerful tool for natural and human resource management in least developed countries such as Ethiopia (Diao *et al.,* 2010). Moreover, farming system characterization is important to identify and analyze the intensity of agricultural diversification, production and other activities with great emphasis on major constraints in the existing farming system for further development and research interventions of the targeted areas (Dennis, *et al*., 2012).

The Somali Regional State (SRS) is endowed with huge livestock resources with an estimated total population of more than 40 million which is the highest owner of livestock population at national level (CSA, 2021). Livestock rearing or pastoralism is the dominant and indispensable livelihood practice followed by crop production. Crop production is also a growing sector in the region where most of the rural smallholder agro-pastoralists are involved in producing crops both for home consumption and cash income. Field crops, such as cereals, pulses and oil crops constitute the major part of crop production sector in the region.

According to central statistical agency (CSA, 2021), more than hundred thousand hectares of land was cultivated with different grain crops yielding close to two million quintals of grains. Moreover, the region has untapped natural resources, such as ample arable land, high potential ground water, major permanent

rivers (Wabi Shebele, Dawa, and Genale), several seasonal rivers, wide area of rangeland, different forest products (Gum, Incense, and Myrrh), and fertile soil, all of which could potentially contribute to agricultural development. In spite of these, the region has not yet harnessed its potentials leading to persistent food insecurity and poverty.

1.1 Rationale

The agricultural sector of SRS is not yet able produce adequate food for its population because of numerous biophysical, socio-economic, and technological challenges. To ensure food security and minimize poverty, these and other associated constraints need to be addressed with research and extension, developmental and policy interventions. It is indispensable to design technically sound, economically feasible and culturally acceptable research, extension and development strategies which help to address the constraints on sustainable basis.

The first step towards the design of the strategy developments is understanding farmers' production practices, constraints and opportunities, and their priority development needs through conducting farming systems research. However, there is no adequate information available in the region that enables to comprehend the different perspectives of the whole farming systems and design research and development strategies. Therefore, this study was conducted with the aim of characterizing the farming systems of the region, identifying and prioritizing constraints and opportunities, and proposing research, development and policy intervention options which help address the constraints and boost the production and productivity of agriculture sector.

1.2. Objectives

The overall objective of the study was to understand the prevailing agricultural production practices, identify overall constraints and propose recommendations. Specifically, the study addressed the following objectives:

- To explore the farming systems practices of the farmers including livestock and crop production, and natural resources management practices
- To assess farmers' access to improved agricultural technologies and their status of utilization
- To identify and prioritize major socioeconomic and biophysical production constraints
- To suggest research, extension, development, and policy intervention options that help address the prioritized constraints

CHAPTER 2
THE STUDY APPROACHES AND METHODOLOGY

2.1 Site Selection and Clustering of SRS

Somali Regional State is heterogeneous in its farming systems practices and agro-ecological diversity. This implies that the same technology may not work good for all the agro-ecologies and farming systems. Because of this, the whole region was stratified into homogenous clusters. Primarily, the entire region was stratified into five major Agroecological zones (AEZs) or Farming Systems (FS) units by considering the natural, ecological and socio-economic characteristics (Figure 1). These included:

1. Hot arid lowland,
2. warm arid lowland,
3. warm moist lowland,
4. Hot sub-moist lowland,
5. Mixed agroecology (Tepid to cool moist plains and Tepid to cool moist plateaus)

Secondly, all of the 11 administrative zones of SRS were aligned to each of the identified AEZs (Table 1). Accordingly, six administrative zones (Sitti, Dawa, Jarar, Korahey, Dollo and Nogob) are geographically located under Warm Arid Lowland agro-ecology while the two zones (Shabele and Afder) fall under Hot Arid Lowland agro-ecology. Liban zone is located in Warm Moist Lowland agro-ecology while Fafan and Erer zones are located in Mixed and Hot Sub-most lowlands agro-ecology,

respectively. Farming systems and agro-ecology based stratification of SRS into homogenous units helped to easily make zonal sampling for in-depth farming systems analysis, as a result of which the overall seven sample zones were selected for further farming systems study.

Thirdly, the woredas located within zones were stratified into homogenous units to help identify and select sample woredas for detail farming systems studies. Overall, 12 sample woredas were selected for farming systems study of SRS. To catch up variability within woredas, three kebeles were sampled from each of the selected woredas. These sample kebeles have been drawn from different ecological and socio-economic features within the selected woredas. Overall, a total of 36 sample kebeles were drawn from all the sampled woredas in SRS. However, due to resource limitation (both technical and financial), all the selected woredas and kebeles in SRS were not studied at once, but in two phases: In the first phase, one of the zones and a couple of sample woredas were selected to be studied as a pilot with the limited budget available. Piloting helped not only to collect data but also to gain technical competence of the study team and build their skills further. The experiences and lessons obtained from the pilot phase will also clear the ground for survey of the other six zones in the second phase when the required financial resources are secured.

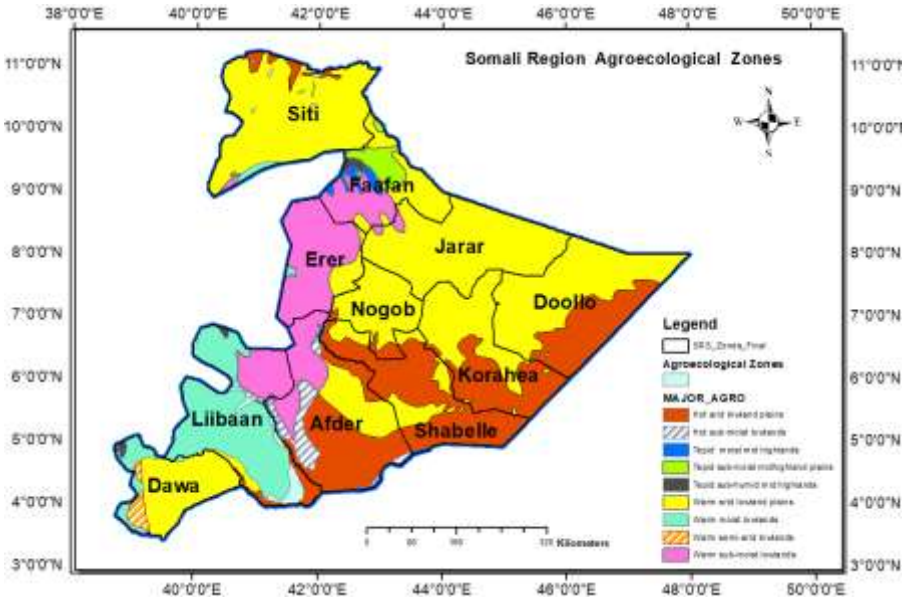


Figure 1. Agro-ecological zones of Somali Region

Piloting the Farming Systems Survey

The pilot survey was made in Fafan zone of Somali Region, for this zone contains some elements of almost all the agro-ecological zones and it was believed to be a good representative of the region. Out of the 11 woredas in Fafan zone, two of them (Gursum and Awbare) were selected for detailed study. From each of these woredas, three sample kebeles representing diverse agro-ecology and farming systems features of the woredas were selected for data collection, making a total of six study kebeles.

The piloting exercise had two main purposes: the first was building the technical capacity and skills of the survey team drawn from SORPARI and Jigjiga University. The team received in-depth training on application of participatory rural appraisal (PRA) tools and techniques. Piloting helped the team to exercise in the field and learn more on practical application of

participatory tools and techniques. The team members have gone through all the processes required to collect quality data from preparation stage to final report submission. It is believed that the team has adequately built the skills required to run similar studies in the region and beyond. The second purpose was to collect quality data and generate standard report containing a bundle of information which can be used for designing subsequent research, extension, and development strategies. The information generated can have crucial importance in that it can be extrapolated and used to similar agro-ecologies and farming systems practices in Somali Region.

Clustering of the Pilot Study Areas

Taking into consideration of farming systems diversity, soil types and ecological features, six of the selected kebeles were further stratified into three homogenous clusters. The first cluster was tepid to cool moist plain mainly characterized by plain topography, crop dominated farming systems, black vertisols, and receives relatively better rainfall. Jare and Kabrinune kebeles from Awbare woreda were included in this cluster. The second cluster was Tepid to cool sub-moist plateau mainly characterized by rugged topography, irrigation-based agriculture in part of the cluster, high crop diversity including cash crops, and shallow ground water potentials. All the three kebeles in Gursum woreda belong to this cluster, and it is presented throughout this report as Upper Fafan. The third cluster, also presented as 'Upper Harawa' in this report, was unique in that it is characterized by mountainous and undulating topography, rock surface with shallow soil depth, and livestock dominated farming systems. This cluster is uniquely prone to soil erosion, which is reported to be the cause in exacerbating poverty of the farming community.

Table 1. Clustering the study areas based on agroecology and landscape homogeneity, 2023.

Agroecology	**landscape**	**Study woredas and Kebeles)**	**Descriptive features**
Tepid to cool moist plains (Flat topography with better rainfall distribution)	Jigjiga plain	Awbarre (Jare and Kabrinune)	▪ Higher altitude and rainfall ▪ High Rainfall amount ▪ Flat feature plains ▪ Black soil (vertosols) ▪ Crop dominated farming system
Tepid to cool sub-moist plateaus and mountains (diversified crop dominated farming systems with cash crops and irrigation access)	Upper Fafan	Gursum (Gorey, Adado, and Kubijarre)	▪ Mountainous and valleys relief topography ▪ Higher altitude and rainfall ▪ Both irrigated and rainfed agriculture ▪ Crop dominated mixed farming system ▪ Shallow ground water potential areas ▪ Investment area ▪ High crop diversity including cash crops
Warm arid lowlands (Mountainous and hilly topography with severe flood erosion)	Upper Harawa	Awbarre (Hilingab)	▪ Low altitude ▪ low rainfall ▪ Rainfed agriculture ▪ Undulating topography ▪ Rock surface with shallow soil depth ▪ Low organic matter soil ▪ Livestock dominated mixed farming system

2.2. The Study Approaches and Methods

The required data and information was collected by employing blends of tools and techniques, mainly in two stages: The first stage was intensive desk review of published and unpublished materials from earlier studies which illustrate information related to the farming systems of the region. Some of these materials included journal articles, scientific books, annual & progress reports, CSA reports, and reports of Woreda Offices and Regional Bureaus. The materials were drawn from a number of sources including Agricultural Research Institutes, University, Bureau of Agriculture, Zonal and Woreda Offices of Agriculture, and Meteorological stations. This stage was helpful to develop data collection tools for use during primary data collection stages.

The second stage of the study was qualitative approach of data collection which largely employed Participatory rural appraisal (PRA) tools. The most common PRA tools applied were focus group discussions (FGDs), key informant interviews (KII), proportional pilling, transect walk and participant observation, direct matrix and pair-wise raking, preference raking, T-table, and resource mapping to collect primary data from different target groups**.**

Focus Group Discussions (FGDs)

Focus group discussions (FGDs) were held in each of the selected kebeles, dividing the sample population into crops, livestock, natural resources management, socioeconomic and gender sub-groups. Each group comprised of 5 – 10 community representatives selected based on diverse age groups (elders, adults, and youth) and gender mix (men and women) (Figure 2).

In general, a total of 234 community members participated in FGD in all the study kebeles (Figure 3). In addition to FGDs, seasonal calendars, transect walk, pair-wise and direct matrix rankings, historical analysis, proportional pilling techniques, and visual portraying tools were employed to collect the required information.

Figure 2. Pictures illustrating FGDs made with the farming community and application of participatory tools 2023.

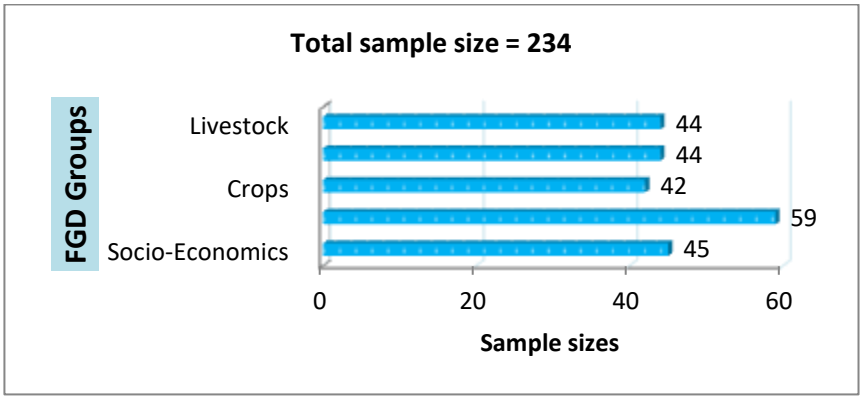


Figure 3. Sample sizes of FGD group participants in the study kebeles, 2023.

Key-informant interviews (KII)

The study also employed key-informant interview (KII) approach especially with Heads or representatives of various Departments in Gursum and Awbare woredas (Figure 4). The same approach was used with Kebele administration and farmer representatives, agricultural experts and developmental agents, NGOs focal persons, elders, and religious preachers. KII approach helped to triangulate the findings from FGDs and also to collect additional information related key issues, such as input distribution mechanisms, resource availability, man-power allocation, woreda level agricultural constraints, infrastructural issues and development plans.

Figure 4. KIIs made with Agricultural Officers in Awbare and Gurusm Woredas, 2023.

Field observation and Transect Walk

Field observation was also made as supplementary technique to collect information about the landscape, soils, observable farming problems, land degradation, vegetation cover and other farming systems features. Topographic transect walk was made with community members across the slope to perceive farming systems practices and discuss the constraints and opportunities in crop, livestock, and natural resources including soil, water resources, land use, and vegetation. Pictures of farming systems features

were also captured along the way, some of which have been illustrated in Figure 5. Interactive discussions were held with community representatives during transect walk and samples of soil, plant diseases and pests, and livestock diseases were also collected for further inspection and analysis.

Figure 5. Farming systems features captured during transect walk in the study agro-ecologies, 2023.

2.3. Information Synthesis and Report Write-Up

The data collected from various sources was synthesized using appropriate methods of techniques to summarize information. Synthesizing information started at field levels during evening sessions on daily basis with the team to discuss the progress of the

day, the key findings and plans of the next day. Information was summarized using tables, graphs, and narrations.

The report was structured in chapters, sections and sub-sections according to pre-determined report framework. The first chapter deals with introduction while the second on methodological approaches and techniques. The third chapter was devoted to presenting the study findings of Socio-Economics group while the fourth chapter contains the findings from NRM. The fifth chapter deals with the findings of crops groups while the sixth chapter presents about livestock production practices in the region. Chapter seven provides conclusion and ways forward while chapter eight references.

CHAPTER 3
SOCIO-ECONOMIC CIRCUMSTANCES

Socioeconomic circumstances refer to a wide range of interrelated and diverse aspects and variables involving a combination of social and economic factors. Generally, it embraces several dimensions including infrastructure and basic social services, land ownership status, labor sources and mechanization, agricultural extension services, wealth indicators and wealth ranking, introduction to agricultural technologies, access to markets and marketing products, income generating activities, gender roles in agriculture and decision-making at the household levels. Desirable social and economic factors strengthen agriculture sector production and productivity on a long-term basis.

As a result, the following sections present the current state of some of the major social and economic factors in the study areas. The characterization and description of these factors would help in designing the strategy of appropriate research directions and other intervention options for enhancing the development of agriculture sector in the region, in general, and in the Fafan Zone, in particular.

3.1 Infrastructure and Basic Social Services

3.1.1. Education

The local farmers from the upper Fafan and upper Harawo complained about the limited quality and inadequate attention given to education. The schools didn't have enough teachers, and the majority of them are working in agriculture instead of reporting to work. Consequently, the pupils do not regularly attend classes and they are also engaged in farming activities. Because of this, pastoralists in the study areas have not kept up with modern schooling. Particularly among women and girls, low literacy rates have a negative impact on development making it more difficult to receive and analyze information and limit prospects for growth. FGD discussants indicated that the meager status of education is not only the feature of their kebeles, but also of other kebeles in the region. This has led to limited literacy level of rural households, which in turn has negative effects on adoption of improved technologies and practices, and overall livelihoods. It was also recognized that Bureau of Education did not make adequate follow-up and monitoring of school attendance of not only students but also the teachers. Especially, the irregular attendance of teachers has serious implication on the overall access and quality of education in the region.

3.1.2 Health Services

The study areas (the upper Fafan and upper Harawa) reported scanty medical services and lack of quality drugs. FGDs with the community revealed that the agro-pastoral and pastoralist way of life was largely characterized by seasonality and vulnerability, shortage of skilled manpower, inadequate medical services,

absence of modern medical equipment, and lack of ambulance services, motorbikes, and other transportation services. The farmers have also reported the dearth of medical facilities, including clinics and outposts, and the high cost of drugs.

3.1.3. Access to Vehicle Transportation and Water Supply

In the study areas, there is no safe water supply which affected the livelihood of the community. Unavailability of dams and wells which farmers can use has worsened the situation. People used surface water which is far away from their village. Water, in general, is a scarce resource in most part of the study areas although the extent differs from one location to another, and from season to season. Water scarcity is severe not only to human consumption and safety, but also for livestock drinking and irrigation.

The study has also identified inadequate access of the rural community to all-weather roads which connect their villages to towns. Because of this, access to public transport became limited, conditional and high cost. The community has to make walking to near-by towns for about 1 – 3 hours one-way. Especially, the livestock markets are located far away for most of the community members because of inaccessibility of their villages to transport services. Since traders are not coming to their villages, they are compelled to sale their produces at lowest price in the village markets where there are no competing traders. This limited market participation of the rural community and engagements in off-farm income generating activities. It also made the situation worse for timely delivery of inputs and social services, such as health, extension and education. Unless the regional and federal governments made investments on rural transportation, it is going to continue being one of the biggest development challenges. It

will also restrict effectiveness of other development interventions and attraction of private investors.

3.1.4 Access to Telecommunication Services

The government has made massive investments on installing and expanding mobile phone networks across the country including Somali Region. Because of this, the community was observed to have access to mobile phones. According to community estimates through proportional pilling tools, about 42% of men had access to mobile phones (Figure 6). It was, however, observed that access of women to mobile phones was very less, with only about 7% of them having access to mobile phones at the time of this study (March 2023). Youth, instead, had better access to mobile phones compared to their parents. The findings indicate the existence of high gender disparity among the rural community in access to mobile phones, with youths having better access followed by men (fathers) and women (mothers). Economic reasons are limiting factors to most of the community members for not yet having access to mobile phones to afford the handset and airtime.

The expansion of mobile networks and access of the community to mobile phones is a great opportunity for the Bureau of Agriculture and NGOs to introduce digital technologies, such as digital extension services. This technology ensures broadcasting of quality extension messages mainly through local and regional FM radio stations.

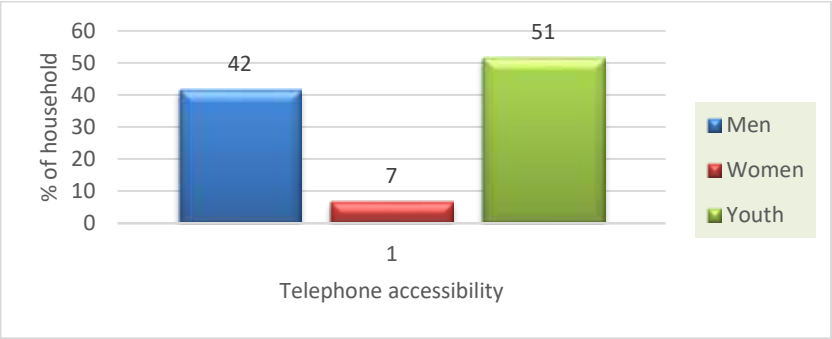


Figure 6. Access of households to mobile phones, 2023.
Source: FGD estimation through proportional pilling

3.2. Land Ownership Status

In the context of Somali Region, agricultural land is commonly obtained through inheritance from their parents although it is often managed by the community or clan/sub-clan leaders. In some locations, land ownership is limited to river banks where there is access to irrigation. The size of land ownership largely depends on the capacity of a household to cultivate the land, where better-off households owned large area of land while resource poor owned limited land. According to the findings, average size of land holding in the upper Fafan woreda was reported to be two hectares per household while in upper Harawo woreda, it was in the range of 2 – 10 hectares depending on the size of family. On the other hand, grazing/range lands are communal even though herd migration during drought period compels households to move their animals far away from their communal land. Even though not as such common, other mechanisms of acquiring land included renting-in, contractual arrangement and gifts. In some of the locations, there are also landless households, but their relatives/households with adequate land provide land gifts to help them cultivate by their own.

According to the gender perspectives in land management and control, men dominated in productive farming activities, such as land plowing and cultivation, harvesting and threshing. On the other hand, women's roles were limited to reproductive domestic activities, such as child care, constructing and managing the house, cooking and similar other household chores. It was also recognized that female of the region are still victims of harmful traditional practices, such FGM, limited access to and control over resources and benefits, such as land, mobile phones and other farm assets of the household.

Even though there seems to be extensive land in the region, land resources are getting scarcer over time in response to population growth and increased shifting of households from pastoralism way of life to agro-pastoralism and sedentary life. Land scarcity is especially eminent in uppder Harawo woredas which are characterized by mountainous topography, and shallow and infertile soils mainly caused by flood erosion. Available farmlands are already degraded by severe soil erosion which originates from the hills and runs through farm fields. Unless erosion control and preventive measures are massively taken with immediate effects, cultivable farmlands are turning into degraded and barren lands in the upper Harawo woredas, further exacerbating land scarcity and poverty. The flat topographies of the study areas are characterized by relatively flat topography with fertile loam soils. Land scarcity is not a major issue in these areas and landless households are rarely found.

3.3 Labour Resources and Mechanization

The most interesting trend the study has identified in the study areas was replacement of human and oxen labor with machine labor. The use of tractors and combine harvesters is increasingly becoming common in the study woredas. However, machine use was limited to households who can afford the services.

Households with less income depend on human and oxen labor. This means, human labor resource is still very essential for most of the farming households. These households also plow their land using oxen and camels.

Family is the major source of labor for most of the farming households (an estimated 56%) in Upper Fafan woredas while this proportion is an estimate of 46% in Upper Harawo woredas (Figure 7). Family labor was required for plowing the land, weeding and harvesting. The second essential source of labor is local labor sharing arrangement, commonly known as *Guus*. Neighbors team-up and work together on one's farms in turns. An estimated 24% of the Upper Fafan households depend on *Guus* while this proportion is an estimate of 32% for the households of Upper Harawo woredas. The third source was hired labor despite it is not common. It was noted that an estimated 12% of the households in Upper Fafan and 18% in Upper Harawo woreda experienced hiring of labor during peak agricultural seasons, such as planting and harvesting. In such cases, most of the laborers come from neighboring regions while some of them from the locality. High cost of labor is a major issue, where they spend as high as Birr 600 per day excluding foods, drinks and chatt.

It is a favorable opportunity that most of the households are aware of the use of tractors for plowing and combine harvesters for harvesting and threshing. Service charge of tractors for plowing was Birr 1000 per hectare while combine harvesters Birr 600 per quintal of grain threshed. The limiting factor for most of the households was, however, financial constraints to pay for the services. Once economic capacity is improved, it is evident that most of the households will be ready to use tractors and combine harvesters. The other problem limiting the use of mechanization was limited availability especially during peak agricultural seasons, such as planting and harvesting. Even the farmers who can afford described that tractors and combine harvesters are not

adequately available during peak agricultural seasons. Because of this, some of the woredas access tractors from neighboring regions even though the cost of service is relatively high (Birr 1200 per hectare).

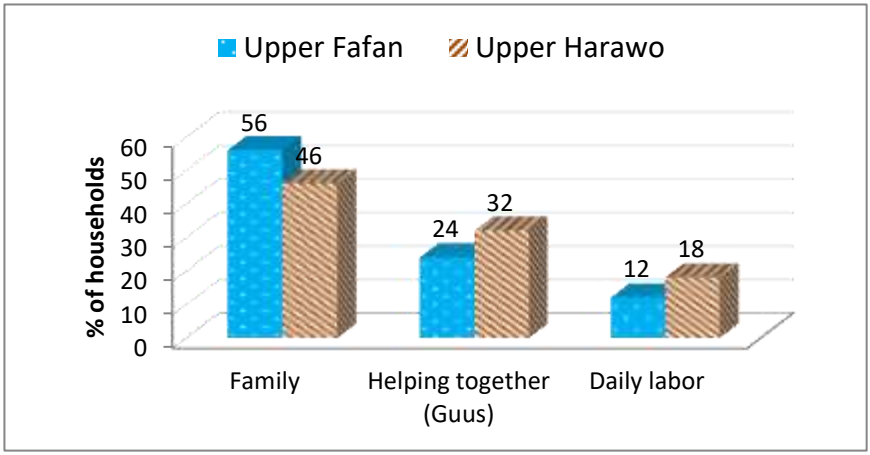


Figure 7. Farmers' labor sources, 2023.
Source: FGD estimation through proportional pilling

3.4 Wealth Indicators and Wealth Ranking

3.4.1 Wealth indicators

Assessment and definition of the community's wealth status is a necessary and prerequisite approach for developing affordable and adoptable agricultural technologies based on their economic status. Wealth ranking is one of the PRA tools and techniques that is efficient in identifying wealth indicators based on community perception. As indicated in Table 2, the most important wealth indicators, according to community perceptions, are livestock

ownership, owning/providing tractor rental services, and size of cultivated farmlands.

Among the livestock, camel and cattle ownership are generally accepted indicators of wealth in the community where a household owning more than 20 camels, 20 – 30 cattle and 30 – 50 sheep is perceived to be rich/better-off. Better-off households also owned more than five hectares of land. Some of the rich households even owned tractors not only to cultivate their own farmlands, but also to provide rental services for the community. However, this does not mean all the rich/better-off households own tractors, but only a few of them. The poor category is characterized by limited land ownership (a hectare or less) and limited livestock ownership (about five or less cows). They rent-in additional land to produce adequate for their families.

3.4.2 Wealth Category

According to farmers' estimate through proportional pilling tool, better-off (rich) farmers are a few in number among the community (an estimate of only 6% for Upper Fafan and 4% for Upper Harawo woredas) (Figure 8). Instead, the poor and very poor categories of the community were estimated to be about 80% in both the study areas. The findings clearly indicate that most of the households in the study areas were in a resource poor category of livelihoods. This implies that the community requires a lot of development supports not only by the regional government but also by non-governmental and private development partners.

Table 2. Wealth ranking according to the community perception

Ranking	Key wealth indicators	
	livestock	**Land**
Better- off (Rich)	20-30 cows	>5 ha of land
	5 oxen	
	> 20 camels	
	>50 sheep and goats	
Medium	10 cows	3 ha of land
	15 sheep	
	One camel	
	One ox	
Poor	5 cows	0.5-1ha of land
		Rent-in additional land for cultivation
Very poor (The poorest of the poor)	One cow	0.3 ha of land
		Gets some temporary land for cultivation from relatives

Source: FGD, 2023

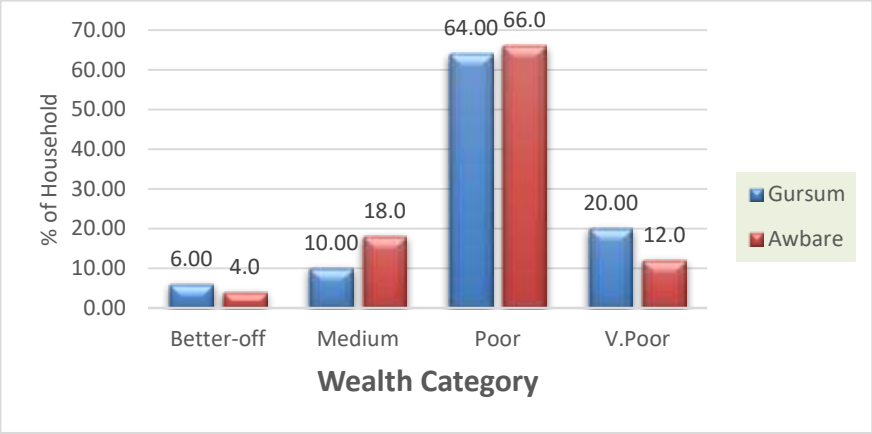


Figure 8. Estimates of farmers' wealth category, 2023.
Source: FGD proportional pilling tool

3.5 Income Generating Activities

Agro-pastoralists in the study area derive their livelihoods mainly from crop production and livestock keeping. They also generate supplementary incomes from off-farm activities. However,

alternative livelihood options for agro-pastoral households in the rural areas are very limited, the result of which is financial scarcity imposing severe stress on their livelihoods. In the study areas, an estimate of only 14% of the households were engaged in off-farm income generating activities to supplement their on-farm incomes (Figure 9). During FGD, it was noted that most of the households depend mainly on agriculture for their source of food and on-farm incomes.

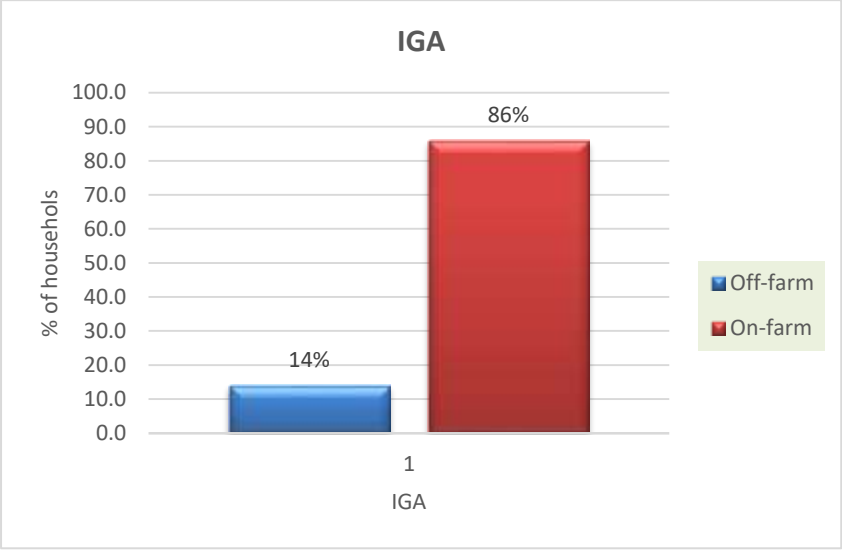


Figure 9. Farmers' income sources in the study areas, 2023.
Source: FGD proportional pilling estimates

3.6 Overview of Gender Dimensions in the Farming Systems

3.6.1 Land resource management

FGD was held with a separate group of women (both married and female household heads) to learn their experiences in access to

and control over land resources. In male-headed households (MHH), an estimate of 80% of the sample women in Upper Harawo and 70% in Upper Fafan indicated that land resource was mainly controlled by men while in female headed households (FHH), it was by women (Figure 10). This is a similar practice to most parts of the country where men dominated access to and control over major assets of a household.

In the case of MHH, land is registered under the name of a man, but for widows under the name of a woman. This is contrary to some other parts of the country, where land registration is made under the name of both a husband and wife in married households. However, married women of the study areas did not express objection over registration of land under the name of the man for the reason associated with culture in their locality. In addition to this, men make a decision on the use of external inputs on the land, such as fertilizers and agro-chemicals.

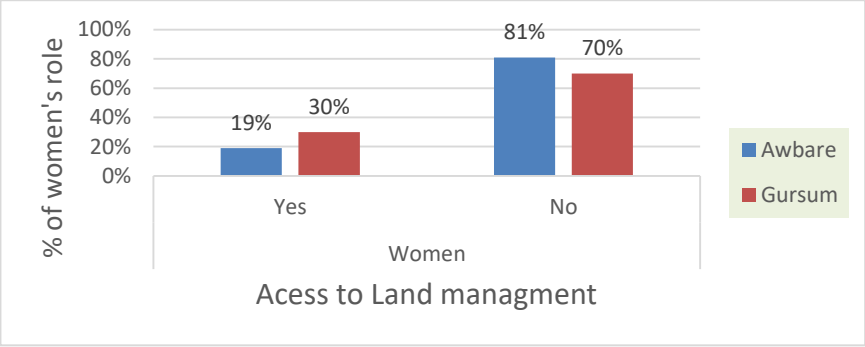


Figure 10.Women's access to and control over land resource, 2023.
Source: Women FGD proportional pilling tool

3.6.2 Household water fetching

According to an estimated 76% of women's FGD discussants, domestic activities, such as water fetching, are the major

responsibilities of women being supported by girls. The involvement of men in water fetching was rare (an estimate of 8%) (Figure 11). In earlier days, youths used to get involved in domestic activities to support women. However, this trend is changing now in response to expansion of education and urbanization. Youth often goes to school or near-by towns, often without nothing to do. In now a days, introduction and expansion of mobile phone is also becoming a hiding device for youths where they play games and browse something instead of supporting their parents. This all trend left women over-burdened.

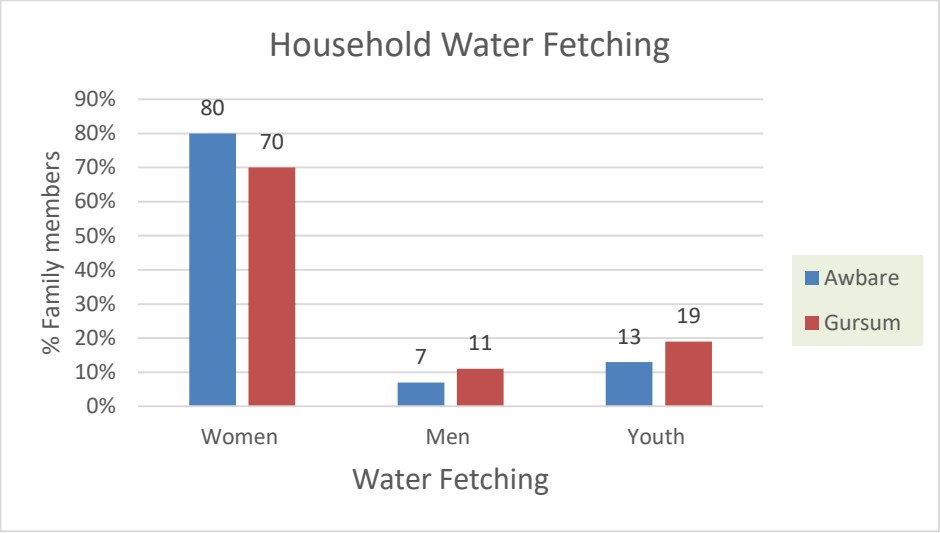


Figure 11. Gender roles in household chores, 2023.
Source: - Women's FGD proportional pilling tool

3.6.3 Involvement Family Members in Farming and Marketing

Table 3 reveals the roles of family members in various farming and household operations. The findings demonstrated that women bear the majority of duties in managing the house and the

children. Women are nearly entirely responsible for chores related to reproduction, such as fuel wood collection, fetching water, food preparation and processing, and taking care of children. Firewood is being collected ranging from once every two days to once a week. Women's lack of access to improved fuel saving stoves, along with their reliance on firewood for cooking, exacerbated the issue of firewood scarcity and increased a burden on women. Somali women also work hard and productively, earning supplemental incomes for their family through engagements in marketing. The majority of women respondents stated that they travel to adjacent towns for marketing purposes. They visit larger markets less frequently than smaller ones closer to their homes. The average distance a woman needs to get to her favorite market is in the range of 2.5 - 11 kilometers. The frequency of their trips to the market typically relies on whether or not a woman is engaged in trading activities. It ranges from once every two days to once a week or a month, the majority experiencing once a week or once every two weeks. They trade cereals, chatt and cattle.

3.6.4 Participation of the Somali Women in Household Decision Making

One of the areas where there is a glaring gender inequality is decision-making at the household level. The survey results show that the participation of women in the overall decision-making processes at the household level is very low. However, a closer look at the specific types of decisions indicates that women's pattern of participation is variable depending on the type of decisions to be made.

Table 3. Family members on farming and household works (% of households)

Activity	Gursum			Awbare		
	Men	Women	Youth	Men	Women	Youth
Land Cultivation	95	3	2	95	3	2
Animal Husbandry	20	50	30	10	60	30
Home Gardening	8	82	10	2	88	10
Selling byproduct	1	79	20	1	89	10
Purchasing home Supplies	2	90	8	2	90	8
Income Generating Activities	49	50	1	49	50	1
Food Preparation	2	70	28	2	70	28
Firewood Collection	14	80	6	14	80	6
Fetching Water	7	70	23	2	70	28
Washing Clothes	1	59	40	1	79	20

Source: FGD proportional pilling tool

Table 4, illustrates those women who have a lot of say in food and clothing decisions; areas with little economic value, but cropping schedule and family expenditure decisions are mostly made by their spouses. In addition, limited agricultural knowledge of women in the area appears to be based on the belief that women cannot cultivate with heavy traditional farm implements. The findings indicate that about 80% of the land, camel and cattle and their income from sales is controlled by men while women have a say in what to do with cattle. However, traditionally deciding on camel and land is not the concern of women. This is because, an estimated 80% of the women said that they are okay with men's decision on major resources of the family as far as they do not interfere with the controls of sheep (almost fully controlled by women) and goats (controlled by about 80% of women). According to the views of close to 90% of women FGD discussants, issues of cropping calendar, when and what to plant are the responsibilities of men. Interestingly, women are the ones responsible in purchasing the seed from the market and storing it at home. According of an estimate of 60% of women FGD

discussants, men take the major role of controlling household incomes.

These practices are common to most parts of the country where in married households men take the lead in controlling major household resources while women are restricted to less valuable resources. However, lots of improvements are in progress in other parts of the country where both the husband and wife commonly control resources and benefits in consultation. However, such improvements are not yet observed in Somali region.

Table 4. Women's role in decision-making at household Level, 2023

TYPE OF DECISION	Upper Fafan				Upper Harawo			
	Women		Men		Women		Men	
	n	%	n	%	n	%	n	%
Family expenditure	55	55	45	45	75	75	25	25
Participation in income generating activities	75	75	25	25	55	55	45	45
Control of land, camel and cattle and their income	15	15	85	85	15	15	85	85
Control of household incomes and household level decision making	40	40	60	60	40	40	60	60
Decision to buy and sell goats and sheep	82	82	18	18	90	90	10	10
Type of meal to be cooked	100	100	0	0	70	70	30	30
Decisions on cropping calendar and what to plant (agricultural production)	13	13	87	87	13	13	87	87.00

Source: FGD proportional pilling tool

3.7 Agricultural Extension Services

To improve the production and productivity of agriculture, the farming community is supposed to be supported with improved agricultural technologies through provision of extension services. It was, however, observed that there was a high shortage of

development agents (DAs) in all the study areas. There were also locations where we did not find DAs on duty. As seen in Table 5, there were 16 DAs in Upper Fafan while 15 in Upper Harawo woredas. During FGD, the farmers reported that the DAs of the kebeles are not devoting their time fully for extension work and visit their farm fields rarely. It was realized that this was a common phenomenon in both of the study woredas and there was also high dissatisfaction from the farmers on extension service provision.

During key informant interviews with Woreda Agriculture Officers, they also reinstated that the DAs are not available in their work stations because of lack of motivations, such as inadequate salary to support their lives, either limited or unavailability of education and short-term training opportunities, and lack of operational budget for extension services. Since the woredas cannot provide adequate resources which DAs require to provide extension services for the farmers, monitoring and supervision is either very limited or inexistent. Even about half of the FTCs in the woredas are not functioning as envisaged. According to the findings, extension service delivery in the study woredas, which might also be the same in most parts of Somali region, was realized to be at stake. DAs were often unavailable on their duty, and if available they are not efficient for lack of resources, such as budget and transportation services, and limited or no motivation.

3.8 Agricultural Inputs Utilization Status

In the study woredas, the use of external inputs was not extensively practiced mainly due to limited availability and unaffordability. The farmers described that only scarce amount of key inputs (especially improved varieties and inorganic fertilizers) are supplied only catering for a few farmers. Because of this, most of the farmers in the Upper Fafan and Upper Harawo

woredas are not beneficiaries of these inputs. Key informant interviews with Woreda Agriculture Staffs indicated that the regional government and woreda administration were not allocating adequate budget for the purchase of improved varieties and fertilizers.

Table 5. Number of Development Agents (DAs) and FTCs in the study areas, 2023

Woredas	Number of DAs	No. FTC	
		Functioning	Non-functioning
Upper Fafan	16	5	5
Upper Harawo	15	2	1
Total	31	7	6

Source: Woreda Agriculture Office

Out of the total cost of improved varieties and fertilizer, the farmers are supposed to cover 25% of it while the remaining 75% was a subsidy by the regional government. With this commitment of subsidy, the regional government and woreda administration were not able to allocate adequate budget every year. Consequently, adoption status of improved varieties and fertilizers was observed to be very limited in the study woredas. Without the use of these inputs, it is obviously clear that the farmers' production and productivity will remain very limited, further exacerbating food insecurity and poverty. The option of supplying these inputs on cash basis for those who can afford should be considered to improve adoption of technologies. Sustainable approach will be supplying the required inputs in adequate quantity on cash basis to all the farmers instead of subsidy.

While improved varieties and fertilizers are supplied through Woreda Agriculture Office, the farmers obtain pesticides from the market. According to an estimate of 86% of the farmers from Upper Fafan and 78% from Upper Harawo, they purchased pesticides from the near-by towns (Figure 12). It was also

reported that an estimated 84% of the farmers from Upper Harawo and 80% from Upper Fafen woredas purchased the seeds from the local markets, despite they do not know whether it was improved or local variety.

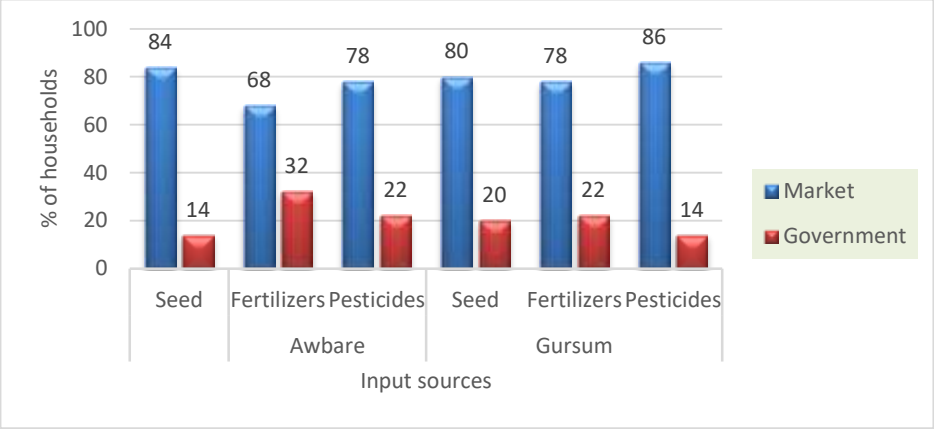


Figure 12. Agricultural input sources to the farmers of the study areas, 2023.
Source: FGD (proportional pilling tool)

3.9 Marketing and Market Access

3.9.1 Marketing Practices

As indicated in Figure 13 from the survey results of the (SRS PEBD, 2022), there are 11 market places in Fafan zone, most of which are livestock markets. However, the agro-pastoralist community of both the upper Fafan and upper Harawo woredas mentioned that they have limited access to markets due to rough and inconvenient vehicle road conditions and consequent high cost of the transportation services. The upper Fafan community produces nuts and Beans as cash crops whereas, the upper Harawo produce wheat as a cash crop followed by livestock rearing especially cattle, goat, and sheep. In Upper Harawo, the farmers lack market access due to seasonal roads, because of

which they sell their products at low prices in the village markets. The community complained about the price instability of agricultural commodities over time because of limited or no competition among traders which are not coming to village markets because of either unavailable or seasonal road access.

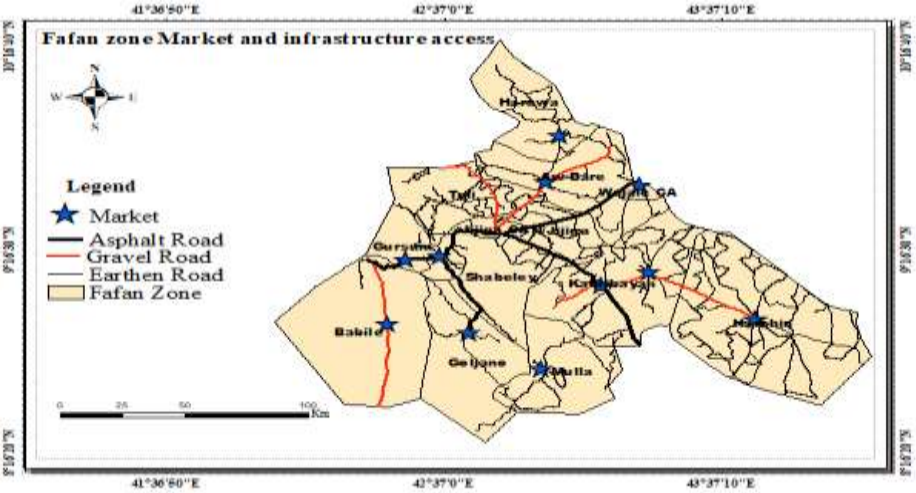


Figure 13. Fafan zone access to market and infrastructure
Source: SRS PEBD (2022)

3.9.2 Market access

The closeness of the market and extension centers enables the smallholders to have access to information and technology. As presented in Table 6, 84% of the roads in Fafan zone are earthen while asphalt road accounts for only 7%. This indicates that woredas have limited access to markets since most farmers live in rural villages far away from the markets with bad road access. Upper Fafan woreda has relatively better market access than Upper Harawo as there is the highway asphalt road from Jigjiga to Harar city crossing through the woreda enabling the farmers to easily access markets. But still, most of the rural kebeles were

connected through rough seasonal roads which are not accessible to public transportation.

Table 6. Infrastructure coverage of Fafan Zone, 2023.

S/n	Roads	Length(km)	Percent
1	Asphalt	279.59	7
2	Grave	334.46	9
3	Earthen	3333.06	84
Total		3947.11	100

3.10 Major socio-economic constraints

According to pair-wise matrix results illustrated in Table 7, the top three socio-economic constraints identified were water shortages, limited access to agricultural inputs and either limited or no access to extension services. Inadequate educational service was also another factor prioritized by the farmers. It is believed that unless these socio-economic problems are addressed, it will hardly be possible to address other problems sustainability and efficiently. In the short run, Woreda Administration and Regional government should provide priority focus to construct all-weather roads connecting rural kebeles with woreda towns. Next to this, attention should be paid to reinforce collaboration with development partners and NGOs to provide focus and supports in strengthening education, health and extension services.

Table 7. Pair wise ranking for socio-economic problems in the study areas, 2023.

Problems	**RD**	**PHS**	**WS**	**LES**	**LAI**	**LMPRH**	**LCS**	**LQE**	**Score**	**Rank**
Recurrent droughts (RD)	X	RD	RD	RD	RD	RD	RD	RD	7^{+1}	1
Limited health services (PHS)		X	WS	LES	LAI	LMPRH	LCS	PHS	1^{+1}	7
Water shortage (WS)			X	WS	WS	WS	WS	WS	6^{+1}	2
Limited Extension Services (LES)				X	LAI	LES	LES	LES	4^{+1}	4
Limited Agricultural inputs (LAI)					X	LAI	LAI	LAI	5^{+1}	3
Limited market participation of rural households (LMPRH)						X	LMPRH	LQE	2^{+1}	6
Limited Credit services (LCS)							X	LQE	1	8
Low-quality Education (LQE)								X	2^{+1+1}	5

Source: FGD

3.11 Farmers' Production Goals and the Pattern of Food Consumption

3.11.1 Farmers' Production Goals

Rural households allocated their agricultural products for various purposes. Out of all the produce, the largest proportion (an estimate of 66%) goes to home consumption while part of the produce also goes for seeds, saving and sale (Figure 14). They generate on-farm incomes from sales to meet household cash needs and pay loans. Even though the farmers' primary goal is to be self-sufficient in food, the climate change in the last 10 years increased occurrence of crops and livestock diseases and made agriculture vulnerable and unproductive, further exacerbating food insecurity. Unless mechanisms are taken to help farmers adapt to and cope with climate change, the farmers' resilience will keep deteriorating and food insecurity will get worsened.

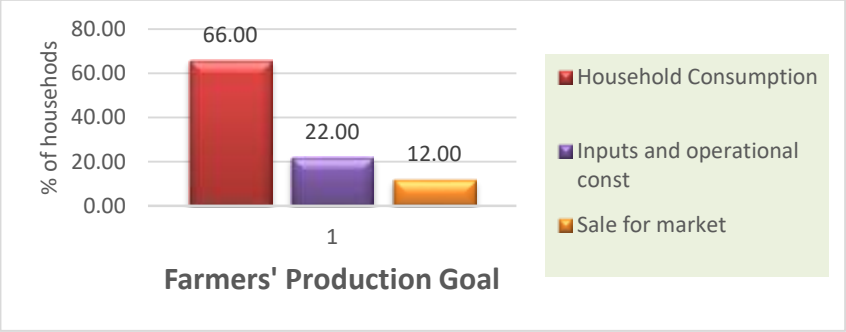


Figure 14. Farmers' production goals in the study areas, 2023.
Source: FGD (proportional pilling tool)

3.11.2 Farmers' Food Consumption Patterns

The results of the study indicated that most of the farmers' food consumption patterns were different because cereal crops grown in the Upper Fafan woreda were different from that of Upper Harawo. In the Upper Fafan woreda, most of the farmers cultivate maize and sorghum mainly for consumption while ground nuts as cash crop. In the Upper Harawo woreda, most of the farmers cultivate maize, sorghum, barley, and oats mainly for home consumption while wheat was considered a cash crop.

Based on the food consumption preference ranking, the farmers of Upper Harawo woreda prioritized the different sorghum varieties for different food types as illustrated in Table 8. Some of the varieties are preferred for home consumption while others either for marketing or other specific merits. The direct matrix preference ranking of Upper Fafan was also presented in Table 9. In both woredas, some of the sorghum varieties were most preferred for home consumption, such as Cilmi Jama, for its taste features and cook-ability.

Every variety of a crop was produced for some unique features, whether for consumption, marketing, drought tolerance, high-yielding ability, disease tolerance, or others. Knowledge of these features helps crop breeders to take into consideration of these attributes in their breeding programs. For instance, they should take into consideration of the taste and cook-ability attributes in their breeding programs.

Table 8. Direct matrix ranking of food preferences of Sorghum local varieties in upper Harawo, 2023.

Food type	Varieties				
	Cilmi Jama	Aden gab	Caqli badan	Case	Cade
Kimis	1	3	2	5	4
Shuro	1	3	2	5	4
Garow	1	3	2	5	4
Salol	1	3	2	5	4

Sources: FGD, 2023

Table 9. Direct matrix ranking of food preferences of Sorghum local varieties in Upper Fafan, 2023.

Food type	Varieties			
	Cilmi jamac	Aden gab	Wagaro	Dange
Kimis	1	3	2	4
Shuro	1	3	2	4
Garow	1	3	2	4
Salol	1	3	2	4

Sources: FGD, 2023

3.11.3 The Workload of Men and Women during Peak Farming Season

As indicated in Tables 10, the T-table workload comparison of men and women indicates that women worked for 16 hours a day while it was 7 hours for men during peak farming seasons. It was also observed that this practice was a similar circumstance in all of the study areas. Out of the total time spent by women, 25% of it was spent for productive activities while 75% for reproductive or domestic roles. Men spent all of their time in productive farming activities. However, it was not common to see men engaged in reproductive or domestic roles.

The findings clearly indicate the extent to which women were overburdened by being engaged in both reproductive/domestic and productive roles. This status of overburden does not significantly decrease for women even during slack seasonal periods while it does for men. During slack periods, men are almost free of engagements since farming is a seasonal activity and they are not involved in reproductive/domestic roles.

3.12 Cause-effect Analysis of Farming Systems Problems

The main socioeconomic issues from Upper Fafan and Upper Harawo were identified during the field survey in consultation with the community and Woreda Offices of Agriculture. We identified the important causes, and effects of problems, opportunities available and potential intervention options to improve farm production and productivity. As presented in Table 11, issues related to climate change, agricultural extension, credit, inputs supply, market access, farm equipment and implements, farm equipment rental services, land fragmentation, and shrinking of farm sizes are some of the strategic challenges identified during the study. The causes and effects of these challenges have also been presented in the matrix.

Table 10. Workloads of men and women during peak farming seasons in the study areas, 2023

Women		Men	
Activites	Time	Time	Activites
✓ Wake up ✓ Cleaning house ✓ Prepare breakfast ✓ Barn cleaning ✓ Fetching water for daily usage ✓ Letting the goats, sheep and cattle out of the barn	5 – 8AM	8 – 10AM	✓ Wake up ✓ Eat breakfast ✓ Prepare plowing tools ✓ Take chewing chat from the market
✓ Cultivation ✓ Weeding ✓ Harvesting ✓ Threshing ✓ Collect firewood ✓ Look after children ✓ Cook food for lunch	8am - 1PM	10am - 1PM	✓ Plowing ✓ Planting ✓ Weeding ✓ Harvesting ✓ Threshing
Serve lunch at the farm with my husband	1 – 2PM		Lunch time
✓ Domestic activities such as:- looking after children, ✓ making sure that they go back to school, ✓ washing utensils.	2 - 4PM	2 - 4PM	Rest time at the farm
Domestic activites such as:- ✓ collect firewood, ✓ Herding ✓ taking care of children, milking	4 - 8PM	4 - 8PM	✓ Weeding ✓ Cultivation ✓ Supervision of farms ✓ Look after crops and animals
Serve dinner	8 - 9PM		Dinner
✓ Giving milk to the children and my husband ✓ Preparing the rooms for sleep	9 - 11 PM		Sleeping
Sleeping	11PM - 5AM		
Total time spent at work	16 hrs	7 hrs	

Table 11. Cause-effect analysis of major socioeconomic problems,2023.

Constraints	Cause	Effect	Interventions Options	Opportunities available	Stakeholders
Recurrent droughts	○ Climate change (Limited & unreliable rainfall distribution) ○ Deforestation ○ Degradation of natural resources	○ Low production ○ Internally Displaced People (IDPs) ○ Food insecurity ○ Water shortage ○ Malnutrition ○ School closure ○ Increased crops & livestock diseases ○ Increased vulnerability & limited resilience of farming households	○ Afforestation ○ Constructing water dams and wells ○ Climate change coping mechanism and mitigation programs ○ Distribution of early maturing and drought-tolerant crop varieties ○ Designing sustainable natural resources management practices	○ Ground water availability ○ Increased Community awareness ○ Availability of development partners (public organizations & NGOs) ○ Global support programs to climate change	○ BoANR ○ BoWRD ○ BoID ○ DRM ○ BoEPRLA ○ LLRP ○ SoRPARI ○ JJU ○ NGOs ○ Community
Insufficient health services	○ Shortage of budget ○ Limited staff motivation & encouragement ○ Inadequate monitoring of Woreda Health Offices and Regional Health Bureaus ○ Shortage of health staff ○ Shortage of H/post/center ○ Shortage of medicine ○ High-cost of medicine ○ Lack of motorcycles	○ Increased risk of waterborne disease ○ Increased malnutrition ○ More prevalence of infectious diseases ○ Severe illness ○ Inability to manage a farm ○ Unable to feed children ○ Increased zoonotic Diseases	○ Increased budget allocation for Health Sector ○ Provision of Health staff motivation and career development mechanisms ○ Set-up increased monitoring and accountability mechanisms ○ Health service improvement ○ Dietary complementation for vulnerable groups	○ Availability of health infrastructure ○ Availability of earthen roads ○ Network services ○ Availability of development partners (public organizations & NGOs) working on Health Services ○	○ RHB ○ NGOs ○ JJU

	○ Lack of ambulance ○ Lack of animal and human health sectors cooperation	○ Scanty productivity of victims and their families ○ Further livelihoods deterioration			
Water shortage	○ Limited rainfall ○ Limited water supply infrastructures ○ Recurrent drought ○ Inadequate budget allocation for development of water resources	○ Water scarcity ○ Poor water quality ○ Increased water cost ○ Increased mobility ○ Diarrheal diseases in the community ○ Increased conflicts with neighboring communities	○ Allocation of adequate budget & development of water resources ○ Implantation of water supply ○ wells and dams ○ rainwater harvesting ○ Increased afforestation programs to increase ground water recharge	○ Availability of underground water potential ○ Building initiatives of water harvesting systems like dams and wells	○ BoWRD ○ BoPD ○ BoID ○ DRM ○ BoEPRLA ○ LLRP ○ NGOs
Limited Extension Services	○ Limited budget allocated for extension services ○ Limited or no motivation of development agents (DAs) and limited career development ○ High turn-over of DAs because of inadequate salary ○ Interests dropping to learn agriculture in colleges ○ Shortage of DAs and experts ○ Un functional and limited	○ Limited adoption of technologies ○ Traditional farming practices still dominant ○ Lack of information ○ Lack of awareness of improved technologies ○ Information gap among the agro-pastoralists ○ Inappropriate usage of agricultural inputs ○ Limited agricultural	○ Allocate adequate budget for extension services ○ Provide motivation mechanisms and career development for DAs ○ Increase monitoring and accountability mechanisms from District Agriculture Offices and Regional Agriculture Bureau ○ Revise salary scale of DAs and Agriculture staff ○ Functionalizing the existing FTCs ○ Establishment of new FTCs ○ Awareness creation among the agro-pastoral communities ○ Strengthening Agricultural TVET	○ Policy attention ○ Availability of TVET colleges ○ New graduates available ○ Community aware on technology adoptability ○ Mass media (FM-radio & TVs) ○ Social media ○ Increased mobile phone & radio ownership	○ MoA ○ BoA ○ BoPD ○ BoC ○ SRTV ○ ETC

	numbers of FTCs	production and productivity ○ Increased risk of food insecurity	○ Introduce Digital extension services		
Limited Agricultural inputs	○ Inadequate budget allocated for purchases of inputs (improved crop seeds & fertilizer) ○ Inadequate focus of the woreda to monitor and limited accountability mechanisms ○ Shortage of inputs (seeds, fertilizers and chemicals) ○ Lack of credits access ○ Limited seed production cooperative	○ Limited adoption of improved technologies ○ Low crop productivity ○ High cost of inputs ○ Delay of planting and harvesting ○ Low external input use	○ Allocate adequate budget for purchase of inputs ○ Remove government input subsidy & help farmers afford by their own to ensure sustainability ○ Improving quality seeds and its availability ○ Facilitating loan access ○ Establishment & strengthening of seed producer cooperative organizations ○ Distribution of fertilizers and chemicals ○ Introducing and expansion of organic fertilizers	○ Community aware on the quality seeds ○ Availability of Ethiopian Seed Enterprise and other seed producers ○	○ MFI ○ Development banks ○ SRS cooperative agency ○ BoA ○ SoRPARI
Limited market participation of rural households	○ Limited road access to rural villages ○ Limited availability of public transportation services ○ High cost of transportation ○ Price fluctuation ○ High influences of	○ Limited traders coming to villages and less competition ○ Farmers offered low-selling prices to their products ○ Limited motivation of farmers to invest	○ Improving road access ○ Market information linkages ○ Agriculture potential of the locality ○ Business orientation of the community	○ Government and private sectors investment	○ Trade and investment bureau ○ BoA ○ Cooperative agency

	imported commodities ○ Market information gap ○ Limited stores	on improved technologies			
Limited Credit services	○ limited farmers association, credit union, banking branches, and MFI ○ Inadequate awareness of the community about credit services and financial institutes ○ Inadequate awareness of financial institutes about agriculture sector	○ Farmers increased financial limitation ○ Inability to afford improved agricultural technologies ○ Limited interest of financial institutes to provide rural credit ○ Less engagement of rural communities on IGAs (off-farm income generating activities) ○ Limited market participation of the rural community ○ Lack of saving ○ Low production ○ Low investment	○ Increase awareness of the community about the importance of credit ○ Increase awareness of financial institutes about agriculture ○ Motivate the community to take credit and engage in IGAs ○ Policy support ○ Establishing the credit services	○ Availability of financial institutes ○ Creating Farmers credit association ○ Provisions of microfinance institute services ○ Increased market orientation of the community	○ MFI ○ Banks ○ FCAs ○ BoA ○ NGOs
Low-quality Education	○ Less or no monitoring and accountability mechanism of Woreda Office of Education and	○ Low quality education ○ Students drop out due to excessive	○ Establishment of monitoring and accountability mechanisms of teachers, supervisors and other staff	○ Availability of NGOs supporting education sector	○ BoE ○ BoANR ○ NGOs

	Regional Bureau of Education ○ Limited motivation mechanisms of teachers ○ Inadequate commitment of teachers ○ Lack of teaching aids ○ Lack of community awareness on education quality ○ Shortage of qualified teachers ○ Limited school facilities and hygiene services ○ Increased school drop-outs due to food insecurity of rural households	workload ○ School's closure ○ Adult education for agro-pastoral communities	○ Increase technology use of rural households to boost agricultural productivity and improve food availability for the family ○ Establishment of school feeding programs ○ Govt should improve access to education and quality ○ Community awareness about education access for their children ○	○ Experiences of other regions in quality education and school feeding programs ○ Agriculture potentials to increase productivity and food security	

3.13 Recommendations to Socio-Economic and Extension Issues

According to the results of the survey, the following strategies and issues have been suggested for some of the identified socio-economic constraints for possible research and development interventions that are expected to improve the smallholder farmers' production and productivity. The following researchable areas and development intervention directions were suggested for consideration.

Extension and Development Intervention Options

- The establishment of an appropriate improved seed multiplication base should get attention in the region to ensure adequate and timely supply
- Establish and strengthen the capacity of Farmers' Cooperatives in the input markets through technology and financial support
- The FTCs should be functionalized and strengthened to deliver extension services
- Adapt and introduce small-scale farm implements such as row planters for cereals as well as small-scale types of machinery like small threshers
- Improve the human resources capacity of the agricultural extension service system
- Create a conducive working environment for development agents including some incentive mechanisms
- Drought, disease tolerant and early-maturing vegetable varieties should be provided to women.
- By building new schools, renovating the ones that already exist, and improving teacher knowledge and abilities, basic education can be made more accessible to everybody, especially in remote areas. It Is also essential to establish motivation mechanisms for teachers, such as favorable career systems, compensation payments for working in remote and inaccessible areas, revision of salary scales and reward system for those who demonstrated exemplary performances.

- Programs and initiatives in education should be created to decrease the number of drop-out students who leave school early owing to a variety of reasons, including financial hardship, low female enrolment, and movements from place to place. Introducing school feeding programs could be one of the options.
- It is necessary to improve social services generally, placing more of an emphasis on education, safe drinking water, and human health. This can be done by expanding the physical reach of hospitals, schools, and public water systems while also enhancing the efficiency and effectiveness of those that are already operational.
- Increase access to necessary medications, skilled medical personnel, and strengthened oversight and support structures are all necessary in the health industry.
- It should be thought about improving conventional water collection, management, and utilization knowledge and skills.
- Managing and battling drought and other related slow-onset disasters through effective water resource allocation, redistribution, transfer, storage, and use
- Attention must be paid to increasing the full participation of women through projects and programs that promote their equal ownership of land, access to regular and adult education, capacity building, reduction of their workload, and equal participation in political issues.
- It is crucial to develop social infrastructure, including better roads, energy, and market facilities.
- The regional bureau of agriculture, the zonal office of agriculture, and the woredas development office in the region should work on the expansion of agricultural extension services and work closely with inputs and credit-supplying institutions
- Introduce, promote and pilot digital extension systems in collaboration with NGOs who are skilled and experienced in providing such services
- Planning and priority setting should be exercised only within the domain of agricultural extension services that address the needs of smallholder farmers

- Extension workers should possess core competencies such as knowledge, skills, attitudes, and behaviors that help them attain excellence in their professions and effectively address the problem of pastoral and agro-pastoral communities' needs.
- Involving agro-pastoralists and extension workers in the planning and implementation phases is necessary to bring the desired and sustainable changes.
- The involvement and participation of stakeholders are critical to the success of the extension service expansion.
- Provide technical and financial supports, and experience sharing programs to cooperative organizations to increase the availability of agricultural inputs (Improved seeds, fertilizers, pesticides, herbicides, and insecticides).
- Raise awareness and encourage community action for the establishment and advancement of local based seed production systems.
- Strengthen and encourage private sector involvement in the supply of agricultural inputs, such as improved variety seeds, fertilizers, agro-chemicals, and crop seedlings.
- Awareness should be created on gender equality and women empowerment; Increased employment of female extension agents should be encouraged in agricultural extension services to better support women farmers.
- Nutrition education and counseling should be provided to female headed households.

Policy Recommendations

- Build and strengthen the existing agricultural extension system through developing career development strategies and structural revision to encourage existing Development agents and attract new ones. There should be special policy support for agricultural extension service providers.
- Introduce and promote pluralistic extension services in the region allowing private sectors and cooperatives, and development partners to engage in extension service provision

- Climate change mitigation and adaptation projects should be initiated and implemented as climate related problems are becoming serious concerns in the region.
- Pay attention to developing infrastructure in the region, such as all-weather vehicle roads, schools, and health centers.
- Organize and provide trainings to the community (men and women) on agriculture-related skills, technologies, organic and inorganic fertilizers, food hygiene and safety, and value addition
- Trainings and extension services should be gender sensitive actively engaging women.

CHAPTER 4
NATURAL RESOURCES AND MANAGEMENT

The natural resources, mainly land, water and climate play key roles in the development and enhancement of agricultural productivity. The land and water support the growth and production of most crops and unlike land, no crop can be grown without water. Similarly, Forests are vital natural resources that provide a full spectrum of goods and services that contribute to the socio-economic development of forest dependent communities. In tropical countries, the diversity of stakeholders depending on forests with their divergent interests and expectations make sustainable forest management (SFM) difficult to achieve. The livelihood of 85% of the Ethiopian population is dependent on natural resources, particularly renewable natural resources (Shibru and Kifle, 1998).

4.1. Major Soil types and Fertility Status

According to field observation and the farmers' perception, black clay soils dominate (an estimate of 60%) upper Fafan while reddish silt soils dominate (an estimate of 50%) upper Harawa (Figure 15). More specifically, vertisols, cambisols, luvisols, and leptisols were found to be dominant soil types in the study areas (Table 12). According to farmers' perception, the fertility status of the major soils types was identified as fertile, moderately fertile, slightly fertile and not fertile for vertisols, cambisols, luvisols, and leptosols, respectively. Though the major soil types of the study area except the leptosols, are suitable for crop production, they also have some yield limiting problems. In this

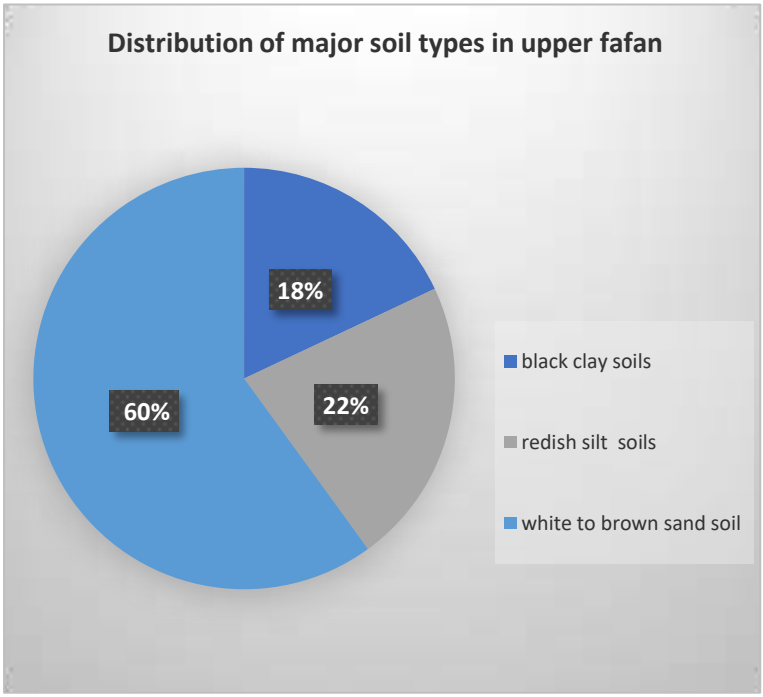
case, our field survey identified the productivity potential and limitations of major soil types in the study areas. Low soil moisture holding capacity, poor infiltration capacity, and susceptibility to erosion were identified to be the major limiting soil properties to agricultural productivity.

Vertislos are medium depth, imperfectly to poorly drained, medium to heavy textured, and dark reddish brown clay loams. According to local people's perception, such soils are resistant to soil erosion and they are mostly found in Jigjiga plains. They are also mostly found in flat sloped cultivated lands of upper Fafan and upper Harawa agro-ecologies. The soils are used for the production of different crops such as wheat, barley, maize, and chickpea. According to the report by OWWDE (2012), these soils in major parts of the study areas were found to be slightly alkaline with an average pH value ranging from 7 to 8.2 in the top soil, and 7.8 to 8.2 in the sub soil. The CEC value of these soils varied ranging from 53.2cmol$_c$/kg (very high) to 9.2 cmol$_c$/kg (low) with an average value of 30.29 cmol$_c$/kg (high). Base saturation percentage was greater than 100%.

Cambisols are the major soil units in upper Fafan valley and also found in cultivated lands of Harawa watershed. The farmers perceived that these soils are characterized with deep soil depth and medium infiltration, moisture holding capacity, and resistant to erosion. The soils have favorable physical characteristics depending on topography and climate; thus, they are intensively to moderately cultivated for peasant subsistence agriculture in the study areas. Groundnut and onion were major crops grown in these soils.

Luvisols:-These are the second major soils in spacial distribution and developed only in well drained areas of Upper Fafan. According to field observation and farmers' perception, such soils were medium to coarse textured with shallow to medium depth.

They were also characterized with medium infiltration capacity, erosion sensitivity and low to medium moisture holding capacity. The major crops grown in these soils were sorghum, watermelon, and tomato.



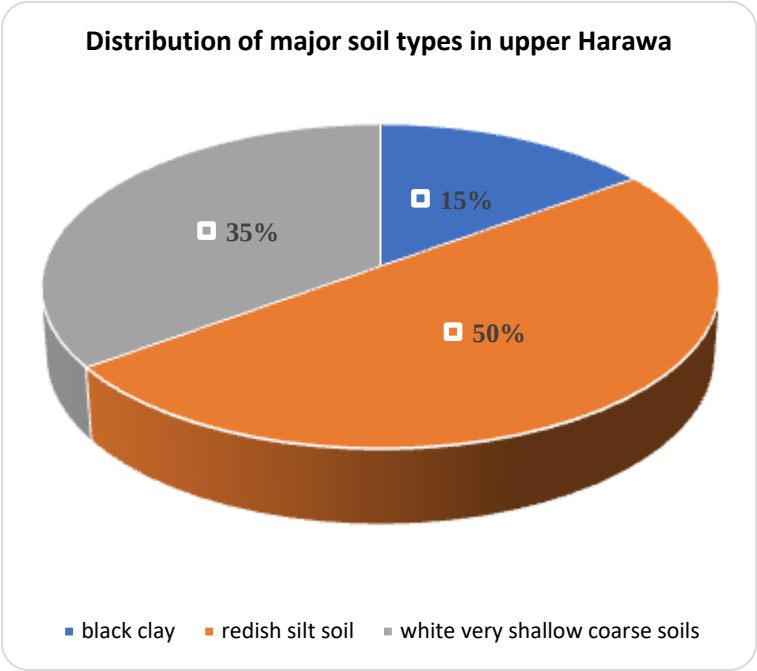


Figure 15. Distribution of major soil types in upper Fafan valley areas (left) and Upper Harawa (right) as estimated by local farmers, 2023.
Source: FGD proportional pilling

Leptosols:- These soils occur mainly, along the rivers and stream channels and steep hill and mountain side slopes of Upper Harawa watershed. The soils are generally young, which are limited by their topsoil horizon over an initial development of subsoil horizon or directly over an altered parent rocks from which they have developed. They are shallow to very shallow with limited profile development and thus are usually prone to draught. They are well to excessively drained, reddish brown to dark reddish brown to very dark reddish brown. Structure is mainly weak to moderately developed, fine to medium sub-angular blocky. Consistence is friable (moist), slightly sticky and slightly plastic (wet). Apart from offering limited grazing

resources, they have little sustainable agricultural potential. The susceptibility of these soils to erosion is one of the reasons, which precludes their sustained use for agriculture.

4.2 Status of Forest Resources

During the FGDs, some elderly members of the ago-pastoralists indicated that historically the forest cover of the area was estimated to be 75% some decades ago which in the current days has drastically shrank to about 30% (Figure 16). Agricultural expansion, illegal tree cutting, over grazing, charcoal and fuel wood production, and settlement of internally displaced people (IDPs) were reported to be the causes of destruction of the forests.

As listed in Table 13, there are still diverse species of forest trees in the study areas. The common tree species available was acacia wood land in most parts, despite its coverage is declining from time to time due to clearance for agricultural land expansion, invasive species expansion, increment of human demand and improper settlement of internally (IDP) and externally displaced people (EDP) (refugee camp). Since the forest is communal resource and it is open access for utilization according to communities' perception, the major problem of forestry in Fafan zone was agricultural expansion followed by drought and deforestation.

Table 12. Major soil types, their physical characteristics, fertility status and major crops grown as perceived by the local farmers, 2023.

Soil type	Areas commonly found	Relative fertility	Soil depth	Moisture holding capacity	Infiltration capacity	Erosion sensitivity	Major crops grown
Heavy Black clay (vertisols)	Flat plains (Jigjiga, Awbarre)	Fertile soil	Medium	High	Low	Low	Maize, Sorghum, Wheat , Cheque pea
Reddish colored soil (cambisols)	Undulating topographic upper Fafan valley areas (Gursum)	ModeratelyFertile	Deep	Medium	Medium	Medium	Ground nut Onion
White-Brown silt soil (luvisols)	Undulating topographic upper Fafan valley areas (Gursum,)	Slightly fertile	Shallow to medium	Low to medium	Medium	Medium	Sorghum, Watermelon, tomato
White very shallow coarse textured soils (Leptisol)	Hilly terrain and rock surface areas (Harawa watershed)	Not fertile	Very shallow	Very low	Very low	Very high	Not suitable for crop production and utilized as Grazing and browsing resources

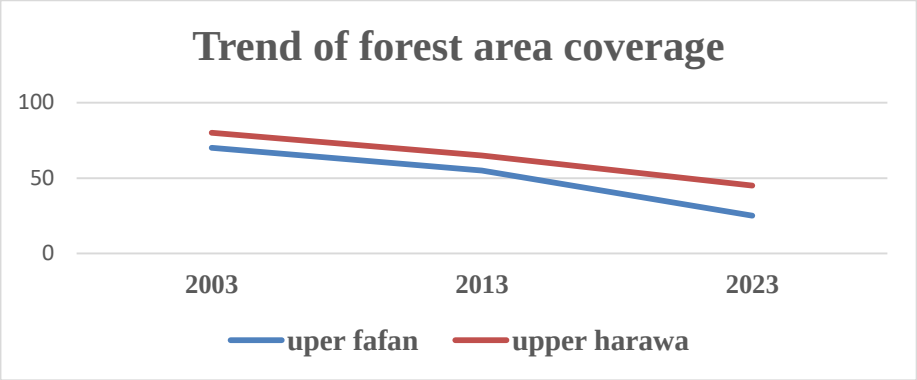


Figure 16. Trend of forest cover in the Fafan (farmer's perception)

Table 13. List of woody and non-woody plant species in the study areas

spp no	Local name	Scientific	spp no	Local name	Scientific
1	Qudhac	*Acacia tortilis*	19	Maraa	*Acacia nilotica*
2	Warsameys		20	Xayramad	*Dodonaeaviscosa*
3	Gaboobeys		21	Gumar	*Acacia orfola*
4	Bilcil	*Acacia mellifera*	22	Iswadhwadh	
5	Cadaad	*Acacia Senegal*	23	Maygaag	*Bosciaminimifolia*
6	Timirloojir		24	Dhebi	**Grewia mollis**
7	Garbi	*Acacia albida*	25	Ulaag	
8	Xagar	*Commiphoraerythraeae*	26	Waleensi	
9	Madheed	*Cordia sinensis*	27	Sogsog	Acacia etbaica
10	Wadhi		28	Dhikri	Acalypha Fruticosa
11	Woob	*Terminalia brownie*	29	Cobal	
12	Dhulfaliid		30	Jilbodharo	
13	Kabaw		31	Hadaan	
14	Gombesh	*Grewiavillosa*	32	Faraxood	
15	Kadi	*Balanites glabra*	33	Dhosoq	
16	Hudhe		34	Agamse	
17	Galool	*Acacia bussei*	35	MudhoJiidjid	
18	Gob	*Ziziphus mauritiana*	36	Casokuri	

4.3 Agro-climatic Resources

4.3.1 Rainfall Amount

Rainfall is one of the major climatic elements that affect the presence, abundance and distribution of natural resources. The amount of surface and subterranean water is determined by the amount of rainfall. The density and types of natural vegetation as well as the intensity of human activity are affected by the amount and distribution of rainfall. As to the rainfall of the study area, its amount decreases in the directions from west (upper Fafan valley and Jigjiga plains) to the north east (Awbarre and Upper Harawa watershed). The mean annual rainfall of the study area ranges from 318 mm at part of the north east to 890mm in the west (Gursum). In general, the rainfall amount decreases in the study area with descending elevation from west to north east direction.

4.3.2 Rainfall Pattern

According to the data obtained from nearby meteorological station (Figure 17), the rainfall regime is bimodal type -2 with the first growing season extending from March to early June and the second rainy season from July to late November; the peak is in April and August, respectively. The intensity of the rainfall is high for the first rainy season in all stations but the duration is very short. Though the first rainy season is more prominent, both wet seasons have equal importance. However, the area is characterized in its erratic distribution and also flush floods when the intensity of the rainfall is high. Generally, the pattern was brought about by the wind system coming from the Indian Ocean from September to November and from March to May (NMSA, 2001).

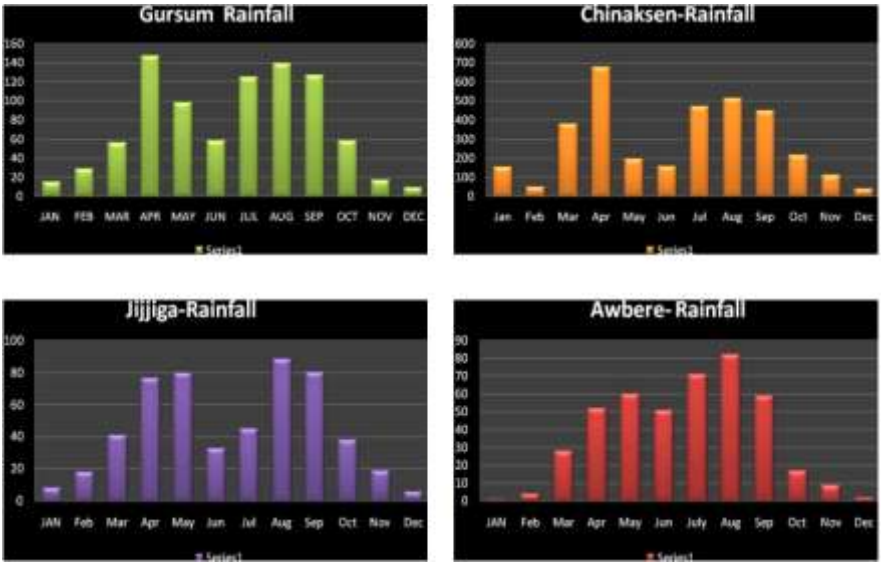


Figure 17. Rainfall patterns in different meteorological stations of the study areas

4.3.3 Rainfall Seasons

According to the FGD, and meteorological data analysis, the study area is characterized by bimodal seasons: Gu'u (wet season) and *Jilal* (dry season). Within the Gu there are three sub seasons: dira' (late March - late May), Hagaa (late May - late July), and Karan (late July - late September). The Jilaal (late September - late March) can be further divided into two sub seasons: deyr (late September - late November) and kalil (late November - late March). Most of the major crops in the areas are grown during the Gu (wet season) season. Generally, the livelihood of the area is highly dependent on the dira and the karan rainy seasons as both of them are equally important for crop production, availability of water and regeneration of pasture.

4.3.4 Water Resources

Water availability and supply for domestic and livestock consumptions

Water in general is a scarce and valuable commodity in the study area although the degree of availability differs among the places and from season to season. Community members, local administrators and experts with whom discussions were held pointed out that scarcity of potable water is an acute problem which calls for urgent intervention. The scarcity of water is not only related to human consumption and safety, but also for livestock and irrigation. Currently people of the area are using all available water sources like rivers, shallow hand dug wells, drilled wells, and surface running water for domestic and livestock consumption. Potentially, water availability is better in the upper Fafan valley of Gursum and some part of Tulliguled woredas. In these areas, water is available from shallow wells and river, however in Jigjiga-Didawale plains, *birkads* and *balleys* predominate, where the running water in dry stream banks are the only sources of water in the low land areas of upper Harawa. In these areas, especially during the dry season, water shortage is so severe that resident agro-pastoralists temporarily migrate to other places where the availability of water is relatively better.

According to the report by OWWDE (2012) regarding problems encountered in relation to water supply, about 73.7, 12.8, and 2.56% indicated to have problems of shortage of water supply, very low access to pure drinking water and salt affected water resource, respectively. On the other hand, with regard to livestock drinking water, respondents in sedentary crop-livestock farming system areas indicated that there is no serious shortage of water because water can be obtained from the nearby rivers and shallow wells along the Fafan river.

To curb water shortage problems and improve the existing services, the local community suggested that more hand dug wells and/or power generated water supply schemes should be introduced to the area where shallow ground water is potentially available, such as upper Fafan; whereas surface water harvesting structures need to be constructed for the other areas, such as Jigjiga plains and upper Harawa watershed. During the peak dry seasons, mainly from February to June, water for both household use and livestock was obtained from traditionally dug wells, *Birkas, Balays*, natural ponds and cisterns.

As respondents pointed out, one of the water supply problems in the area was sharing of the same source of water with wild animals for drinking. as a result of which people are exposed to different zoonotic diseases. In general, FGD participants claim that water shortage is very serious problem of the area and even inhabitants of some villages travel 1- 4 hrs in search of water. FGD participants reported that the community faced many problems in relation to water supply. The water they are using is not adequate to serve the whole community and is not of good quality for drinking. The location of water sources is also too far which takes women to walk 1-4 hours and people stay on the line for about 12 hours. This situation has direct influence on the drudgery of women whom already carryout various productive, reproductive and community related roles.

According to Ministry of Water, Irrigation and Electricity (MoWIE, 2015), water supply service level standard in the second Growth and Transformation National Plan (GTP-2) was set to provide a minimum of 25 litter/capita/day safe water within a distance of 1 km for 85% of the rural population. However, the average distance of the water sources in reality was found to be much higher than this standard. For instance, the local people in Harawa watershed traveled the average distance of 2.3 km to fetch water (Mahamed, 2020).

Irrigated Agriculture

Crop production is mainly rain-fed making the agriculture sector vulnerable to climate change and variability in the study area. Although the practice of irrigation farming still remains traditional, it is being practiced in Upper Fafan valley. However, the development of small-scale irrigation farming has the potential to improve farmers' livelihood in terms of income and food security in these areas. Several vegetables, fruits and field crops including potato, tomato, onion, cabbage, pepper, banana, maize and chickpea are produced by farmers based on their crop calendar and market demand. According to FGD, Upper Fafan seasonal river has great potential for the development of irrigation farming, because of which it has also attracted the attention of external investors. However, the following constraints were identified to strengthen irrigation farming:

- Presence of soil salinity and water logging problems due to shallow water table with high amount of saline water;
- Limited capacity to afford costs of land leveling, irrigation canal construction, and water supply equipment such as water pump motors and water pipes;
- Improper irrigation methods with high water loss;
- Unavailability of improved technology packages suitable for small-scale irrigation schemes;
- Inadequate land and irrigation water management; Shortage or absence of improved crop variety seeds and seedlings;
- Absence of research recommendations on fertilizer types and application rates, agronomic practices, crop water requirement, and irrigation water management;
- Perpetual incidence of insect pests and diseases (e.g., citrus, chickpea, pepper, and Garlic are affected);
- Absence of pesticide supply to control insect pests and diseases;
- Low extension services for irrigation agriculture;
- High post-harvest losses due to lack of appropriate post-harvest management techniques;

- Market fluctuation, and absence of small-scale agro-processing facilities.

❖ In spite of the apparent challenges, the following positive changes were observed in the agriculture sector:

- Potential shallow ground water that can be extracted from a depth of 4-6m
- Good market access
- Expansion of irrigated farming in Fafan irrigation potential areas;
- Increased awareness of farmers in the adoption of improved agricultural practices; and improved farmers' livelihood.

4.5 Natural Resources Degradation Problems

Degradation of both quality and quantity of natural resources viz: soil, water, and vegetation caused tremendous environmental problems in the study areas that diminished the capacity of land resources to perform essential functions and services in ecosystems. As illustrated in Table 14, recurrent drought, soil erosion, rangeland degradation and soil fertility decline were problems related natural resources degradation as prioritized the farmers.

4.5.1 Soil degradation

Soil degradation implies the physical, chemical and biological decline in soil quality. It can be the loss of organic matter, decline in soil fertility, and structural condition, erosion, adverse changes in salinity, acidity or alkalinity, and the effects of toxic chemicals, pollutants or excessive flooding. According to farmers' interview and filed observation, soil erosion by water and wind, fertility depletion, salinity, and water logging were identified as the typical soil degradation problems existing in the study areas.

A. Soil erosion

Soil erosion by water in different forms was observed in the study areas that occurs following the runoff from the upper land. Such soil erosion is very detrimental in undulating topographic areas of upper Fafan valley and upper Harawa, but soil erosion by wind is common in flat plains particularly during dry season due to lack of vegetation cover. The local farmers believe that soil erosion hazard is sever and expanding time after time at alarming rate where hundreds of hectares of fertile croplands are changing into gullies and productive cultivated lands become abandoned due to loss of top fertile soils after being eroded by running water. According to FGD and KII, the major causes of soil erosion in the study areas include: high intensity rainfall, hilly nature of land form, overgrazing, and deforestation.

In areas characterized with undulating and rugged terrain with hills, hummocks, escarpments, mountains with steep slopes, shallow coarse soil dominantly on rock surface like upper Harawa watershed, soil erosion has devastated tremendously and developed to irreversible stages with over a 10-meter depth and about 20-meter width. Several chains of gully cuttings have also formed gorges and hummocks. Similarly, the runoff from the uplands following the heavy storm characteristic of short period rainfall is a major cause of erosion that washes the fertile top soils, creates small rills, extends to large channels and finally gullies. Likewise, Overgrazing has resulted in land degradation in all areas of the study with more pronounced effects of Fafan and upper Harawa watersheds. The effects of compaction and deformation by trampling are wide ranging. Closure of the pore spaces inhibits root development and reduces plant growth. It increases moisture retention and causes a reduction in infiltration capacity. It destroys soil organisms thereby interfering with

organic matter decomposition and nutrient cycling. Ultimately it led to changes in grass composition and soil erosion.

Erosion is a major composer of droughts. During interviews in the hilly and mountainous areas, community members mentioned erosion as a major threat to their livelihoods. Erosion resulted in the loss of ecosystem services, and thereby in the loss of natural resources that are vital to local communities. Erosion impacts are severe and widespread, some of which included the following:

- Fertile soils are lost and agricultural productivity is dropping
- Infrastructure and dwelling houses are destroyed
- Mobility and access to resources and services are limited
- Vegetation including wetland vegetation is lost
- Infiltration, soil moisture and groundwater recharge are reducing, lowering the yield of water sources.

B. Soil fertility depletion

Farmers recognize that the status of soil fertility is decreasing from time to time due to exploitative type of agriculture and poor soil fertility management practices. Everything is harvested and nothing is returned to the soil to replace nutrients harvested with crops and restore soil fertility. Anthropogenic factors are the major causes of land degradation and deterioration of soil fertility. The increasing population pressure and subsequent termination of traditional soil fertility management practices, such as fallowing due to shortage of agricultural land has resulted in the deterioration of soil fertility. In general, a balanced and innovative approach is needed for the management of soil and water resources. A report by OWWDE (2012) demonstrated a low organic carbon in all soil types of the study areas with the average value of 0.17, 0.59, 0.58, and 0.85 for cambisols, luvisols, leptisols, and vertisols, respectively, and recommended that organic and inorganic fertilizers are required to get high yield. In addition, low total nitrogen percentage and low to medium

available P was revealed by the report and therefore, suggested the applications of N and P fertilizers to enrich the soil.

Table 14. Identified NRM problems using pairwise matrix tool in the study areas, 2023

identified NRM	RD	SE	SFD	SAW	RLD	Df	Score	Rank
Recurrent Drought	X	RD	RD	RD	RD	RD	5	1
soil erosion (SE)		X	SE	SE	SE	SE	4	2
soil fertility decline (SFD)			X	SFD	RLD	SFD	2	4
soil acidity and waterlogging (SAW)				X	RLD	DF	0	6
rangeland degradation (RLD)					X	RLD	3	3
Deforestation (Df)						X	1	5

4.5.2 Deforestation and rangeland degradation

The low amount of rainfall results in meteorological drought; where the rainfall is deficient compared to normal rainfall of the study area. Not only is the amount, but also the distribution was very erratic. As a result of low amount and erratic distribution, the available soil moisture becomes inadequate for regeneration of pasture lands which becomes a serious threat to the agro-pastoralists. In the study areas, the rangelands are limited in area coverage due to intensive agricultural expansion and also became degraded due to land degradation, over grazing, erosion, flood hazard, bush encroachment, and invasion of rangeland weeds such as Lantana camara and Cactus species.

Cutting of trees, less regeneration status of natural vegetation, and conversion of forest and bush lands to agricultural land due to population pressure are the major causes of deforestation. The change in the land use system and disruption of the ecological balance has been the driving force for accelerated soil erosion, climate change and decline in agricultural productivity. Suggested solutions include: Increased afforestation, reforestation, and area

enclosure and forest management. Regular planting of tree seedlings without proper management cannot be a solution for expansion of forest areas. Development and implementation of forest management plans is crucial for successful afforestation program. It is also suggested to establish clear proclamations and respect customary laws and participatory forest management practices. If the farmers have increased awareness about the resource benefit on ecological, economical, and social aspects of forest management, they will develop a sense of ownership, and take the responsibility to replace cleared areas and manage regenerating seedlings. In addition, promoting agro-forestry system and practices will help to significantly minimize the clearing of forest areas and cultivation of marginal lands.

The main bio-degrading agents that damage woody species are termite and fungus. To prevent termite damage, farmers in this area did not use any prevention nor control mechanisms. There is no specific time of cutting wood trees either during the dry or the wet seasons, such improper and indiscriminate cutting and harvesting of wood trees diminished the number of trees used for timber production and this led rural households to depend on purchased timber products for making house door and windows. The most commonly used non-timber forest products include *gob* and *kedi* fruit for human food and source of income. Creating awareness and exercising customary law by the local communities was the major conservation practice implemented in this area

4.5.3 Recurrent drought

Drought is defined as a period of dryness (dryness of water or climate) that affect the earth and preventing the growth of plants (Thornthwaite, 1947). There are three main types of droughts: meteorological, agricultural, and hydrological (National Drought Mitigation Center, 1996). All these drought types occur in

different areas of the study depending on their landscape, soil, and climatic characteristics. Agricultural drought is the typical drought extensively recognized in Jigjiga plains, particularly in areas prominent with cultivation of wheat, barley, and cowpea, where hydrological and mereological droughts occur in the upper Fafan and Upper Harawa areas. According to FGD, farmers' believed that drought occurs in Jigjiga plains when the *Karan* rainy season fails, which is the main cropping season in their area. In addition, these areas are dominated by clay vertisols that highly conserve the moisture for crops. On the other hand, the failure of *Gu'u* rainy season is considered as drought in the upper Fafan and Upper Harawa areas. Similarly, a prolonged dry season, which can give rise to severe drought condition is recognized in the entire study area, when both of the rainy seasons fail. According to OWWDE (2012), the result of drought probability range is found to be 31% and 64% for areas around Jijiga plains and upper Harawa, respectively. Thus, the study area is classified as Moderate to high drought probability Zone. While opinions vary on the severity and frequency of drought in the historical past, recent reports and community opinions show that drought hazards have increased in frequency, intensity and magnitude over the recent decades adversely impacting on food, feed and water security and sustainable livelihoods of the agro-pastoral community.

Drought hazards, combined with high level of vulnerability, have a major effect in the study area. The effects can be classified as economic, environmental, and social. Economic impacts include poor crop and pasture stand, depletion of water, poor body condition of the livestock, and increased livestock disease or very less/no milk production. The second effect of great significance is environmental which is mainly a result of coping mechanisms. Deforestation, biodiversity loss, soil erosion and desertification are some of the environmental effects that need due consideration in the study areas. Cutting of trees for fuel, bush encroachment to

extend farm lands, invasive weeds and burning of pasture lands are also some of the human activities that exacerbate the above mentioned environmental effects. Regarding the social impacts, distress migration to other places where they can get feed and fodder, and malnutrition were also observed in the study areas.

4.6. Natural Resources Conservation Practices

4.6.1. Soil and water conservation practices

Soil and water conservation (SWC) targets the conservation of soil, water and related natural resources on agricultural land, rangeland, and forestland. SWC was often directed primarily to either soil or water conservation, but mostly contains an element of both. Water conservation mostly entails the implementation of land use changes, farming practices, or physical structures, which often counteracts erosion. SWC usually involves improving soil properties, reducing erosion, crust formation or breakdown of soil structure, all of which also increase infiltration, and hence contribute to water conservation.

According to field observation, FGD, and KII, hillside terraces, soil bunds and sandbag check-dams were the only SWC measures practiced at community levels in the entire study areas. These interventions have predominantly been done through PSNP food or cash for work programs, especially on communal lands. Some other SWC measures, such as hillside terraces, gabion check-dams, water spreading weir, and masonry structures have been implemented in some parts of Jigjiga plains, Karamara ridge, and Awbarre hilly terrain areas through top-down approach with no much participation of the local community. According to FGD, the employed interventions were executed by SRS, Bureau of agriculture and GIZ largely through top-down approach. According to the local community's reflection, due to the

implemented SWC measures, surface water availability, soil moisture content, crop yield, and vegetation cover were increased. Moreover, the soil erosion decreased and gullies stabilized and changed into cultivated land. However, the interventions are still limited compared to the magnitude of the current soil erosion problem. In addition, the limited SWC measures implemented have been facing the following constraints:

- Some check dams were applied to large gullies, that resulted in limited lifespan of the structures without upper watershed management interventions
- Demolishing of structures with heavy erosion and lack of maintenance of the structures after construction (Figure 18)
- Physical measures have been applied alone and the biological SWC measures were ignored
- Lack/limited local community participation during the implementation of SWC projects
- Since communities get compensation for restoration of a problem which is mostly caused by themselves (overgrazing/deforestation), the incentive to deal with the challenges and up-scaling of the interventions remained limited.

Figure 18. Check-dams demolishing and losing their physical appearance and functionality at Karamarda mountain.

4.6.2 Tree planting and agroforestry practices

Even though the agro forestry practice in the study area is not well developed, there is an interest by some agro-pastoralists to

plant trees on their farms and around their homesteads. However, after the trees have grown, they don't have enough knowledge on the ways of tree management on the farms. The common exotic tree species planted in the farm lands by the agro-pastoralists are eucalyptus, Mangifera indica, Guava, and citrus fruit, while some of the most dominantly grown native tree species include *Ziziphus mauritiana*, Acacia *abyssinica*, and *Acacia albida*, which are the most commonly retained tree species on farms. The farmers use the trees as farm implements, fencing and firewood. The contribution of trees to soil fertility improvement as well as increasing crop productivity was not well understood by agro-pastoralists. For instance, they have planted environmentally unfriendly trees on farms, such as eucalyptus, which exacerbates water drainage and suppresses growth of other vegetation.

Farm forestry practice is not well-developed by the agro pastoralists in Fafan area. However, there are some start up actions being introduced and scaled-up to different sites. Incorporation of trees/shrubs into farming systems could contribute to maintain ecological stability and improving the environment. With proper integration and management of trees / shrubs, it is possible to exploit their protective ability to enhance food crops and livestock production. The most preferred tree species by farmers and their uses are indicated in Table 15. *Sansevieri*a, *Azandrichata indica*, *eucalyptus* and *Acacia* are the trees and shrubs planted at the households' homestead and farmlands. Eucalypts is multi-purpose and used for house construction, commercialization, farm implements and income. *Azandrichata indica* is mainly used for shade and to some extent for house construction while *ziziphus* is used for farm equipment and fencing of house and source of feed for livestock.

Table 15. Farmers' preference ranking of tree species based on their use value, 2023

Major uses	Most preferred species										
	Maraa	Wadhi	Qudhac	Gob	Cadaad	Miays	Xagar	Garbi	Sogsog	Wabey	Galool
Fuel Wood	1	1	4	4	4	5	5	5	4	2	2
Charcoal	2	3	1	5	5	4	4	3	3	4	1
Construction	3	2	2	2	3	3	2	4	5	1	3
House material	4	4	3	3	2	2	1	2	1	3	4
Fencing and boundary marking	5	5	5	1	1	1	3	1	2	5	5

Challenges and opportunities of tree planting

A. Challenges

According to the FGD participants, the major challenges of tree planting in the study areas included free grazing practices, expansion of farmlands, deforestation, and improper cultivation as well as low level of community involvement on agro-forestry practices. In addition, lack of proper land tenure rights, difficulty of managing community woodlots, lack of incentives for tree planting and replanting to replace harvested trees, lack of proper institutional arrangements, lack of community forest and participatory forest management systems have also impacted the tree planting schemes. On top of these, some technical challenges witnessed during tree planting of the green legacy initiative include; low quality seedlings, inappropriate tree species, poor soil depth, lack of adequate moisture, inappropriate planting time, inappropriate site selection for tree planting and unavailability of sufficient number of seedlings.

B. Opportunities

The following opportunities were also identified during the study, which could help to address the challenges on sustainable basis:

- Increased community's interest to engage in forest conservation and tree planting activities
- Availability of sufficient labor for implementation of agro forestry practices
- Positive attitude of the community in forest development efforts
- Availability of potential productive and suitable land for reforestation and afforestation
- Integrated on farm tree demonstrations for improved production
- Demonstration of integrated backyard multipurpose trees.

4.7. Cause and Effect analysis of NRM Problems

FGD participant farmers identified and prioritized NRM related problems as presented in Table 16. Moreover, they have indicated the root causes of these problems and the effects if the problems remain unsolved. They have also suggested solutions on how the problems could be addressed. The study team has also enriched the causes, effects and possible solutions from their experiences and knowledge. The team has also identified some of the opportunities which could be harnessed to implement the proposed solutions. Development actors which could have stakes in addressing the challenges have also been suggested.

Table 16. Cause and effect analysis of NRM problems in the study areas, 2023.

Rank	Problem	Cause	Effects	Solutions	Opportunities	Actors
1	Recurrent drought	• Climate change/variability • degradation of natural resources	• land degradation • low crop yield • limited feed resources • food and water shortages • Dismal livelihoods	• Natural resource rehabilitation and restoration • Expand irrigated agriculture • Water harvesting and ground water exploitation • Introduce early maturing crop varieties. • Assess and Predict climate and variability	High potential ground water at Upper Fafan areas. Availability of early maturing crop varieties.	Forest, climate change and Environmental protection, RBoANR, Livestock Resources Development Burau, DRM, Irrigation and lowland valley development, water resources Bureaus. LLRP, SORPARI, EIAR, CIAT, JJU, TVETs, NGOs, Local community etc.
2	Shortage of potable water	• limited unreliable rainfall • limited water supply infrastructures	• limited available water for humans and livestock • Expending more time for fetching water • Conflict	• Development of Water harvesting structures • Exploitation ground water • Introduce suitable water harvesting technologies	• High potential ground water at Upper Fafan areas. • Smart topography for flood water harvesting at Upper Harawa	Water resource Bureau. Irrigation and lowland valley development Bureau, SRDWWE, LLRP, SoPARI etc.

3	Soil erosion	• Lack of appropriate land management interventions • Path ways and roads • Overgrazing • Steep slope • Surface runoff • Deforestation	• Soil fertility depletion • Soil productivity loss • Low crop yield • Limited feed resources • Land use change; e.g cropland into gullies • Expansion of gullies	• Establishment of Soil and water conservation (SWC). • Evaluate Soil erosion risk trends and identify its prone areas • Introduce suitable SWC technologies • Introduce agroforestry technologies	• Availability of resources for SWC • Availability of institutes working on natural resources conservation	Forest, climate change and Environmental protection, RBoANR, SoPPARI, LLRP, JJU, NGOs, local community.
4	Soil fertility depletion	• Soil erosion • Monocropping over long-time period • Crop residue removal • Poor soil management • Domination of invasive plant species e.g Lantena Camera, Cactus etc.	• Low soil productivity • Low crop yield • Limited feed resources	• Application of vegetative and agronomic Conservation practices • Application of Organic and inorganic fertilizers • Introduce soil fertility restoration and improving technologies	• good transportation access for technology dissemination • available resources for SWC practices	RBoANR, SoPPARI, Forest, climate change and Environmental protection, LLRP, JJU, NGOs, local community.
5	Rangeland degradation	• Climate change and variability • Agricultural expansion	• Prevalence of Poisonous plants to livestock • Loss of plant	• Application of mechanical control measures to reduce invasive plant	• Community is aware of the problem and its effects.	Forest, climate change and Environmental protection, RBoANR, SoPPARI, LLRP, JJU,

		• Overgrazing • Bush and woody encroachment • Soil erosion	diversity • Bush encroachment • Limited feed resources • Soil fertility decline • Limited rangeland productivity	species • introduce of appropriate mechanical and biological control measures and technologies • Rangeland rehabilitation interventions • Regeneration of threated plant species	• Available resources for rangeland rehabilitation	NGOs, local community.
6	Deforestation and forest degradation	• Conversion to farmland • Increased population • Overexploitation of forest resources • Compaction of soil • Internal & externally displaced people (refugee camps)	• Limited feed resources • Climate change • Soil erosion • Habitat loss	• Afforestation and reforestation • Strategic plan for forest utilization • Awareness creation to refugees and IDP settled areas	Green Legacy program & commitment of the government, increased awareness of the community, availability of organizations working on natural resources conservation	Local community, woredas Environment bureau

Identified problems and suggested interventions

Depending on the nature of the problem, the causes and opportunities available, the study team suggested the following intervention options to help address the constraints and improve NRM circumstances. The recommendations can be applicable not only in the study areas, but also in other similar agro-ecologies of the region.

Developmental interventions

- Nursery establishment for seedling raising is important for the local communities to plant and regenerate as well as propagate locally important plant species.
- Community based and appropriate soil and water conservation technologies entailing physical and biological measures should be designed and established
- Participatory afforestation program for locally adapted fruit and forest trees entailing nursery establishment, tree planting, management and sustainable utilization should be developed and implemented
- Community based water harvesting technologies that integrate agriculture, livestock and tree planting should be designed, constructed and established
- Well-designed agroforestry systems should be promoted for restoring the productive capacity of degraded agricultural fields
- Restoring the fertility and productivity of soils through an integrated soil fertility management approach should be promoted

Researchable directions

- Regeneration capacity of forest trees, particularly of threatened plant species needs to be studied further. The contribution of agroforestry in improving soil fertility & organic matter content, minimizing erosion, increasing soil water holding capacity and

soil water infiltration as well as carbon sequestration should be studied.

- The resource potential of non-timber forest products and their socio-economic significance in the study areas should be explored
- Introduce different agroforestry system and practice technologies, such as orchard-based agro-forestry, Silvo-pastoral system, and Agro-Silvo-pastoral systems.
- Soil salinity appraisal should be undertaken
- Suitable soil and water conservation measures should be evaluated and introduced
- Soil fertility studies should be conducted and available soil fertility technologies should be scaled-up

Policy interventions

- Green legacy initiative should focus on locally preferred tree species considering the various bio- physical factors. In this regard, the characteristics of the planting site, the type of tree species to be planted, purpose of tree planting, time of tree planting, nature of soil depth, moisture content and others should be taken in to account. Policy guideline that clearly stipulate as to how trees planted through the green legacy initiative are managed, maintained and utilized should be developed. The policy document should also clearly state the mandates of the major actors (implementing institutes) and relevant stakeholders in sustaining the green legacy initiative.

- Internally displaced community and refugees should appropriately be settled and their level of awareness and knowledge about optimum utilization and forest resource protection should be enhanced

CHAPTER 5
CROP PRODUCTION PRACTICES

5.1. Major crops grown

5.1.1. Field crops (Cereals, Pulses and Oil Crops)

Crop production is one of the agricultural sectors where most of the rural small holder farmers are involved in producing basic items both for food and market. Field crops such as cereals, pulses, oil crops and fiber crops are the major classes which constitute the major part of crop production sector in the study areas. Among the field crops, cereals and pulses are the major components of crop production systems in Somali region, in general, and in Fafan zone, in particular. In the Upper Fafan agro-ecolgy, maize (*Zea mays L*) and sorghum (*Sorghum bicolor (L.*) Moench), are the major cereal crops grown by the farmers while wheat (*Triticum aestivum*), barley (*Hordeum vulgare L*), and oats *(Avena sativa)* are commonly grown cereals in Jigjiga Plain agro-ecology (Table 17). Moreover, in the Upper Harawa agro-ecology, pear millet (*Pennisetum glaucum*) is the third most dominantly grown crop after maize and sorghum.

In sub-moist mid highland, the major pulse crops produced are ground nut and cowpea but a few farmers also produce haricot bean where the rest two agro-ecologies practice growing of chick pea and cowpea.

5.1.2. Horticultural crops

Somali region has a great diversity of climates and soil conditions favorable for the production of different horticultural crops including fruits, vegetables, root and tuber crops. In the Upper Fafan agro-ecology, tomato, onion, hot pepper, and cabbage are most predominantly produced vegetable crops but water melon is most commonly produced in all agro-ecologies except Jigjiga Plain.

Table 17. Major crops grown across agro-ecologies of the study areas, 2023.

Agro-ecology	District	Kebele	Crops
Upper Fafan	Gursum	Kubijaro,adade and goray	Maize,sorghum,groundnut,cowpea ,haricotbean,tomato, onion hot pepper ,cabbage and water melon.
Jigjiga Plain	Awbarre	Kabrinune and Jare	Maize, sorghum, wheat, barley, Oats and chick pea
Upper Harawo	Awbarre	Hilingab	Maize,sorghum,pear millet ,onion tomato and water melon

Source: FGD, 2023

5.2. Crop varieties grown across agro-ecologies

Sorghum has been the staple food crop for people in drier or moisture stress areas where other cereals may not be well adapted. It has been found as an indigenous crop to Somali region with enormous genetic diversity particularly in Fafan zone. As a result, the different types of sorghum local varieties grown in the area are *cilmi-jama*, *adan gab*, *wagoro*, *dangi*, *masango* and *casey. Cilmi-jamac* is the most preferred variety in Upper Fafan and Jigjiga Plain agro-ecology due to its higher number of heads,

tillering capacity, high biomass, tolerant to moisture stress and its good attributes to make various food products (*shuro* and *laxoox*) whereas dangi variety is preferred by some farmers due to its tolerance to bird attack in the Upper Fafan agro-ecology. Moreover, masango variety is the most preferred in the arid lowland agro-ecology due to its higher biomass and grain yield.

The local maize varieties grown in the area included *caddey* and *nijaar (Casey)*. Most of the farmers in the Upper Fafan agro-ecology produce *caddey* variety due to its high yielding and good attributes to make *shuro* (maize flour). On the other hand a few farmers in this agro-ecology prefer to grow *casey* variety for its early maturing attribute. Moreover *nijaar (Casey)* is predominantly grown by the farmers of Jigjiga Plain and Upper Harawo agro-ecology for its adaptability to the area, early maturity (3 months) and better taste.

In the Jigjiga Plain agro-ecology, farmers grow local wheat verities of maize mainly *caddey* and *casey*. The former is high yielder but highly vulnerable to moisture stress. With regard to barley, only the farmers in Jigjiga Plain agro-ecology produce local varieties, such as heed *madow* and *ifaad (casey*). *Heed madow* is preferred by the farmers mainly for its seed size.

The farmers in the Upper Harawo agro-ecology grow pear millet. They only produce local varieties such as *tukhun cad* and *tukhun madow*. *Tukhun madow* is predominantly produced due to its many seed numbers per head and seed size. Oats are also produced by the farmers in Jigjiga Plain agro-ecology using a local variety named as *sareen.*

Cowpea is the major legume crop predominantly produced by the farmers in all the agro-ecologies. According to the farmers of Upper Fafan agro-ecology, the local cowpea varieties grown included danguli, yusufe (*haricot ase*), shonkore and haricot adde.

The variety called yusufe (*haricot ase*) dominates the production for it is the most preferred variety among cowpea varieties by the farmers for its better yield potential in this agro-ecology. On the other hand, some of the farmers also produce *haricot adde* variety for sale due to its early maturing attribute. On the other hand, the farmers in Jigjiga Plain and Upper Harawo agro-ecology produce only one local variety called *digir.*

In the Upper Fafan agro-ecology, ground nut is the most important legume crop. Framers mainly grow jaws (bunch type) and *saarti* (spreading type) ground nut local varieties but *jaws* variety is the dominant and mostly preferred by the farmers for its bigger sized pegs, early maturing and easiness to harvest compared to *saarti* variety. However, a few farmers still produce *saarti* variety for its high yielding attribute. Rather than ground nut, farmers in Jigjiga Plain and Upper Harawo agro-ecologies grow chick pea as important pulse crop by using early maturing local variety called *shunburo.*

Knowledge of variety attributes largely helps to strengthen and make breeding programs demand driven and client oriented. In developing and generating improved varieties that can easily be adopted by producers, the breeding programs should take into consideration of the positive attributes of the varieties which are preferred by the producers and consumers.

The consumption and marketing of vegetables and fruits is relatively limited in Jigjiga Plain and Upper Harawo agro-ecology because of their high perish-ability, long time maturity and high production cost, but vegetables are majorly grown in Upper Fafan agro-ecology. In Upper Fafan agro-ecology, horticultural crops (vegetables & fruits) such as tomato, onion, cabbage, Pepper (green and red) and water melon are the major ones. Moreover

water melon is grown to some extent by the farmers of Upper Harawo agro-ecology as a fruit crop for sale purposes.

The survey results also indicate very low use of improved varieties in most of the crops mainly due to unavailability of the improved variety seeds, and supply shortages. The available technologies in different parts of the country might not have reached the farmers adequately and timely. A few farmers have ever adopted improved varieties of sorghum, wheat, onion and water melon despite they do not know the right names of most of the varieties (Table 18). Instead, they called in local variety names for improved varieties as well in all agro-ecologies. This is because of inadequate extension services in creating awareness of the community about the features of improved varieties and their names. This in turn makes difficulty of tracking adoption rates and impacts of improved varieties in the later years after introduction and dissemination.

5.3. Crop Production and Land Coverage

5.3.1. Rain-fed Crop Production

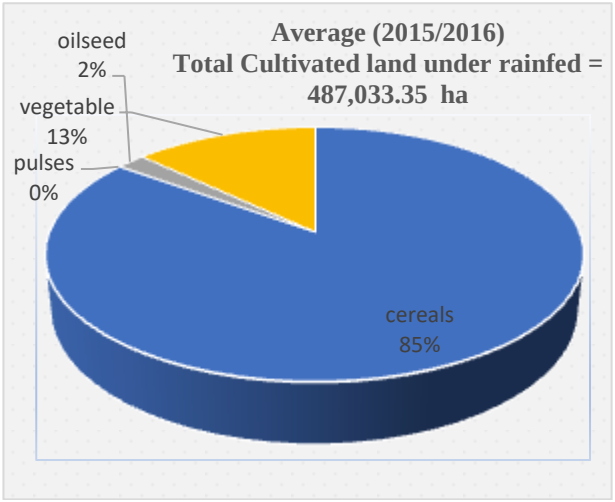
Fafan zone is among the high potential crop production areas in SRS with a marketable surplus for the urban markets in both under rain-fed and irrigated farming. Crop production is mainly rainfed (about 94%) supplemented with some extent of small-scale irrigation (about 6%). The availability of suitable and diversified agro-ecologies enables the production of a variety of crops. Evidence shows that, on average, nearly 12 million quintals of different crops are produced annually from 487 thousand hectares of land under rainfed condition (Figure 19). In this case, cereals take the lion's share where they accounted for **85%** and 68% of the total crop production and cultivated land in the zone,

respectively. Other important crops in terms of area coverage include vegetables (13%), oilseeds (2%), and pulses (0.1%). However, accounting for 31% of the total production, vegetable crops stand next to cereals in the zone under rainfed condition.

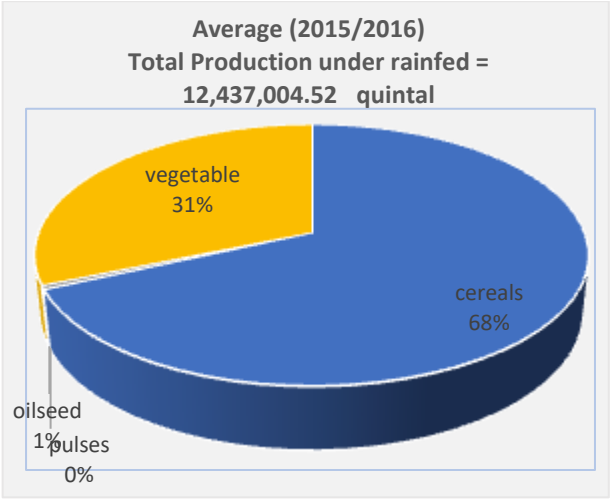
Table 18. Varieties grown by the farmers and their seed selection criteria, 2023.

Sn	Crop name	Farmers local varieties/land races	Selection criteria of seeds for next season plantation	Improved varieties
1	Sorghum	• Ilmi jama • Adan gab • Wagoro • Dangi • Masango	• Healthy and bigger sized seeds • For their sweatiness of the stem part • Their leave midrib color	• Kir-mici (early maturing, low yield) • Kor u saydh and Hadhudh cas
2	Maize	• Addey and • Asey(Nijaar)	• Number of kernels per cobe/ear • Higher number of ears	• Melkasa 1 • Melkasa 2
3	Wheat	-	• No. seed/head, early maturing and yield potential	• Quufe/qoslaye • Jay
4	Barley	• Heed madow and • lifaad (casey)	• Seeds/head, head/plant, stem and Preserved in bags	Not introduced yet
5	Pear millet	• Tukhun cad and • Tukhun madow	• Seeds/head, head/plant, stem and Preserved in bags	No
6	Oats	• Sareen	• Seeds/head, head/plant, stem and Preserved in bags	No
7	Cowpea /attarka	• Danguli • Yusufe • Shonkore • Haricot adde • Digir	Higher number of pods	No

8	Ground nut	• Jaws • Saarti	Higher number of pegs	No
9	Chick pea	• Shumburo	Health, seed size	No
10	Onion	-	No bulbs, bulb size	Yaryar and Yemen hadramut
11	Tomato	-	Fruit size, frequency of harvesting,	Yaryar and waaweyn
12	Cabbage	-	-	-
13	Hot pepper	-	-	-
14	Water melon	-	-	Xabxab cad iyo xabxab madow



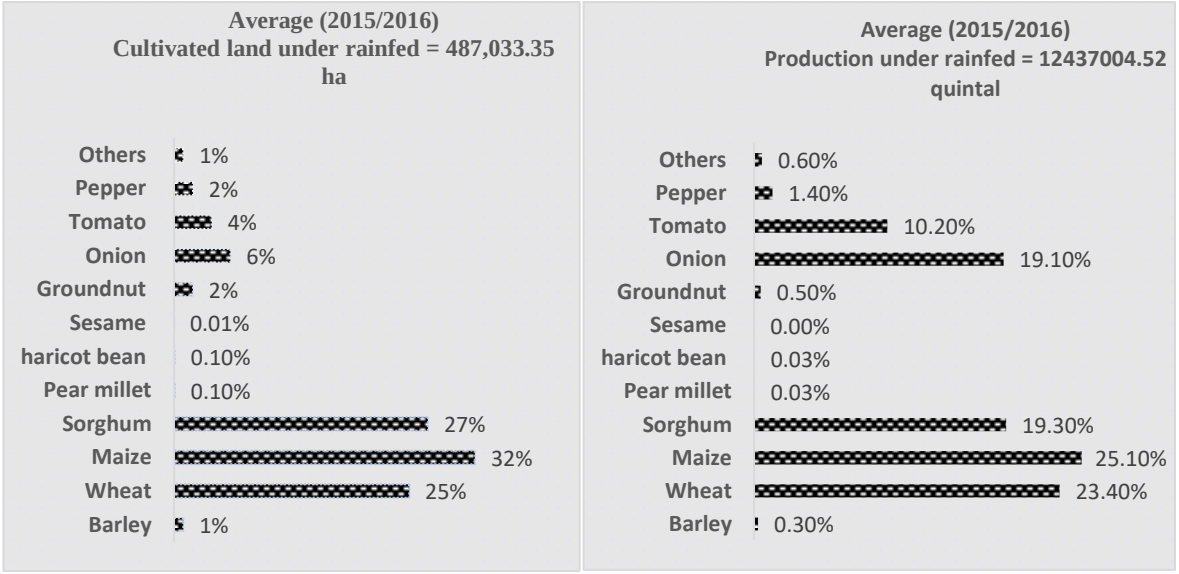
(a) **Total Cultivated land under rainfed**



(b) **Total Production under rainfed**

Figure 19. Area (a) and annual crop production (b) in Fafen zone (rainfed condition)
Source: Zonal Office of Agriculture (2023)

In general, rainfed food grain production is the dominant subsector in the zone. The annual food grain production is estimated at 8.4 million quintals from nearly 415 thousand hectares of land. Here, maize is the most dominant cereal crop accounting for nearly 25.1% of the total food grain production and 32% of the total land (Figure 20). Other important crops in terms of area coverage include sorghum (27%), wheat (25%), barley (1%) and Pear millet (0.01%). However, maize is the dominant crop followed by wheat in terms of their contribution to total food grain production in the zone, the former accounting for nearly 25.1% while the latter 23.4%. Sorghum stands third in terms of total food grain production despite it stands second largest in area coverage.

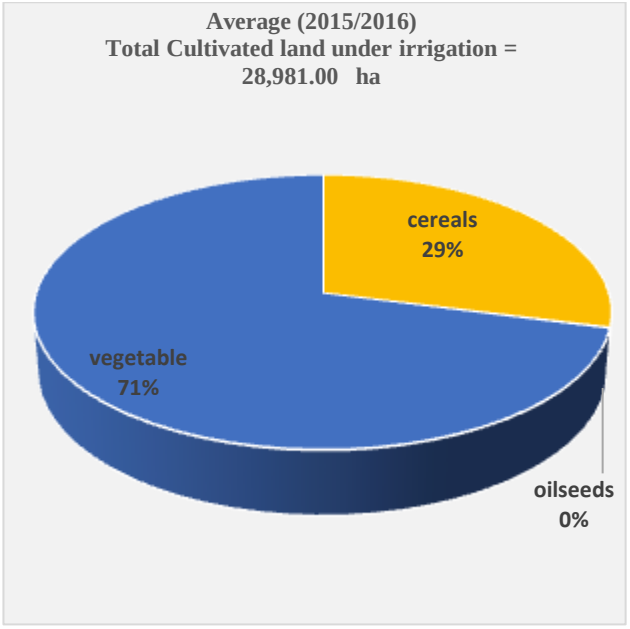


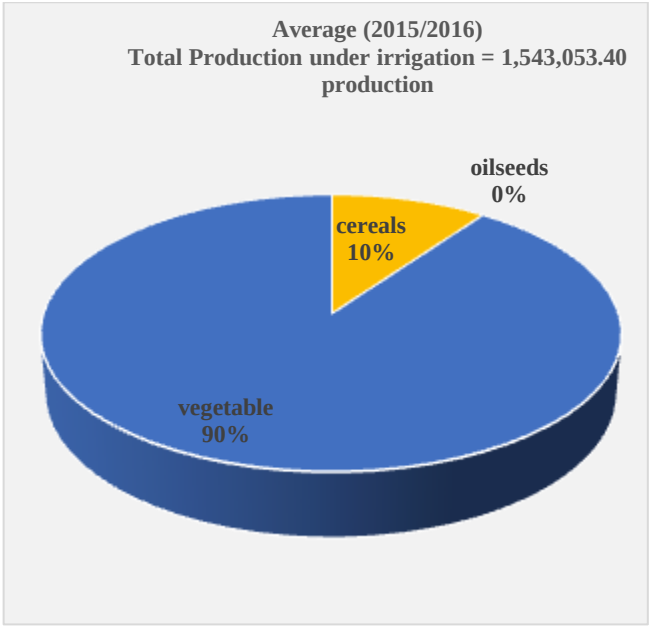
(a) **Major Cultivated crop area under rainfed** (b) **Major crop Production under rainfed**

Figure 20. Major crops area (a) and production (b) in 2022/23 cropping season
Source: Zonal Office of Agriculture (2023)

5.3.2. Irrigation Agriculture

Crops in Fafan zone are also produced under irrigated farming based on a smallholder production system. In Jigjiga Plain and Upper Harawa agro-ecology, the accessibility of irrigation is relatively low but in Upper Fafan agro-ecology, there is better irrigation access but the farmers couldn't economically afford to utilize it because of high cost of motor pump fuel energy and canal maintenance. According to the information from Fafan Zone Office of Agriculture, vegetables take the lion's share to be produced under irrigation accounting for **71%** of the area and **90%** of total crop production (Figure 21). On average, nearly 1.5 million quintals of different crops were produced annually from 28 thousand hectares of land under irrigation condition.





(a) **Total Cultivated land under irrigation** (b) **Total Production under irrigation**

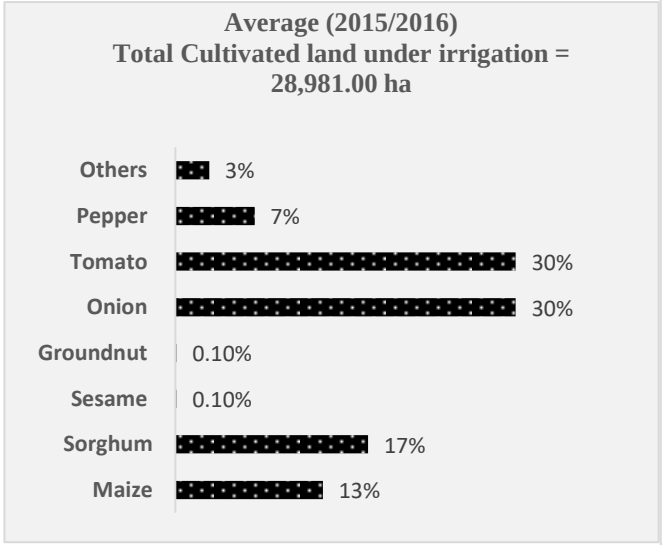
Figure 21. Annual area (a) and production (b) of crops in Fafan zone under irrigated condition

Source: Zonal Office of Agriculture (2023)

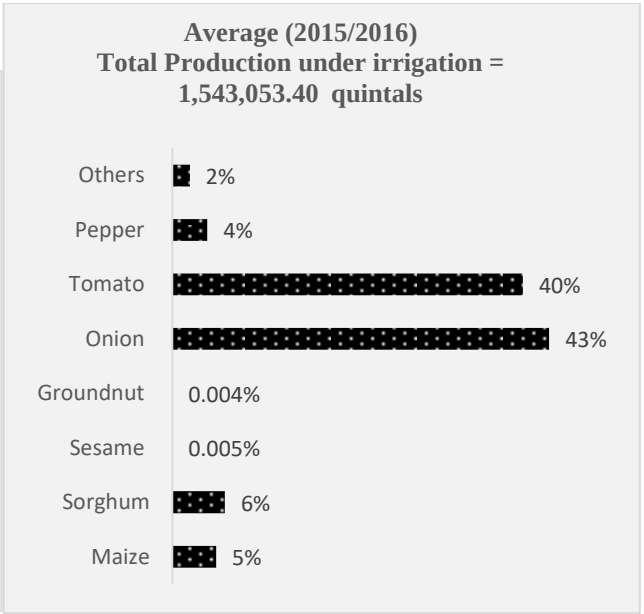
Under irrigated conditions, vegetable production appeared to be the dominant subsector in the zone. Specifically, annual vegetable production is estimated at 1.3 million quintals from nearly 20 thousand hectares of land. Here, onion is the most dominant vegetable accounting for nearly 43% of total vegetable production while covering about 30% of the total food grain cultivated land (Figure 22). Other important crops in terms of area coverage included tomato (30%), and sorghum (17%). However, onion is the dominant crop accounting for 43% followed by tomato (40%) in terms of their contribution to total vegetable production in the zone.

Our survey results also showed that there is diversity in cropping patterns across the three major agro-ecologies. Accordingly, the major crops produced in the dominant moist mid highland agro-ecology in order of importance included maize, sorghum, wheat, oats, barley, and chickpea. In the Upper Fafan agro-ecology, the major crops are primarily sorghum, maize, groundnut, cowpea, onion, tomato, cabbage and haricot bean. Similarly, the major crops in the Arid lowland agro-ecology include maize, sorghum, pear millet, chickpea, onion, tomato and water melon. It was also observed that, regardless of the agro-ecological difference, maize, sorghum and wheat production are mainly grown on black (vertisols) and red soil dominated areas.

An attempt was also made to assess the purpose of crop production in the study areas. Survey results showed that crop production is meant to meet multiple socioeconomic objectives primarily household food security and cash needs. As clearly depicted in Figure 23, the major cash crops in order of importance included wheat, onion, tomato, groundnut, hot pepper, chickpea, and cowpea. For instance, according to 98 and 90% of the households, chickpea and wheat are mainly produced for sale. Other crops, such as sorghum, maize, barley, oats, pear millet and haricot bean are mainly used for home consumption purposes. According to 84% and 79% of the households, barley and maize, respectively, are mainly produced for home consumption.

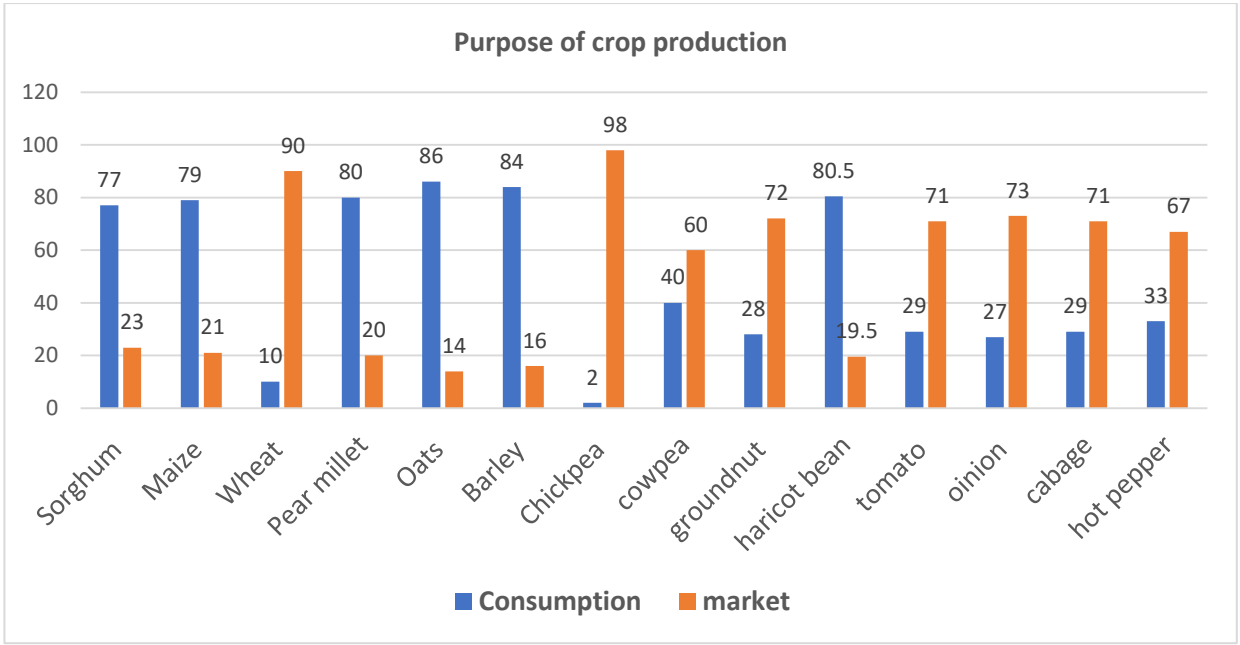


(a) **Major Cultivated crop area under irrigation**



(b) **major crop Production under irrigation**

Figure 22. Major crop types area (a) and production (b) under irrigation in Fafan zone
Source: Zonal Office of Agriculture (2023)



[118]

Figure 23. Farmers' purposes of crop production in Fafan zone, 2023.

5.4 Cropping System and Agronomic Management

5.4.1. Cropping system, Land preparation and planting time

Mono cropping system is mainly being used in all agro-ecologies while intercropping of maize with sorghum and crop rotation over three years are also being used in sub-moist mid-highland. It was recorded that almost all of land preparation operations are commonly done using tractor. Some of the households who cannot afford services of tractors depend on oxen labor. Those households who cannot get tractor services timely also resort to the use of oxen labor. Land preparation in the study area differs depending on the types of cultivated crops. It was reported that there are three different types of land preparations: the first land preparation starts early in March and April following the onset of the long rainy season (***GU or Badheyso***) in arid lowland, Jigjiga Plain and Upper Fafan agro-ecologies for sorghum, maize, groundnut, cowpea and pear millet crops. The second land preparation starts in June (***Xagaa***) in arid lowland and Jigjiga Plain agro-ecologies for barley, oats and chickpea while the third starts in July (***karan***) for only wheat production in Jigjiga Plain. Planting time varies depending on crop types starting early in April for sorghum, maize, groundnut, cowpea and pear millet crops and extends to the last week of June for barley, oats and chickpea and last week of July for wheat cultivation.

Survey results showed that ploughing frequency is closely associated with the capacity of farmers for renting tractor services. In general, the ploughing frequencies tend to be similar for almost all of the major crops and it could reach up to two

times including planting for all the different soils in the study area.

On the aspects of gender roles in crop production, land preparation using oxen is carried out dominantly by male farmers while female participate in helping male farmers in performing activities such as providing meal and water, and feeding oxen at farm. Farming activities are dominantly operated by men while women also participate in weeding and other activities.

5.4.2. Planting Methods and Seed Rate

Broadcasting planting method is still widely being practiced to almost all of the crops except row planting method adopted for some crops, such as groundnut and sorghum. The reasons why farmers still depend on broadcast planting were identified by farmers as: lack of row planter machinery, and labor and capital for row planting. It was emphasized that row planting is not practiced for the crops due to the high labor demand. To use machines, there is no animal drawn row planter equipment available in the study area. Because of this, farmers still continued to use broadcasting by applying high seed rate over the recommended practice when broadcasting the seeds. For instance, wheat seed rate using broadcasting was estimated between 150 to 200 kg per hectare which is much higher than the recommended rate of 100 kg per hectare (Table 19).

Farmers justified that they use high seed rate to compensate for poor seed germination as a result of insufficient seedbed preparation and picking of seeds by birds. There are also cases where farmers use less seed rates than recommended. For instance, farmers' maize seed rate widely used by farmers for broadcasting was 12 kg per hectare, while the recommended rate is 25 kg/ha. Similarly, groundnut farmers use below the recommended seed rate (40 kg/ha) while the recommended was in the range of 80 – 100 kg/ha.

Table 19. Land preparation, seed rate and major crop production calendar, 2023.

Crops	**1st plowing**	**Planting**	**Method of planting/sowing**	**Seed rate kg/ha**	**Recommended**	**Seed covering method**
Sorghum	March and April	April	Broadcasting	8 kg	20-24 kg	Oxen, tractor and hand
Maize	March and April	April	Broadcasting	12 kg	25 kg	Oxen, tractor and hand
Pear millet	March and April	April	Broadcasting	10 kg	-	Oxen, tractor and hand
Wheat	July	July	Broadcasting	150 kg	100-120	Oxen, tractor and hand
Chickpea	June	June	Broadcasting	16 kg	120-140 kg	Manually
Cowpea	March and April	April	Broadcasting	17 kg	-	Manually
Barley	June	June	Broadcasting	75 kg	125 kg	Oxen, tractor and hand
Oats	June	June	Broadcasting	75kg	100 kg	Oxen, tractor and
Onion and tomato	April	April		0.75 and 25kg respectively	-	Manually
Groundnut	March and April	April	Row planting	40 kg	80-100 kg	Manually

Source: - own survey result, 2023

5.4.3. Pest Management Practices

Major weeds

The farmers in the study area revealed that there are a number of different problematic weeds
affecting crop production in the study areas. The distribution of weed types varied across agro-ecologies and crop types. However, broad leaved are the most widely distributed weeds followed by grass weeds. As an exception, the most problematic weeds in the sub-moist mid-highland, Upper Harawo and arid mid high-land agroecologies, in order of importance include Bermuda thistle (*Qodxaale*), Bidenpilosa (*Baasuke or kuunbe)* and *Sanaadh*, respectively. Weeds are generally problematic on all crops in the study areas. It was found that farmers usually use hand weeding method to control problematic weeds. The weeds identified in the study areas are briefly outlined in Table 20.

Table 20. Major weeds and farmers' control methods, 2023.

Crop	Major weeds	Frequency of weeding of major crops	Control method used by farmers
Sorghum, maize, cowpea and ground nut	Bermuda thistle *Argemone mexicana* L.) (Qodxaale)	Commonly two times	Mechanical (sickle)
All crops	Qoodho tamaadh	Commonly two times	Hand weeding
All crops	Parthenium	Commonly two times	Hand weeding
Sorghum, maize, cowpea, wheat, barley, oats and pear millet	*Xanthium orientale* L. (*Baasuke or uunbe)* *	Commonly two times	Hand weeding
All crops	*Garan-waa*	Commonly two times	Hand weeding
Wheat, barley and oats	Annual ryegrass *(Midaado)*	Commonly two times	Hand weeding
	sanaadh *	Commonly two times	Hand weeding
All crops	Shaqshaq	Commonly two times	Hand weeding
All crops	Couch grass or Quackgrass *(Elytrigia repens) (Hadhudh shinbireed)*	Commonly two times	Hand weeding

Source: - Own survey result, 2023

Major Crop Diseases

Diseases and pests are other problems of crop production in the study area. These diseases attack crops mainly at the very beginning of germination, vegetative, at flowering and grain filling stages of the crop growth. Several pathogenic pests were also reported during our field survey (Table 21). Root rot/dry root (*qalajiye*) is the major maize, sorghum, cowpea, groundnut and wheat production disease while these crops were also reported to have sometimes been affected by Fusarium head blight (*hayaamiso*). Smut and Rust also affected most of the cereals production in the study area. Farmers were found to have no control mechanisms in the case of the outbreak. However, farmers' in parts of the study areas traditionally recite verses of quran to a water and then spray to the corners of the field.

As revealed in Table 22, the survey identified several insect pests affecting crop production in the study areas. Insect pests also vary depending on agroecology and crop types. In general, the Upper Harawa agroecology was observed to have less insect pest problems compared to other agroecologies. Stem borer was reported as the major pest affecting maize and sorghum production. It was estimated that the pest could cause up to 50% maize yield loss. Mono-cropping was indicated as the major caustic factor for the high-level of stalk borer incidence.

Fall Army worm is also an important insect pest affecting maize, sorghum, cowpea and groundnut production. Besides, cereal production is seriously affected by cutworm which is locally named as *qunburse*. Aphids and Arm worms were also reported as major pests affecting cowpea and chickpea crops.

Table 21. Major diseases and crops damaged in the study areas, 2023.

Disease	**Attacked crop (s)**	**Control method used by farmers**
Rust (*harqaan*)	Maize and wheat	(Taxaliil) Reciting verses of quran to a water then spraying the corners of the field in some parts of the study
Leaf blight	Tomato	
Root rot/dry root (*qalajiye*)	Maize, sorghum, cowpea, groundnut and wheat	
Smut	Maize, sorghum	
Daado	Wheat	
Fusarium head blight (*hayaamiso*)	Sorghum, wheat and maize	

Source: - own survey result, 2023

Table 22. Major insects and crops damaged in the study areas, 2023.

Pest	Crop (s)	Control methods used by
Fall Arm worm	Sorghum and maize,	No control mechanism
(qunburse), cutworms	Maize and sorghum	No control mechanism
Stem borer (Doni-shaxar)	sorghum and maize	No control mechanism
Diir (Arm worm)	Cowpea and chickpea	No control mechanism
Stem borer	sorghum	No control mechanism
Aphids (Bambi/injir)	Cowpea (yuusufe)	No control mechanism
Grain weevil	Grain crops	Exposing to sun and tablets
Angoumois grain moth	Maize, sorghum and wheat	Exposing to sun
Dirxi	Maize and sorghum	No control mechanism

Source: own survey result, 2023

Major insect pests

The findings indicate that there were no effective insect pest control mechanisms in the study areas. There were very few reports of chemical application on storage pests, despite it was not possible to identify the names of those chemicals used. Training experiences were not also reported on chemical application for the farmers. Instead, farmers in parts of the study areas indicated using of the traditional control mechanism by applying ***Taxaliil,*** which is reciting verses of quran to water and then spraying holly water to the corners of the effected field.

5.5. Fertilizer and Manure Application Practices

Most of the farmers in the study areas used manure and to some extent chemical fertilizers. Because of unaffordability, most of the farmers tend to use manure while a few of them apply chemical fertilizers to increase crop productivity. Inorganic types of

fertilizer commonly available were DAP and UREA. Farmers applied DAP during planting while UREA during cultivation between rows. They applied one quintal of DAP and Urea per hectare for all crops. Discussant farmers during FGD reported that they used split application for Urea in which the first half application was done during planting while the second half at vegetative stage for all crops. Problems encountered by farmers in using chemical fertilizers were unaffordable price, inadequacy of supply, inadequate of awareness of application methods and recommended rate, and unavailability. Manure collection, preparation /storing and application are also commonly practiced in the area. Manure is collected during dry season and applied mainly to all crops. Some of the FGD discussants also reported that they didn't use manure as fertilizer due to fear of aggravation of intensive weeds, the seeds of which pass through manures when the livestock feed on those weeds. Therefore, if the manure is applied in to the field, the weed will emerge from the manure and harbor crop fields.

5.6. Farm Mechanization

The major machine power used in the study area for plowing is the tractor while oxen, and hand tools are also used to a lesser extent. There are traditional implements called 'maresha' used by farmers in the study area for tillage (both primary and secondary), cultivation, and other soil shaping activities. Wheat, barley, and oats are harvested and threshed with combined harvesters only in arid mid-highland agro-ecology at service charge of 600 Birr per quintal. It was also recognized that the only farmers' method of controlling weeds was hand weeding.

In the study areas, farmers, as any parts of the country, still use traditional and inefficient implements which date back to

thousands of years. Traditional ‘Maresha’ and sickle are still dominant farm tools in the farming systems, even though the trend of using farm machines, such as tractors and combine harvesters is becoming common over time. But still, the agricultural mechanization use of the study area can be said at low levels dominated by tractor and combine harvester. Most of the farmers are facing problems of limited awareness on the availability and uses of improved implements. Limited extension service was also noticed on the promotion and use of improved farm implements for different operations.

The use of mechanization in terms of improved machineries and farm implements is still scanty in the study areas. Oxen and human labor have been overworked for centuries, and postharvest problems continued to be one of the causes for high yield loss and quality degradation. However, the farmers are in need of animal drawn row planters, since broadcast sowing was recognized to have serious productivity limitations. They believed that with the row planter, they will be able to save time spent on manual row planting, which is labor demanding task. From their experiences of manual row planting for groundnuts and sorghum, the farmers have realized that row planting increases efficiency, decreases seed rate, and increases crop yield. Because of this, the farmers are now interested to use row planting for wheat, sorghum, cowpea, barley, and oats if they get access to row planter machines.

Harvesting and threshing are also major farm operations which demand the use of mechanization. This is because, the cost of labor for harvesting is getting very expensive and threshing by cattle has become very difficult due to the decreasing number of livestock associated with recurrent drought, shortage of feed and shrinking of grazing lands. In response, farmers’ interest in the use of machines for plowing, planting, harvesting and threshing

of their crops have been steadily growing. For instance, there has been a growing demand for combine harvester in the wheat, barley and oats growing areas of Upper Harawo district.

Farm machinery service charges were observed to fluctuate in response to macro-economic circumstance of the country, such as continuous increment of fuel costs and unavailability of hard currency to purchase the machinery and associated spare parts. Apart from this, timely unavailability of tractor service during peak seasons of planting was reported to be the major problem of farmers.

5.7. Crop Productivity

Agricultural productivity is influenced by growing conditions, level of management, and extent of use of inputs. A number of factors contribute to low productivity including inadequate management practices, low soil fertility, inadequate agricultural inputs especially fertilizer, and adverse weather conditions. On the other hand, crop productivity can be increased by adopting improved technologies, such as improved crop varieties, fertilizer and recommended agro-chemicals. Even though farmers produce maize and sorghum in all the agro-ecolgies of the study areas, both as rain-fed and irrigation, they mainly use the local cultivars. The major reason is that they could not get access to sustainable supply of improved variety seeds.

5.7.1. Productivity under Rainfed Farming Conditions

Evidences show that vegetables were generally observed to have better productivity in Fafan Zone followed by cereals, oilseeds and food legumes in both rain-fed and irrigation conditions

(Figure 24). Under rain-fed, the highest average yield was recorded for onion at 7.6 tons/ha while tomato and wheat stand second and third at an average yield of 6 and 2.4 tons/ha, respectively. Wheat with an average yield of 2.4 tons/ha showed to have better productivity among major cereals followed by maize and sorghum with an average yield of 2.0 and 1.8 tons/ha, respectively. Pear millet was also observed to have lower productivity with an average yield of 0.6 tons/ha which is below the average national yield. Among food legumes, haricot-bean was found to have a yield of 0.6 tons/ha. Among the oilseeds, the highest yield was 0.7 ton/ha for groundnut while the least was 0.3 ton/ha for sesame.

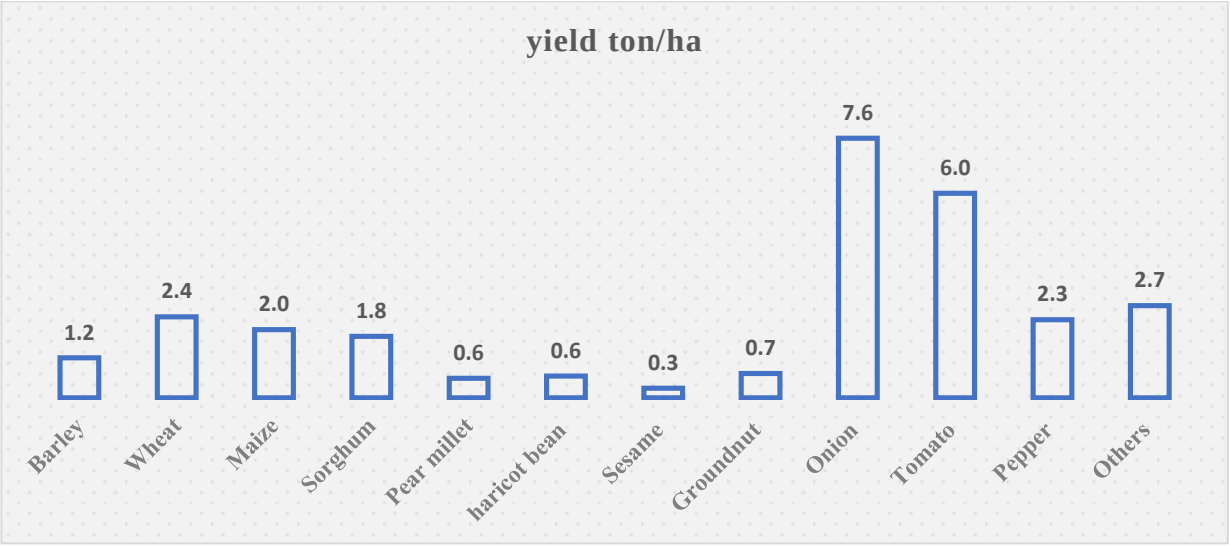


Figure 24. Aaverage yield of major crops under rainfed conditions in Fafan Zone, 2023.
Source: Zonal Office of Agriculture (2023)

The productivity trend of major crops was observed to vary across agro-ecologies and crop types. Survey results showed that the productivity of major cereal crops has been decreasing over the past years in the zone due to threats of recurrent drought, disease, pests and weeds. Either limited or no access to application of improved varieties along with their recommended management practices was also the other factor for the low productivity.

5.7.2 Productivity under Irrigated Farming Conditions

The productivity level of crops under irrigation was observed to be closely similar to rain-fed. For instance, the productivity of onion was 7.6 tons/ha which is similar with that of rain-fed while tomato and pepper stand second and third at an average yield of 7.2 and 2.7 tons/ha, respectively (Figure 25). The productivity of maize was 2 tons/ha followed by sorghum with an average yield of 1.8 tons/ha.

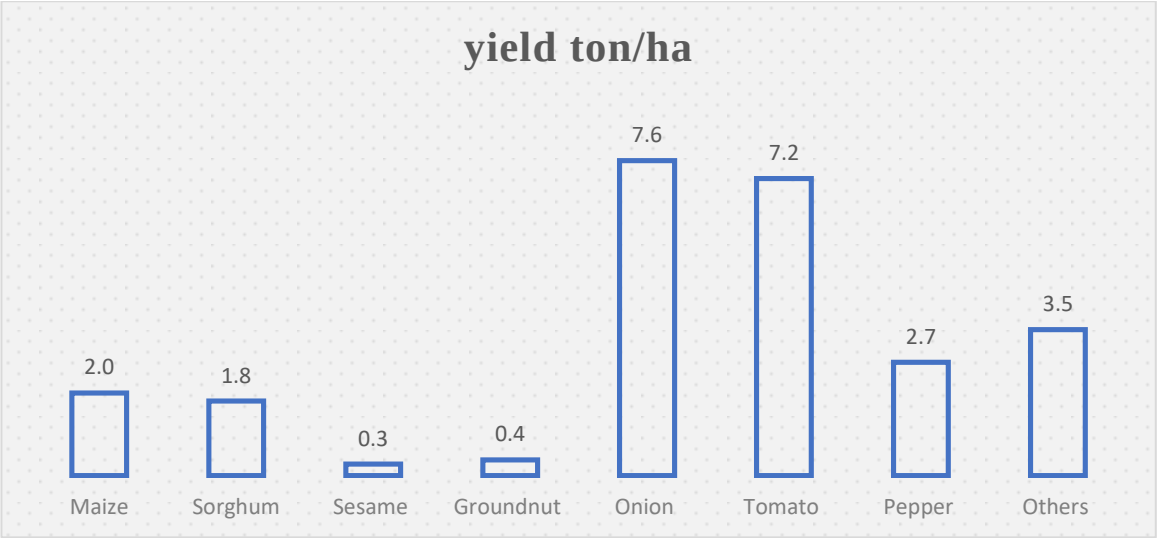


Figure 25. The average yield of major crops under irrigation condition in Fafen Zone (2023/2024)
Source: Zonal Office of Agriculture (2023)

FGD discussant farmers described that the productivity of major cereal crops is declining over the past years due to insect pests, disease, unaffordable input price, land degradation, soil fertility problem, and recurrent drought in both rain-fed and irrigated farming conditions.

5.8. Harvesting and Storage

In the study areas, wheat, barley and oats are harvested and threshed using combined harvester while all other crops were harvested and threshed manually. Manual threshing takes place using cattle, such as oxen. However, there is no improved storage technology available in the study areas which can help to minimize post-harvest storage loses.

Farmers depend on their own traditional mechanisms of storing their products, such as underground storage structures and plastic bags. However, these structures are responsible for high post-harvest loses. Plastic bags and *Bohol* are commonly used as storage containers. It has been observed that plastic bags can be utilized to store grains for a certain period. In arid regions, pits are also used to store sorghum. Because of unavailability of improved storage structures, the farmers still maintain their traditional post-harvest grain storage units.

In traditional harvesting and threshing practices, yield loss is eminent due to delays and attacks by rodents, birds, and insects, inconvenient threshing grounds, inefficient storage facilities and untimely rains. The harvest season is the most demanding season of the year, which also involves the use of casual labor, which is not adequately available and its wage is very high with increasing trend over time.

The FGD farmers also reported that sorghum, maize, wheat, and haricot bean grains are being affected by angoumois grain moths and weevils. Most of the farmers used sacks, underground storage and ground floor of their residential house as a store. There are high postharvest losses due to improper harvesting, handling, packaging and low facilities to market. The FGD farmers demanded introduction and demonstration of improved storage structures suitable to local conditions.

5.9. The Role of Women in Crop Production

Understanding the gender context of agriculture will be central to successful outcomes. The role of women plays determinant role in the work load and sharing of resource and benefits of production in agriculture. Women participate in some aspects of crop production and other family activities, such as providing meal and water, feeding oxen at farm, clearing weed and crop residues from the land, in the threshing and processing of pulse crops and maize, and housekeeping activities. Improving the capacity of women in fruit propagation, home gardening and seed production activities of vegetable crops is very crucial in this sector.

5.10. Dynamism of Crop Production

The smallholder farmers grow a wide variety of crops as a risk-aversion strategy. Insects, diseases, weeds, and many other crop pests are typically part of a dynamic agro-ecological ecosystem. The pests continue to be the major agricultural production constraints, their effect being exacerbated by increasingly unpredictable climate change. The pests could seriously harm crop production and threaten smallholder farmers' livelihoods,

resulting in a significant loss of crop diversity. Over time, some traditional crops which farmers used to widely grow are now increasingly getting out of production, while on the other hand, new crops have emerged to replace the old ones. Besides biotic factors, abiotic factors, such as degradation of natural resources, are also contributing to crop diversity losses.

The study has also identified the major drivers of crop and variety diversity loss in the study areas. One of these is recurrent drought which caused most of the oxen to die because of inability to get adequate feed resources. This placed oxen drawn land preparation at stake and consequent loss of traditional plowing implements. The other drivers included:

- Recurrent drought overtime changed almost everything in the farming systems
- Introduction of improved varieties is increasing despite at slow pace
- Disease and insect damages increased over time
- Low productivity has become a feature of the area
- Late maturing varieties getting out of production due to moisture stress
- Lack of seed conservation mechanisms to maintain landraces for breeding purposes
- Lack of skill to adapt to and cope with climate change effects

All the FGD discussants in the study areas agreed that crop production is declining in the last 10 years, particularly in the last five years, which were the worst drought years. Other causes of crop production decline included shortage of feed, animal diseases, lack of vet services, and shrinking of range land shifting into crop production, rangeland degradation, expansion of poisonous plants, and lack of government support.

Referring to CSA data reveals that smallholder farmers in Fafan zone grow only maize and sorghum as cereal staples in the last decade (Figure 26). However, this is incomplete and misses the data of other cereals, pulses and oil corps. The CSA data for the last decades for area and crop production statistics of Somali Region doesn't adequately represent the reality and crop diversity. This might because, CSA takes samples and collects data from only three zones (Fafan, Sitti and Liban) in the region which cannot adequately represent the regions crop production status. The data collected from these zones is not even valid because the area and production data is much higher and diversified than that of the CSA data.

Since CSA data is accessible by any of the development partners worldwide, we sincerely request CSA to revise its data collection procedures in Somali Region, and strive to collect representative data which reveals the reality.

5.11. Cause-Effect Analysis of Crop Production Problems

FGD discussant agro-pastoralists have reported several constraints that limit crop production and ranked them in their orders of severity (Table 23). Shortage of improved seed and fertilizer, recurrent drought (RD), insect pests and diseases, lack of capital, lack of mechanization (tractors and combine harvesters), lack of improved technology related skills, and limited market linkage were mentioned as priority problems among others. Shortage of improved seed and fertilizer ranked first followed by recurrent drought and, insects and diseases.

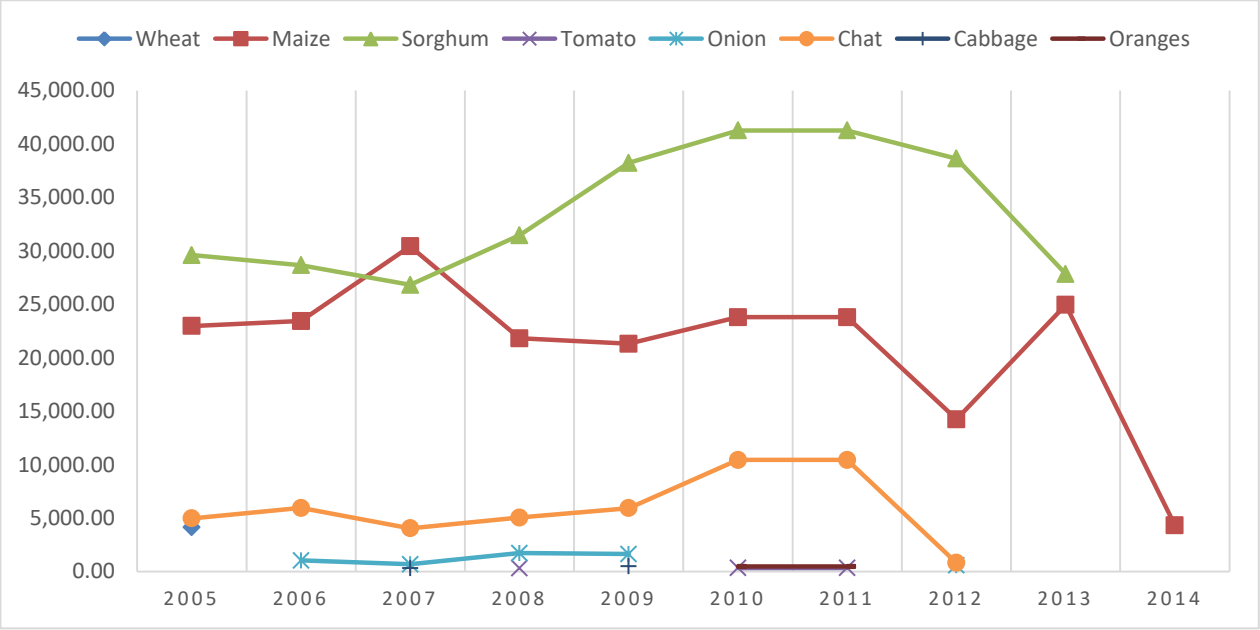


Figure 26. Land coverage trend of crops in Fafan zone in the last ten years, 2023.
Source: CSA (2005-2014)

Table 23. Pair wise matrix ranking of crop production constraints based on their severity, 2023.

Crop production constraints	AI	RD	LC	ID	LM	LS	PM	Score	Rank
Shortage of improved seed varieties (AI)		AI	AI	AI	AI	AI	AI	6	1
Recurrent drought (RD)			RD	RD	RD	RD	RD	5	2
Lack of capital (LC)				ID	LC	LC	LC	3	4
Insects, weed and diseases (ID)					ID	ID	ID	4	3
Low mechanization access (LM)						LM	LM	2	5
Lack of skills (LS)							LS	1	6
Poor market linkage (PM)								0	7

Source: Own survey result, 2023

Having identified several crop production constraints from our survey results, an attempt was also made to provide an in-depth cause-effect analysis indicating major causes, effects, intervention options and opportunities available to improve crop production and productivity. Accordingly, the cause-effect analysis is summarized in Table 24. Each of the key problems have been briefly described as follows:

1. Shortage of improved seed varieties of major crops

There has been limited use of improved seeds by most farmers despite the release of several technologies, particularly improved crop varieties. Somali Seed Enterprise is not yet operating in its full potential to meet improved seed demands of the region. Because of this, shortage of improved seeds has been a priority issue in the study agro-ecologies.

Cause of the problem. The limited use of improved seeds has been attributed to a lack of quality seeds at the right time and place, coupled with an ineffective promotion system. Although legumes and oils fetch higher prices than cereals, they are grown on smaller plots of land.

It is difficult to find improved seed varieties in the study areas, and this is also true of cereals. Farmers mentioned two reasons for the limited availability of improved variety seeds; one is lack of source of the seed with reasonable price and the other is timely availability. Hence, most of the time, farmers grow their local varieties.

Intervention options: The following options are suggested to address this problem:

- Seed multiplication of adapted varieties
    - One of the most crucial factors that can be considered during the development of new crop

types is the availability of seed through seed multiplication, as this can help improve the availability of the seed and the popularity of the crop. This can help solve the various problems related to the availability of seeds in the area.

- Creating partnerships among stakeholders to establish decentralized seed system
    - Partners that share the same objectives should be prioritized when it comes to establishing a decentralized seed system. This will help improve the availability of seeds in the study area.
- A strong and efficient seed system can be created through the establishment of model farmers and a seed producer network.

- Establishment and capacitating of Farmers' Cooperative Unions (FCUs) in the input markets through technical and finance support. These unions can be trained as 'improved variety seed producers' and experience sharing can also be organized to neighboring regions to learn successful experiences of seed production and distribution.
- Establish and promote community-based seed multiplication systems by providing source seeds and technical backstopping whereby they could gradually be promoted to seed business enterprises subject to certification process; so, local farmers will have better access to quality seeds.
- Conduct agronomic research to develop local agroecology-based recommendations;
- Research activities for the Jigjiga Plain and Upper Harawo areas should focus on wheat, barley, maize, sorghum and pulse varieties that have a high yield potential and tolerance to drought, disease, weeds and insect pests;

- Strengthen Somali Seed Enterprise and address its challenges, such as land for seed multiplication

2. Recurrent drought

The major crop production challenge in Fafan Zone has been identified as drought, in all agro-ecologies. It is stated by farmers that drought is a frequent occurrence in the area and severely affects production of all crops. In the agro-ecologies, local crop varieties, especially cereals, mature slowly and suffer from terminal drought before harvest.

Causes of drought: Among the factors causing drought, human interference with natural environments is the most important through its actions, such as deforestation, overgrazing, and improper land use. Drought is characterized by late arrival, early departure, and erratic rainfall distribution. Influence of global climate change could also be the cause of drought which is recurring frequently in a few years.

Effects of drought. As Chrispeels (2000) points out, drought tolerance can make the difference between life and death. Tilahun (2006) concluded that drought have been occurring in Ethiopia at least once every three years for the last 30 years, resulting in human and environmental disasters.

Farmer opinions indicate that drought prevails at least once in every other cropping season in the study area, indicating that the number of bad seasons is higher than good ones. In light of this, the vulnerability of the study areas to drought as a result of growing population has become a concern, especially regarding food security.

Intervention options: Among the many options, the following could be some of the strategies to address the problem of recurrent drought:

- Introduction, adaptation and demonstration of improved drought tolerant crop varieties either from within or abroad could be one of the coping mechanisms to the problem.
- Introduction and demonstration of solar pumps for irrigation.
- Adaptation and demonstration of new cash crops to strengthen economic capacities of the farmers and increase their resilience to drought effects.
- Scaling up of successful crop varieties:
    - The goal is to expand the availability of crop varieties that have been adapted to changing drought conditions. This will be effective if the varieties are accompanied with their full packages.
- Introduce, promote and implement adaptation strategies such as water harvesting technologies and developing irrigation facilities
- Screen and develop drought tolerant crops varieties:
    - It is essential to strengthen local research to introduce different types of germplasms which are believed to adapt with drought affected agro-ecology for oilseeds, cereals, and pulse crops. Locally developed improved varieties with active participation of the farming community will increase adoptability in changing climate conditions.
- Study on the operation of irrigation schemes and possible ways of improvement through the use of irrigation Participatory Rapid Diagnosis and Action model (PRDA).

3. Insects, weeds and diseases

Diseases, weeds and insect pests are the third most important factors reducing both the yield and the quality of grain in both agro ecologies of the study areas.

Causes of the problem: The various environmental stresses are the main causes of the diseases and pests that affect the area. These include the susceptibility of crops to moisture stresses, as well as the emergence of new and more severe pests. Parasitic weeds are also becoming problematic in agricultural production systems of the study areas. It is believed that mono cropping or growing of the same crop for a long time on the same field or growing of cereals after cereals for years aggravates the problem.

Effect of diseases and insect pests: The various diseases and pests that have resulted in the loss of quality and quantity of grain yield. Under severe conditions, the total yield loss could take place worsening food insecurity, starvation and poverty.

Intervention options: Some of the solutions could be:

- Introduction and adaptation of insect pest and disease tolerant varieties within the country and from abroad
- Provide training on the safe use and demonstrate, scaling up of pesticides management techniques
- Awareness creation of farmers on controlling methods of the insects, weeds and disease.
    - Training of farmers and developmental agents (DAs) on the controlling methods of the problems has a big asset. Farmers should be trained on the symptoms and controlling methods of the major insects and diseases, and be aware of controlling mechanisms of weeds as they can harbor harmful diseases and insects.

- Evaluation of already existing control options of diseases and insect pests
    - Assess and document traditional insect pest and disease management practices in stored grain in the study area and improve for further effectiveness.
- Strengthen cultural methods or the use of agronomic practices (crop rotation, Intercropping, Fertilizer management, etc).
- Development, demonstration and promotion of IPM strategies and options
- Screening and Evaluation of advanced lines for their tolerance and resistance

- Evaluation of advanced lines being tested in other similar sites/locations for their resistance to major weeds, diseases and insect pests, should be considered to screen tolerant varieties of each crop through local research.

4. Lack of capital

Farmers faced shortage of capital to afford agricultural inputs, such as fertilizer, tractor rental services, seeds and labor. For they are living in drought prone agro-ecologies, they often face food insecurity and capital shortages. Some of the rural households also required starting capital to engage in off-farm income generating activities. Some of the options to address this problem could be:

- Credit should be made available on need basis for individuals
- Ensure farmers and financial institutions accessibility to market-enabling physical and information infrastructure to reduce transaction cost rationing.

- Develop value chain finance which links financial institutions to the agricultural value chain, offering financial services to support the product flow and building on the established relationships in the chain.
- Investments in irrigation projects and transport infrastructures.
-

5. Inadequate access to mechanization

Since recurrent drought and consequent feed shortage is imposing a challenge to maintain oxen for land preparation, the use of tractors is becoming an option for the farmers. Combine harvesters, planters and other machineries are also becoming demanded by the farmers. However, accessibility of the farmers to these farm machineries is becoming a big challenge because of limited availability, and high service charges. The following are some of the options to address these problems:

- Support private investments for introduction, demonstration, promotion and supply of agricultural machineries for plowing, planting, harvesting and threshing
- Establishment and strengthening of cooperatives who can purchase farm machineries and provide rental services for the community.
- Strengthen economic capacity of farmers, such as through supports of cash crops and engagements in off-farm income generating activities

6. Lack of skills

Farmers still depend on traditional practices of farming. They are not yet adequately exposed to improved practices and skills.

Because of this, they demanded skill building supports to increase production and productivity of agriculture, and improve their livelihoods. Some of the suggestions to build skills included the following:

- Capacity building on agronomic management of crops for increasing production potential of crops
- Capacity building and demonstration on improved post-harvest technology
- Conducting participatory research in order to facilitate farmer to farmer learning.
- Introduce and promote efficient cropping systems for diversifying and intensifying crop production in the area.

7. Inadequate market linkage

Farmers are suffering from lowest prices of their products mainly because of inadequate market information. Limited access to vehicle roads and public transportation services are also limiting factors to market linkages. Some of the options to address this problem could be:

- Strengthening of extension services: farmers would benefit from extension services being better informed about what the market demands.
- Formation of marketing groups to improve the price regulation and also to use the economies of scale rule to increase profit margins and cut down transportation costs
- Common and permanent market place need to be constructed; market outlets need to be increased in number.
- Illegal traders and brokers should be band and control system need to be implemented
- Permanent market place and time schedule should be known and total market chain need to be improved.

- Developing infrastructural facilities especially transportation and networking
- Facilitate market linkage and information system through establishing cooperatives/union
- Use public media to broadcast market prices of commodities

Table 24. Cause-effect analysis of major crop production problems of the study areas, 2023.

Problem	Causes	Effects	Intervention options	Opportunities available	Stakeholders
Diseases, insect and weeds • Fusarium head blight • Smut • Root rot/dry root • Rust • stalk borer • fly arm worm Aphids	• breakdown of resistant genes by pathogenic pests • dynamics of agroecology • climate change • introduction of alien weeds and pests through various mechanims	• Yield loss • loss of crop diversity • Limited options of Farmers for crop cultivation • Increased food insecurity & poverty	• conduct adaptation trials • develop and introduce resistant varieties • develop effective IPM options • promote and disseminate disease resistant and pest tolerance technology packages • introduce, demonstrate, promote and distribute recommended pest control chemicals	• exchange of breeding materials from local and external sources mainly CGIAR centers • availability of resistant varieties • availability of proven IPM options from local and external sources	• EAIR, • SoRPARI, • JJU, • Ethiopian Biodiversity Institute (EBI), • MoA, • Regional • BoA, • NGO
Limited market linkage	• Less access to all-weather roads and public transportation • Limited extension services • Lack of market places	• Low market accessibility • Low-selling price on products produced • High transportation costs • Low profitability	• Improving road access • Providing value addition capacity building training • Market information linkages • Establish cooperatives/union • Common and permanent market place construction • Strengthen extension service provision	• Policy attention to increase rural development • Government and private sectors investments on communication meda	• Trade and investment bureau • Cooperative agency • Bureau of Agriculture
Lack of capital	• Low production • Limited income source • Limited access to credit services	• Limited use of agricultural inputs & improved technologies	• Increasing productivity through creating access to improved technologies • Policy support	• Farmers knowledge for production • Potential land • Creating Farmers	• MFI • Banks • FCAs • Agricultural

	• Inadequate availability of rural financial services favorable to small holder farmers	• Scarce household income • Lack of saving • Low production • Low credit demand • Low investment	• Establishing the credit services • Creating awareness of financial institutes about rural credit for agriculture • Create awareness of the community about credit services, interest rates, repayment and other details	credit association • Availability of financial institutes	offices • NGOs
Lack of skills	• Limited extension services • Limited access to road infrastructure • Lack of or limited research on problems related to *agronomic management* • Knowledge gap • Traditional practices • Farmers attitude	• Lack of technology option • Low productivity • Disease and insects • Unstainable cropping system. • Insufficient nutrition due to low crop diversity.	• Capacity building on agronomic management of crops • Conduct agronomic research • Demonstrate and scale-up technologies • Provide regular training • Introduce digital extension service • Generate improved agronomic practices.	○ Farmers willingness ○ Adaptation of technologies for similar agroecology ○ Availability of development organizations working on building farmers' skills & extension services ○ Farmers' access to communication media	• EAIR, • SoRPARI, • JJU, MoA, • Regional BoA, • NGO
Shortage of improved seed and fertilizer	• the low performance of the formal agricultural input supply system • lack of strong community- based	• Dependence on less productive local varieties • low input utilization •	• Revitalize and support cooperatives in the seed business • promote and empower community-based seed production system	• Availability of improved varieties in different parts of the country that are compatible to Somali agro-ecology	• EIAR, • SoRPARI, • JJU, • MoA, • Regional BoA, • SRS seed

	seed production system • Very weak seed system • The slow pace of variety release	• low productivity of local varieties • Disease and insect threat • Limited variety options and diversity	• strengthen the private sector through incentives • develop infrastructure • Strengthen the formal and informal seed system • Improve the efficiency of the breeding programs	• Availability of farmers' cooperatives • High demand for improved seeds and associated packages • Availability of public and private seed enterprises • Policy support for national research programs	cooperative agency, • SRS technology innovation, Ethiopian • National and regional seed enterprises
Limited mechanization access • Row planters and tractor • Weeder, harvester and threshers • Others	• Limited availability of farmers preferred small scale and affordable farm implements and machineries • Inadequate focus of regional government on agricultural mechanization • Limited capacity of cooperatives to provide machinery rental services for the community	• High labor cost during peak season • Low labor use efficiency • Low productivity • Low product quality • Late planting or No cultivation due to lack of tractor	• Strengthen the capacity of cooperatives and unions to purchase and provide machinery rental services • Incentivize private investment on farm machineries through creating credit and associated opportunities • Increase awareness of the community on the use of farm machineries and raise demand to attract investors	• Cooperatives available • High government priority to promote farm machineries • Farmers increased willingness to adopt the technologies • Availability of TVETs to train machine operators • Availability of	• MoE, • Regional BoA, • SoPARI, • JJU, • EIAR, • TVET, • SRS technology innovation, • private cooperative/companies • NGOs, • farmers and unions, • MFI,

	• Limited affordability of the farmers for machinery rental services		• Strengthen economic capacities of farmers to afford machinery rental • Adapt and develop suitable and affordable small-scale farm machineries and implements • Promote and disseminate available machineries supported with credit schemes • Increasing availability of communal farm machineries	agricultural mechanization research centers (Bahir Dar, Melkassa, etc) • Availability of private manufacturers and dealers of farm machineries	• Farm Tool Manufacturing Companies
Recurrent drought	• Agro-ecological degradation (deforestation, improper soil and water management, etc) • climate change	• crop failure • low production • household food insecurity • displacement	• develop early maturing and moisture stress-tolerant varieties • implement adoption strategies such as water harvesting technologies • develop irrigation facilities • Afforestation and ecological management	• Availability of irrigable land • Availability of irrigation water potential • community labor available for irrigation infrastructure • availability of improved varieties and germplasm from local and external sources	• MoA, EIAR, JJU, • SoRPARI, • MoWIE (ministry of water, irrigation and electricity), • Regional irrigation development bureau, • NGOs

CHAPTER 6
LIVESTOCK PRODUCTION PRACTICES

Livestock production farming systems consist of several enterprises such as dairying, poultry, fishery, bee keeping, and fodder production which are interrelated. Farming systems characterization research is considered powerful to identify key constraints and address development needs for livestock production. Indeed, livestock provide the social, cultural, and economic benefits to many rural economies in low-income settings, particularly in semi-arid and arid environments. In addition, livestock are the main sources of milk, meat and manure serving as immediate source of cash income and household consumption. The mobility of cattle, sheep, goats, and/or camels allows livestock keepers to utilize grazing and browsing on common land over a potentially wide geographic area optimizing production and reducing vulnerability to the effects of recurrent drought. Drought in Somali region is becoming more frequent and severe over time. In 2020/21, during one of the most severe droughts in living memory of Somali region, up to 250,000 livestock died (LLRP, 2022).

Fafan zone is one of the potential areas endowed with huge livestock population and large rangeland areas. Cattle, sheep, goats, camels and donkeys are the dominant livestock species found in the zone while fishery and apiculture practices are not well established. In spite of the existing huge livestock resource potential in the area, their productivity performance is very low due to feed shortage, prevalence of different diseases, lack of

infrastructure and inadequate development interventions. Supporting livestock production among the rural poor can provide an important route towards sustainable development, equitable livelihoods, and household health and welfare.

6.1. Types of Livestock and Management Practices

Cattle, Goat, Sheep and Camels are widely distributed livestock species in Fafan zone while Donkeys, Poultry and Honey bee keeping are less common in the same area under extensive production system. However, tethering of male animals (including camel, bull/ox, buck and ram for especial cases) is practically practiced in the study areas. Lactating cows are tethered at house where it is provided supplemental feed so as to improve its milk yield for either income generation or home consumption. Similarly, sick animals or animals with poor body conditions are tethered around the household. Such herd diversification is beneficial to sustain the community's livelihood during the worsening effects of drought. Rearing of exotic breeds is not common practice in the study areas. Cattle are the predominant (about 70%) species in the area followed by Goats (about 18%) (Figure 27).

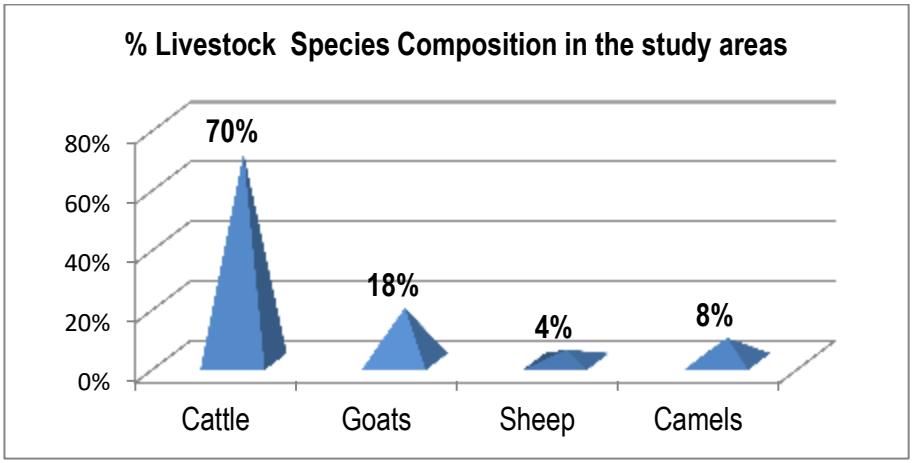


Figure 27. Livestock Composition (%) in the study areas, 2023.
Source: FGD (proportional pilling tool)

6.2. Livestock Role to Household Livelihoods

The indigenous Somali cattle are widely distributed in the area and are kept mainly for the purpose of milk, meat and crop production. In cases of emergency, households sale either ox or bull for cash generation. Cases are common where households keep young ox (bull) for fattening purposes and generate incomes. Of the produced milk, some amount is consumed at home while the majority is marketed for income generation. In all agro-ecologies, goats followed by sheep are mainly kept as source of immediate cash income, in which people consider them as "First aid or emergency response" animals, for they are sold immediately at times of immediate cash needs. Apart from on-farm income sources, sheep and goat are also source of milk in the study areas. Yet unlike dairy goats, sheep milk is confined

only for home consumption. Among the community, sheep milk is perceived to be nutritionally rich (rich in fats and proteins) and also it has medicinal value to treat TB, gastritis, infections and urinary tract infections. Furthermore, sheep meat is used for post healing purpose of those individuals who had broken/fractured bones repairing some parts of the body "locally refer as *buullo*". For these issues people quoted a statement in Somali language as "***Ido waa dawo riyo waa fuud***" meaning that sheep are medicine while goats are pottage. In addition to milk production, sheep and goats are kept for home meat consumption purpose particularly in especial events such as religious festivals and wedding ceremonies.

Female camels are mainly kept by the community for milk purposes either for sale or home consumption especially to elder people in the family. Male camel is used as a draft power including transportation of agricultural products, feeds, fire-wood, charcoal, water and other goods. In addition to their tolerance to feed and water stress, camels are the most valuable animals in raising the social status and prestige of the family, where households who own more camels are respected more than anyone else. In addition, camels are used for "off-farm business" in transporting goods to be sold at markets (Figure 28). Camel rental is also a source of income for households. For instance, people rent their camels privately at a rate of 1000 Ethiopian Birr per day per camel for transportation of agricultural products and animal feeds biomass for about 3 - 4 consecutive months during drought period.

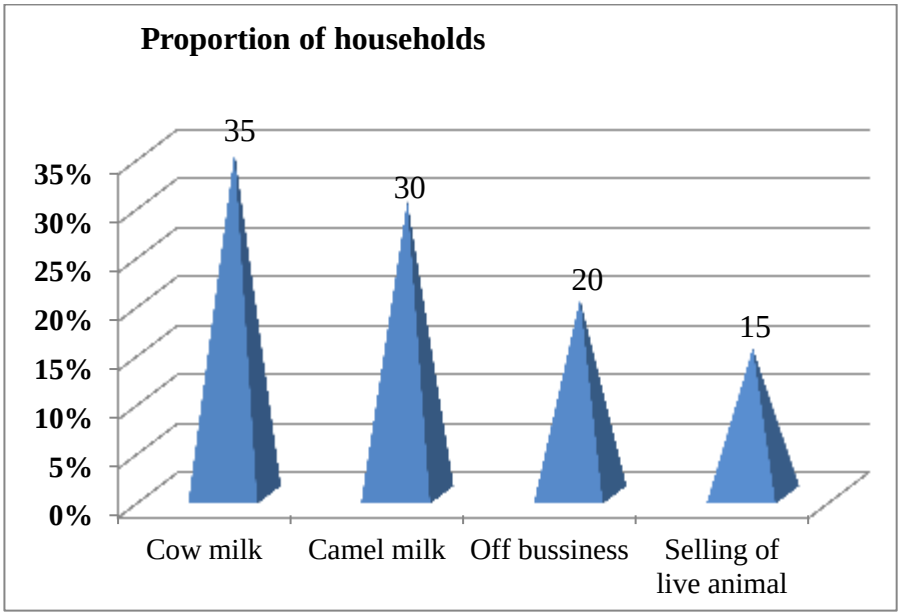


Figure 28. Livestock contributions (%) to Household livelihoods, 2023.
Source: FGD (proportional pilling tool)

Donkeys are also kept by the community solely as source of draft power for transportation of commodities. Despite its contribution, donkeys are not given any attention regarding their welfare and health management aspects by the communities. In terms of other animals, poultry farming is not as such a common practice in the study areas except that some households kept a few numbers of (about 3 – 5) local chickens on average for egg production.

In terms of bee keeping, it was not that much practiced in most of the study areas. Even though there is high potential for honeybee production in some areas, the community is not yet effectively practicing due to certain constraints, including lack of modern beehive packages, different honey bee diseases and bee pests. Furthermore, lack of skills and community awareness is a big

challenge for honey bee production in the study areas. In spite of these, some farmers have received a small number of modern beehives from NGOs working in the study area in the development of livestock sector. However, the beneficiaries did not get adequate supports of beekeeping equipment and knowhow. It was realized that only limited proportion of the population (about 10%) produced honey from traditional beehives. The community has also identified major sources of honey flora in the locality including different *Acacia species*, sorghum flower, lantana camera flower and mango flower. Additionally, flowers of *Haramo dacar*, *Maraga*, *sogsog*, *baxara saafka*, *madheedhka*, *gobka*, *ciinka*, *dhabiga*, *cadadaada* were among the local honey bee flora that grow in the locality. During the feed shortage, people supplemented sugar and more water to honey bees placing in and around beehives. Figure 29 demonstrates how the farmers are practicing bee-keeping around homesteads.

Figure 29. Farmers practicing bee-keeing around homesteads, 2023.

6.3. Livestock Breeding Practices

6.3.1. Milk Production Performance

The milk production performance of cattle and camel in the study area is summarized in Table 25. Lactation length of cattle with an average of 3 liters per day milk yield was 8 – 9 months while it was 11 – 13 months for camel with average daily milk yield of 7.5 liters. According to the FGD, the lactation length depends on the availability of feed and health condition of the animal. Lactation length of camel in the study area is comparable to Tezera and Bruckner (2000), who reported 15 and 13 months in Jigjiga and Shinile zones, respectively. Cattle are weaned at 6 -7 months while camel at 11-12 months.

The quantity of milk production is different between the dry and wet seasons. More milk is produced during wet season than dry season in both agro-ecologies, mainly due to the availability of quality pasture and water in the wet season compared to the dry season. The camel and cow milk has more contribution to the livelihood of the community for it is used both for household consumption and for income generation. However, unlike camels and cattle dairy, sheep and goat milk are confined only for home consumption. Because the daily milk yield of goats and sheep is very low compared to that of large ruminants, most of the community uses small ruminants for meat production rather than for milk.

Table 25. Milk Performance of Dairy Cattles and Camels in the study areas, 2023.

Species	Lactation length (months)	Weaning age (months)	Daily milk yield (Liters per-day per animal)	Milking frequency per day
Camel	11 – 13	11 - 12	5 - 10	2 times
Cattle	8 – 9	6 - 7	2 - 4	2 times

6.3.2. Breeding Practices of farm Animals

Mating is permitted for males with good breeding characteristics based on the various selection criteria. Uncontrolled natural mating (*Garac)* is a common practice for cattle (Figure 30) and goats while control mating is practiced for camel and sheep. The reason why sheep mating is controlled is to minimize lamb mortality during the drought season because sheep are less tolerant to drought. The same holds true for camel mating which is also controlled by the owners to avoid the disturbance of the milk lactation period, which is a source of food for both the calves and the family. Very limited artificial insemination practices were introduced in the two districts (Gursum and Kebribeyah) by Jigjiga University which inseminated 31 cattle, out of which around 84% successfully delivered.

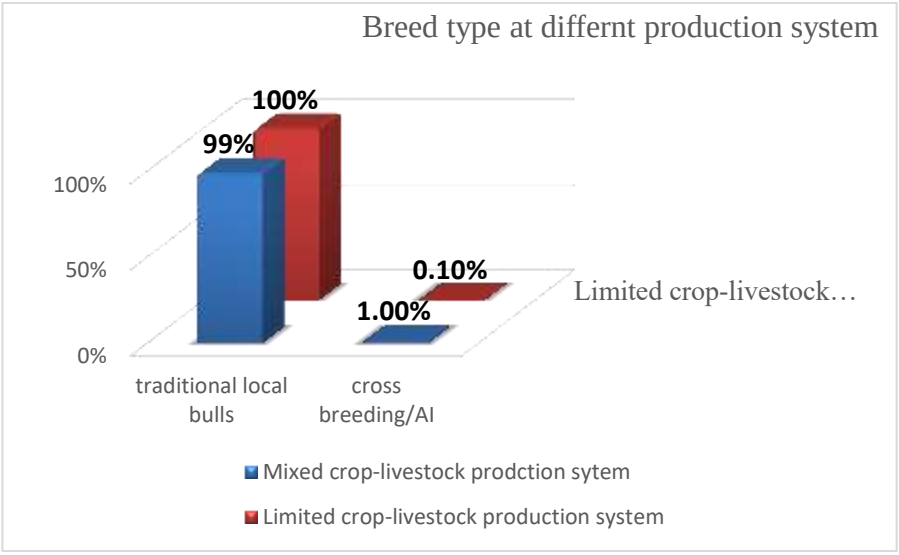


Figure 30. Breeding practices in both agro-ecologies

Selection Criteria of Breeding Animals

The major breeding bull selection criteria in the study areas were physical appearance, beauty, color, body size, and pedigree information. Similarly, the selection criteria for breeding females were beauty, performance (milk, parturition, and twining ability), pedigree information, and body size. According to agro-pastoralists, pedigree information is very important among all selection criteria. However, if the parent information is not known, the community uses their experience and the above criteria to select the best breeding male animals. Male goat (buck) selection criteria were good physical and body posture (strong, tall in height, and wide laterally); non-horned (***Seenyo***); and the two testicles of the buck should be completely separate and longitudinally parallel to each other. In addition, the color of the hair coat matters for breeding selection (the white "***Aybax***" is the preferable one). For male sheep (rams), the most preferred traits were white sheep ***("Ido cad")***, good body posture and gait, and a large rump area. Knowledge of these breed attributes is helpful for research purposes to incorporate in the breeding programs.

For camels, pedigree information (parents) is the most important breed selection criterion. For this issue people quoted a special statement in Somali language as "*Geela iyo Gabdhahaba waa la hidda raaca"*. Additionally, the FGD participants added that there are two types of camel breeds known as *Carrog* and *Cayuun*. Carrog is the best and most preferable breed in this area. In addition, the community complained that *cayuun* breeds are aggressive, dwarf, and not attractive, and they are believed to have come from issa-samaroon areas. Morphological characteristics of *Carrog camel are* very tall with large laterally extended abdomen, large scrotum, and soft palate with attractive sound, long hump (***Kurus cidhheer***) with long thin neck, straight

nasal bones, and white skin ("***Dayr cad***). The rutting male is named in the local language.

Reproductive Performance of Female Animals

Age at sexual maturity, age at first mating, age at first calving, and number of gestation lengths were assessed to determine the reproductive performance of all studied livestock species (Table 26). Mean age of camel at sexually maturity is five years, age at first calving (AFC) six years, and gestation length 12-13 months. These findings are similar with Ibrahim (2008), who reported age at sexually maturity of 3-5 years, gestation length of 12-13 months, and AFC of 5-7 years. Yoseph (2014) has also reported AFC of 61.37±3.83 years, and gestation period of 12.23±0.55 months. For cattle, mean age at sexually maturity is four years, age at first calving (AFC) five years, and gestation length 9 - 10 months. For goats, age at sexual maturity was 8-12 months, age at first calving 14 – 18 months and gestation length 6 - 7 months while for sheep, average age at sexually maturity is 6 – 12 months, age at first calving (AFC) 13 - 19 months, and gestation length 6 -7 months. The findings of the current study are in line with Wendemu (2013) findings in Shebelle zone.

Table 26. Reproductive Performance of Female Animals, 2023

Species/female	Sexual maturity/years	age at first calving/kidding/months	gestation length (months)
Camel	5	72	12-13
Cattle	2-4	36-60	9-10
Goat	0.67-1	14-18	6-7
Sheep	0.5-1	13-19 months	6-7

Reproductive Performance of Male Animals

The reproductive performance of male livestock species in the study area is summarized in Table 27. Age at puberty is a time when the animals attain sexual maturity. This is usually

associated with proper feeding and health care management, besides the selection of the animals themselves. The average age of sexual maturity was 6 years for male camels, 3–4 years for cattle, and 7-9 months for male goats, and sheep. For camels, the result is similar to Afar camels reported by Simenew *et al*. (2013).

Table 27. Reproductive Performance of Male Animals, 2023.

Species	Sexual maturity for females in years	Sexual maturity for males in years
Camel	6	7
Cattle(oxen)	3-4	3-4
Goats	0.583-0.750	0.583-0.833
Sheep	0.583-0.667	0.583-0.750

6.4. Feed Resources Management

The major feed resources for livestock were natural pasture, green grass, maize, cactus, and crop residues (sorghum and maize stover). On the other hand, the major feed resources in the dry season were cactus, Lantana camera, conserved hay, bush encroachment ("*Haramaha, Waabey, and Xayramad*), wheat bran, and groundnut residue. Since the majority of the cultivated land area is shifted to cereal and pulse crop production, the major share of livestock feed is obtained from crop residues, which are mixed and stored around the homestead ***"Kuuska,"*** contributing to around 50% of the dry matter feed of the total diet. However, the case is different in wheat dominated areas. Because, wheat is being harvested and threshed using combine harvesters leaving no crop residue for animals, because of which animals are suffering from feed shortages in wheat belts. FGD participants claimed that the community had previously grown crops (sorghum, maize, and barley), which were good sources of feed for livestock. However, in the past four years, the community's practices have

changed to the cultivation of wheat, which fetches premium price for them but it compromises the feed of livestock.

During the dry season, feed shortage is a common constraint in all agro-ecologies, and the community overcomes such shortages by different mechanisms, such as supplementation through purchases of additional feeds from the market, burning cactus, purchasing crop residues, providing Oliveira "*Dacart***a"**, giving cartoons, minimizing livestock numbers, and allowing the livestock to browse Lantana camara and other bush encroachments**.** Furthermore, in limited crop-livestock production systems**,** livestock mainly relied on the pasture that grew out of the land. However, the pasture in now days has declined substantially or in some areas even perished exposing livestock to be extremely affected by feed shortages. The drought has also forced the community to dig below the surface of the land for pasture and digging out the roots of the grass to feed their livestock **(**Burxaan**)** is the last option of saving the livestock. Supplementation of concentrate feed was rarely practiced in this area except in the dry season, when some parts of the community used to purchase wheat bran **(***buushi***)** and crop residue for their livestock.

FGD Participants stated that majority of the community do not grow improved forage crops although they have great interests to adopt and utilize. However, lack of forage seeds, limited extension services, shortage of water, lack of awareness, and lack of fuel for irrigation motor pumps were some of the reasons why the farmers have not yet adopted improved forage crops in their locality. However, some of the farmers noted that in some areas, the community had once received Sudan grass seeds three years ago. They claimed that the regional government's lack of commitment was to blame for the failure of different livestock technologies to reach them. According to the FGD discussants,

the major livestock feed challenges were scarcity of grazing land or pasture because of agricultural land expansion for crop cultivation and recurrent drought. In addition, there is serious rangeland degradation, which reduced the production of the natural pasture.

The current study revealed that abundant fodders are available in the months of June, July and August (Table 28). Crop residue and conserved hay were available during November and December in addition to communal grazing. Livestock critically suffered feed shortages from January to April due to scarcity of grazing pasture and green forage.

The key informants from Woreda Offices have also highlighted that the community's mixed crop-livestock production cluster didn't receive improved forage seeds other than alfalfa and Sudan grass. These fodder crops were supplied through some local NGOs to help households of specific kebeles despite it wasn't adequate to reach the entire community across the districts. However, there is good motive in Awbare district where the district administrator purchased different improved forage seeds and distributed to the cluster kebeles during rainy seasons. During dry season, farmers feed cactus and others to minimize effects of feed scarcity (Figure 31).

Table 28. Seasonal calendar for feed and forage availability in the study areas, 2023.

	Month											
Season	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul	Aug
Plenty forage	*	*							*	***	**	**
Fodder & forage shortage					x	xx	xxx	xxx				

*= Less, **= medium, ***=sufficient; x=not severe, xx= moderate, xxx=severe

Figure 31. F a of Xayramad (a) and Cactus "Tiin" (b) Plant

b

6.5. Livestock Health Management Practices

Economically important infectious and parasitic livestock diseases were among the major animal health constraints in the study areas. According to FGD discussant farmers, no feed borne animal health problems were observed in the study areas. This was triangulated with Woreda Livestock Health Experts who revealed that more or less livestock diseases that have been identified during FGDs across the study areas are similar to their knowledge. The most prevalent livestock diseases in the study areas are presented in Table 29.

Table 29. Major livestock diseases identified in the study areas, 2023

S/N	Local name	Common name (Scientific)	Species affected
1	*Sambabka riyaha*	Contagious caprine pleuropneumonia (CCPP)	Goats
2	*Sambabka lo'da*	Contagious bovine pleuropneumonia (CCPP)	Cattle
3	*Kud*	Anthrax	Camels
4	*Buur buur/Isbuur*	Lumpy Skin Disease (LSD)	Cattle
5	*Dhabar jabiye*	Botulism	Cattle
6	*Iiteyse*	Black leg	Cattle
7	*Geed caanood*	Sheep and Goat Pox	Sheep and Goat
8	*Cabeeb*	Foot and Mouth Disease (FMD)	Cattle
9	*Amadeello*	Sceneriosis	Sheep
10	*Himish/Shimbir*	Listeriosis	Sheep and Goats
11	*Ajarro*	Orf	Camel calves
12	*Laxaw gaal*	Acute pneumonia	Camels
13	*Maal*	Abscess	Sheep
14	*Indho xanuun*	Pink eye	Goats
15	*Qanje*	Mild form of anthrax	Camels
16	*Shilin*	Ticks' infestation	Cattle and shoats
17	*Cadho*	Mange	Goats
18	*Dhugato*	Chronic pneumonia	Camels
19	*Xadhaadh*	Plant poisoning/ Toxicosis	Sheep and Goats
20	*Xaar ama Qufac*	Pest des petitis ruminants (PPR)	Sheep and Goats
21	*Suus(Dirxiyaryar)*	Worm parasites	Honey bee
22	*Cunebararkaidaha*	Ovine Pasteurellosis	Sheep
23	*Cune bararka lo'da*	Bovine Pasteurellosis	Cattle
24	*Wadno biyood*	Heart water/Cowdriosis	Cattle, Sheep and Goats

Among the identified diseases of goats, CCPP (*Sambabka riyaha*) manifested by severe respiratory distress associated with sero-mucoid nasal discharge, coughing, dyspnea and pyrexia was ranked 1st (Tables 30 and 31). In the study areas characterized by mixed crop-livestock farming systems, the results revealed that sheep and goat pox, and Listeriosis were reported to be highly prevalent viral and bacterial diseases of small ruminants, respectively (Table 32). Ecto-parasites including hard ticks, mites, lice and fleas were the major health problems in the study areas.

"*Canbuufo*" is also another new locally named disease affecting goats. It is characterized by inability of chewing leading accumulation of un-chewed feed on one side of the animal's mouth that may be visible as swelling outside in either of the jaws.

Worm parasite "***Suus***" is the one and only common honey bee disease that was identified in Aadaale kebele of Gursum district. Black leg, botulism, foot and mouth diseases (FMD) and lumpy skin diseases (LSD) were the most frequently occurring diseases affecting cattle in all livestock production systems of the study areas (Tables 33 and 34). The first two diseases are soil borne bacterial diseases mostly occurring in dry season when cattle are scratching closely to the grazing land during which the animals may ingest clostridium chauvoei. The bacteria is most commonly responsible for the occurrence of black leg staying dormant in the soil for years without losing their potency. Similarly, bovine botulism occurs when cattle ingest preformed toxins in feed including the deep down of the natural grass or in anaerobic tissues like the dead body of animal carcasses.

Table 30. Pair wise ranking of goat diseases in Gursum and Awbare districts, 2023

Results of pair wise ranking for Goat diseases intensity achieved from FGDs in Gursum and Awbare district (Excluding Hilingab kebele)

Goat Diseases	CCPP	Ticks	Goat pox	Listeriosis	Mange	Score	Rank
CCPP	X	CCPP	CCPP	CCPP	CCPP	4	1
Ticks		X	Goat pox	Listeriosis	Ticks	1	4
Goat pox			X	Listeriosis	Goat pox	2	3
Listeriosis				X	Listeriosis	3	2
Mange					X	0	5

Table 31. Pair wise matrix ranking of goat diseases in the Upper Harawo (Hilly and mountainous agro-ecology), 2023

Results of pair wise ranking for Goat diseases intensity achieved from FGD in Hilingab kebele of Awbare District

Goat Diseases	CCPP	PE	TA	T	SC	P/T	Score	Rank
CCPP	X	CCPP	CCPP	CCPP	CCPP	CCPP	5	1
Pink Eye		X	PE	PE	SC	PE	3	3
Tooth Ache			X	T	SC	P/T	0	6
Ticks				X	SC	T	2	4
Sceneriosis					X	SC	4	2
Poisoning or Toxicosis						X	1	5

Table 32. Pair wise ranking of sheep diseases in Gursum and Awbare districts, 2023.

Results of pair wise ranking for Sheep diseases intensity achieved from FGDs in Gursum and Awbare district (Excluding Hilingab kebele)

Sheep Diseases	Nervous problem	Listeriosis	Sheep pox	Ticks	Score	Rank
Nervous problem	X	Listeriosis	Nervous problem	Ticks	1	4
Listeriosis		X	Listeriosis	Listeriosis	2	1
Sheep pox			X	Sheep pox	1*+1	3
Ticks				X	1*+1+1	2

FMD is an acute highly contagious disease of all cloven-hoofed animals including cattle which consistently ranked as the most economically important viral disease and among the top important livestock diseases in Ethiopia. FMD is caused by aphthovirus with seven strains (A, O, C, SAT1, SAT2, SAT3 and Asia 1) where each strain requires a specific vaccine. Additionally, the disease spreads mechanically by the movement of animals, humans, vehicles and other FMD virus contaminated objects which could seriously burden the community of the study areas. On the other hand, LSD is an infectious viral disease of cattle characterized by high fever, raised, circular, firm, coalescing nodules on the skin which can develop cores of necrotic material called "sit – fasts". In general LSD is considered as a disease of high economic pressure because of its ability to compromise food security through reduced cattle production and its productivity. Hence, cattle in the area should be regularly vaccinated.

Camels are relatively less suffering from different diseases compared to cattle and shoat, except a few diseases, such as Pneumonia, Anthrax and Abscess (Maal /Kasoo bax) (Table 35). Despite these, there are novel diseases which are locally named by the community as "Ruquus". This disease affects male camels and it was clinically characterized by sternal recumbency, protrusion of the penis in which the animal is acting as if it is having coitus with the ground and later it can lead to death within 2 - 3 days. "Maal oo dhaaf" locally meaning 'milk and pass' is also another new locally named acute disease which mostly affects lactating she camels and is clinically characterized by sudden death, except blood oozing from the nostrils before death.

Table 33. Pair Wise Rank Results of Cattle Diseases in the Mixed Crop-Livestock Production Systems of Gursum and Awbare districts, 2023

Results of pair wise ranking for Cattle diseases intensity achieved from FGDs in Gursum and Awbare district (Excluding Hilingab kebele)

Cattle Diseases	FMD	BL	T	LSD	B	L	Score	Rank
FMD	X	FMD	FMD	FMD	FMD	FMD	5	1
Black leg		X	BL	LSD	B	BL	2	4
Ticks			X	LSD	B	T	1	5
LSD				X	LSD	LSD	4	2
Botulism					X	B	3	3
Listeriosis						X	0	6

Table 34. Pair Wise Ranking Results of Cattle Diseases in the Crop-Livestock Production Systems of Upper Harawo woreda (Hilly and mountainous agro-ecology), 2023

Results of pair wise ranking for Cattle diseases intensity achieved from FGD in Hilingab kebele of Awbare District

Cattle Diseases	BL	LSD	L	FMD	B	MA	Score	Rank
Black leg	X	BL	BL	BL	BL	BL	5	1
Lumpy Skin Dises		X	L	FMD	B	LSD	1	5
Listeriosis			X	L	B	L	2	4
Foot and Mouth Dis				X	FMD	FMD	3*+1	2
Botulism					X	B	3	3
Muscle Ache						X	0	6

Table 35. Pair Wise Ranking Results of Camel Diseases in the study areas, 2023

Results of pair wise ranking for Camel diseases intensity achieved from FGD in Hilingab kebele of Awbare District

Camel Diseases	A	AX	AB	CP	OF	Score	Rank
Abscess	X	AX	AB	CP	OF	0	5
Anthrax		X	AB	CP	AX	2	3
Acute Bronchi-Pneumonia			X	CP	AB	3	2
Chronic pneumonia				X	CP	4	1
Orf					X	1	4

Even though not very common, the community makes all the attempts to treat the sick animals using their own indigenous animal health knowledge and practices. Some of these include cauterizing the sick animals by very hot metal on the sides of both jaws, and lateral sides of the abdominal area and ribs for particular cases of black leg, FMD, LSD, and Sheep and Goat pox. FGD discussants clearly indicated that the animal health services delivery is very inadequate. For example, respondents did not raise that in the last 2-3 years, veterinary vaccination campaign nor mass veterinary treatments were performed in the area. Instead, self-medication of sick animals with veterinary antimicrobials and Anthelmintics purchased from private veterinary pharmacies in the kebele or near-by community were highly prevalent. District experts reported that most of the animal health posts are not functional these days because of lack of man-power and inadequate veterinary inputs including drugs, livestock diagnosis and treatment materials. No capacity building trainings were given to the community except a few trainings provided to certain cooperatives in the woreda by OWDA. However, there were cases where livestock office staffs at woreda level received an upgrade chance of promotion from diploma to degree annually and joined Jigjiga University.

Lack of logistics and transportation problems especially during vaccination and mass treatment campaigns was a serious problem which the Woredas faced. Whenever these services are available, absence of emergency response drugs (in the case of outbreaks) at district level and inadequate veterinary equipment and infrastructures were also other problems reported. To make matters worse, the mandate of purchasing drugs for the woredas was given to a private company who usually procures the drugs without woreda specifications and also in less quantity. Inadequate budget allocated for the sector either at woreda or

regional levels was also reported to be another critical challenge faced by the woredas.

6.6. Role of Women in Livestock Production

Women's role in livestock production includes milking and milk processing; monitoring and feeding young, sick and lactating animals; looking after chickens, and sheep and goats around the homestead; collecting fodder, cleaning barns and watching over animals at the grazing areas. All of these tasks demonstrate that women play an important part in livestock production and it is similar in all of the study areas. The distance of the watering points from the homestead ranges from 1 to 7 Kms.

As provided in Figure 32, women perceived livestock diseases as the major problem affecting their livelihoods. Shortage of water and feed, to which they are responsible, are also major problems reported by women. Generally, livestock related problems are common to both male and female headed households.

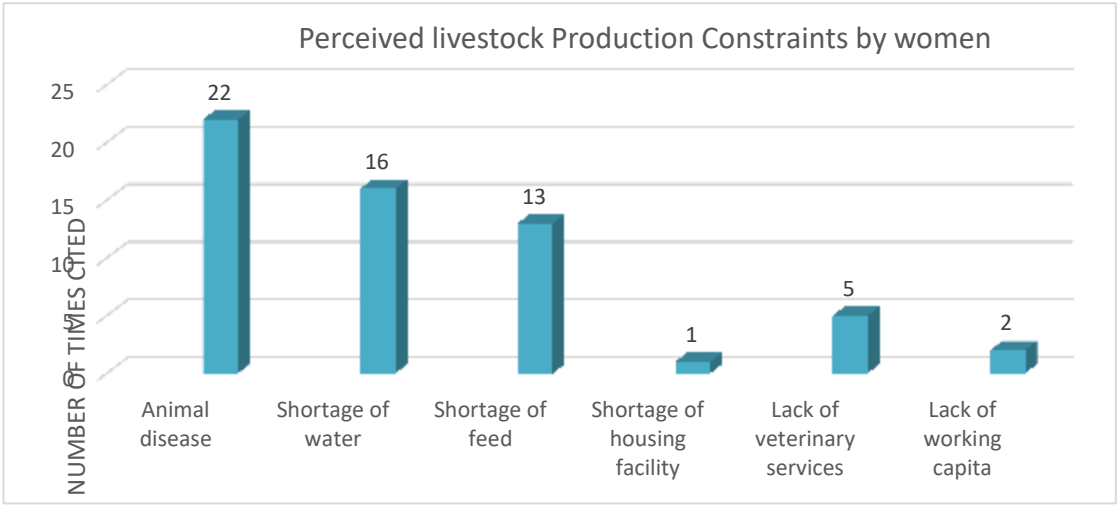


Figure 32. Livestock related problems faced by women in the study areas, 2023.

6.7. Trends in Livestock Population

All the participants in the study areas agreed that livestock population has been declining in the last 10 years, particularly in the last five years, which were the worst drought years which killed about 40% of the livestock population (Figure 33). The major causes attributed to recurrent droughts in the region, shortage of feed, animal diseases, a lack of vet services, the shrinking of range land which shifted into crop production, rangeland degradation, expansion of poisonous plants, and lack of government support. Moreover, destocking of animals due to the current drought and sale of young livestock could contribute to the decline in the local livestock population. The species that are particularly affected were cattle and sheep, which are grazers and less tolerant to harsh environments **(**Figure 34).

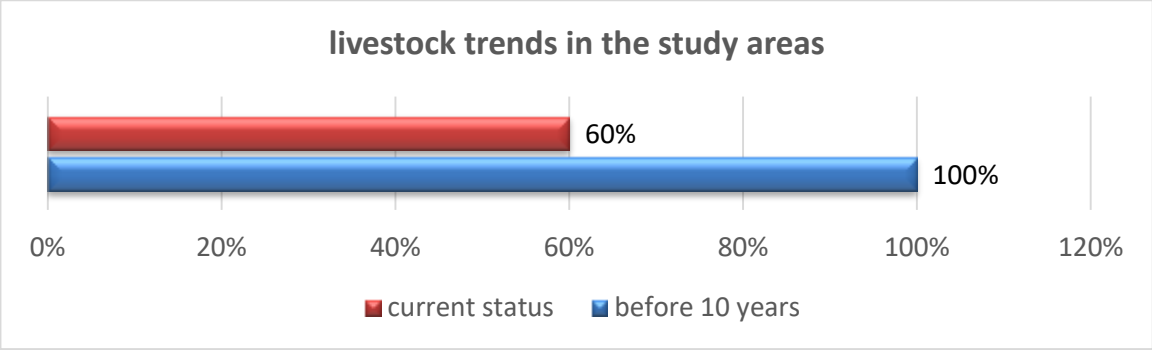


Figure 33. Livestock population trends in the last decade in the study areas (%), 2023.

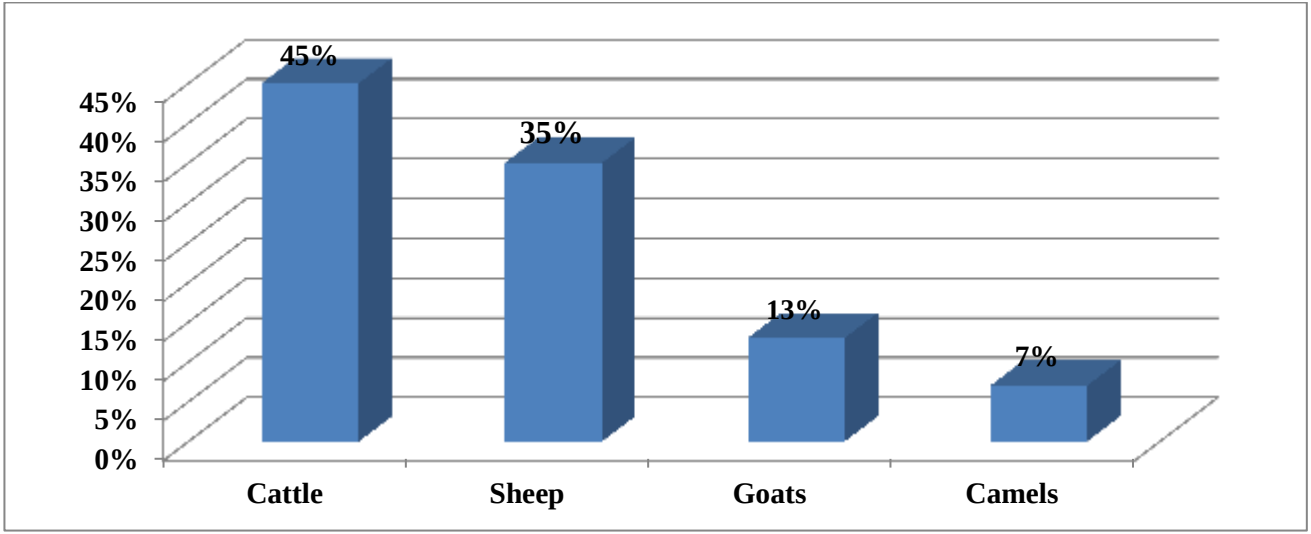


Figure 34. Share of livestock species lost during the last ten years in the study areas, 2023.

The FGD participants also emphasized the tolerance of camels to feed and water shortages and the prolificacy of goats, which have better survival ability and less vulnerability compared to sheep and cattle. The participants also added that if the harsh situation continues for additional years, the cattle and sheep will disappear from the whole region. Key informant interviews with Woreda Agriculture Office Livestock Experts also confirmed the decline of livestock population in the last five years (2019 - 2022) mainly because of recurrent droughts, recurrent animal disease outbreaks, a lack of widespread vaccination, a shortage of veterinary services, trans-boundary diseases, and less government support for the livestock sector.

6.8. Major Livestock Production Constraints

Major livestock problems in the Upper Fafan woreda have been prioritized by the FGD discussant farmers as illustrated in Table 36. The community prioritized feed shortage and animal health problems as the first and second major problems of livestock production. In the Upper Harawo woreda, the first problem was degradation of rangelands mainly because of acute erosion (Table 37). In this agro-ecology, erosion is reported to be a responsible caustic factor which worsened livelihoods of the community.

*T*able 36. Pair wise ranking for prioritization of major livestock production constraints in the mixed crop-livestock systems of Gursum district, 2023.

Results of pair wise ranking for Major livestock production constraint achieved from FGD in the 3 kebeles of Gursum District

Key attributes considered	LS	LVD	LIFS	FS	RD	AD	PP	BE	RSD	LGS	Total score	Rank
Lack of skills	X	LVD	LIFS	FS	RD	AD	PP	LS	RSD	LS	3	8
Lack of vet drugs(LVD)		X	LVD	FS	RD	AD	LVD	LVD	RSD	LVD	4**:6	5
Lack improved forage seeds(LIFS)			X	FS	RD	AD	PP	BE	RSD	LIFS	1***:4	7
Feed shortage(FS)				X	FS	FS	FS	FS	FS	FS	9*:10	1
Recurrent drought(RD)					X	AD	RD	RD	RD	RD	7	3
Animal disease (AD)						X	AD	AD	AD	AD	8*9	2
Poisoning plants(PP)							X	PP	RSD	PP	4*:5	6
Bush Encroachment(BE)								X	RSD	BE	2	7
Rangeland shrinking and degradation(RSD)									X	RSD	5**:7	4
Lack of gov't support(LGS)										X	1	9

Table 37. Results of pair wise matrix ranking for major livestock production constraints in the mountainous agro-ecology of Awbare district, 2023

Results of pair wise ranking for Major livestock production constraint achieved from FGD in Hilingab Kebele of Awbare District

Identified Proble	RD	AD	UFVs	FSh	LIFs	WSh	Pr	Score	Rank
RLand degradati	X	RD	RD	RD	RD	RD	RD	6*7	1
A.Nimal Diseases		X	AD	AD	AD	AD	AD	5	3
Unfunctional Vet.serv			X	FSH	UFVs	WSH	UFVs	2	5
Feed shortage				X	FSH	FSh	FSh	4**6	2
Lack of improved forage					X	WSh	LIFs	1	6
Water shortage						X	WSH	3	4
Predators							X	0	7

In the flat topography of Upper Harawo woreda, the first ranked problem appeared to be feed shortage followed by animal health problems, which is similar to Upper Fafan agro-ecology. These two problems can actually be considered as universal problems not only in the Somali region, but also across the country. Prioritization of other problems next to these two actually differs from one agro-ecology to another. For instance, in Qabrinuno kebele of the Upper Harawo woreda, the third major problem was prioritized to be lack of veterinary service while the fourth recurrent drought (Table 38). On the other hand, in Jare kebele, the third major problem was water shortage followed by rangeland degradation (Table 39). This indicates that the weight of problems is not the same across farming systems and this requires designing of different intervention strategies accordingly.

Table 40 presents cause-effect analysis of livestock production constraints in the study areas. FGD discussants provided various causes of a problem and its effects if it remains untreated. The table also presents opportunities available that can be utilized in addressing the problems. Intervention options were also suggested both by the community and also the research team. The team has also identified some of the development partners which can have a stake in addressing the identified problems.

Table 38. Results of pair wise matrix ranking for major livestock production constraints in mixed crop-livestock production system in Qabri kebele, Awbare district, 2023.

Results of pair wise ranking for Major livestock production constraint achieved from FGD in Qabri nuune Kebele of Awbare District

Identified Proble	RD	FS	LVS	AD	SPL	WSH	Pr	Score	Rank
Recurrent droght	X	FS	LVS	AD	RD	RD	RD	3	4
Feed shortage		X	FS	FS	FS	FS	FS	6	1
Lack of vet service			X	AD	LVS	LVS	LVS	4	3
Animal Diseases				X	AD	AD	AD	5	2
Shortage of pasture land					X	WSH	SPL	1	6
Water shortage						X	WSH	2	5
Predators							X	0	7

Table 39. Results of pair wise matrix ranking for major livestock production constraints in mixed crop-livestock production system in Jarre kebele, Awbare district, 2023.

Results of pair wise ranking for Major livestock production constraint achieved from FGD in Jarre Kebele of Awbare District

Identified Proble	LVD	LV	LVS	SHF	LAC	AD	RD	Pr	WSH	Score	Rank
Lack of vet.drugs	X	LV	LVS	SHF	LAC	AD	RD	LVD	WSH	1	8
Lack of vaccinatio		X	LV	SHF	LV	AD	RD	LV	WSH	4	5
Lack of vet service			X	SHF	LVS	AD	RD	SHF	WSH	2*3	6
Shoratge of feed				X	SHF	SHF	SHF	SHF	SHF	8	1
Lack of awarenes s creation					X	AD	RD	LAC	WSH	2	7
Aniimal diseases						X	AD	AD	AD	7	2
Range land degradatio							X	RD	WSH	5	4
Predators								X	WSH	0	9
Water shortage									X	6	3

[188]

Table 40. Cause-effect analysis matrix of livestock production constraints in the study areas, 2023

Identified Problems	Causes	Effects	Opportunity	Intervention	Responsible body
Feed shortage	• Shortage of water • Land shortage • Pasture land degradation • Limited forage seed/planting input materials • Climate change (recurrent drought) • Expansion of crop production • Limited feed conservation practices (such as crop residues)	• Poverty • Reduced livestock production and productivity	• Availability of high resources of underground water • Availability of research institute and seed enterprise • Availability of highly fertile soil in the study areas	• Capacitating of farmers • Provision of improved seed/forage • Provision of planting material • Establishing irrigation fed crops • Establishment of private cooperatives for seed production and distribution • Afforestation & reforestation • Increasing productivity of crops per unit of land to curb expansion of farmlands	BoANR BoPD BoWI SoRPARI CDA Seed enterprise LLRP NGOs + other stake holders

Animal diseases	• Recurrent drought • Shortage of qualified animal health experts • Low vet services • Improper husbandry management • Livestock mobility • Decreased herd immunity (B/C of irrational use of vet drugs) • Limited budget	• Loss of animals • Reduced animal production and productivity • Insecurity food safety • Poverty • Reduction of national GDP • Public health threats	• Availability of great livestock resources etc. • Commitments of the government and other stakeholders to improve livestock production and productivity • Relatively Availability of medium animal health professionals • Availability of great livestock resources etc.	• Improve frequency of animal vaccination and its coverage area. • Routine mass treatments • Regular survey and surveillance • Functionalizing of veterinary clinics and health posts • Provision of Capacity building for animal health professionals and training of new CAHWs	BoPD , SoRPARI LLRP JJU-CVM NGOs + Community

Recurrent drought	• Lack of rain • Deforestation • Overgrazing • Climate change • Pasture and rangeland degradation • Global effects of climate change	• Feed shortage • Loss of animals • feed and forage Insecurity • re-current animal disease outbreaks • Poverty	• Communities are receptive to the idea of improvement and problem solving • National and international policy attention • Availability of underground water resources	• Afforestation • awareness creation • Rotational grazing • Introducing irrigation fed agricultural farming system • Pasture and rangeland management • Livestock Inter-species herding	DRM BoANR BoPD BoWI SoRPARI CDA Forest and NGOs + Community
Lack of animal health service delivery	• Lack of vet input materials • Shortage of man power • Financial scarcity • Inaccessibility of livestock in remote areas • Lack of animal health information system	• Loss of animals • Reduced animal production and productivity • Insecurity food safety • Poverty • Reduction of national	• Availability of aware community • Capabilities of the government and other stakeholders to improve animal health service delivery • Availability of advanced animal health professionals • Availability of	• Improve frequency of animal vaccination and its coverage area. • Routine mass treatments • Regular survey and surveillance • Functionalizing of veterinary clinics and health posts • Provision of	Livestock office, research institutes and national University + NGOs + Community

		GDP • Public health threats	veterinary science colleges and institutes • Availability of international aids for animal health and production development	Capacity building for animal health professionals and training of new CAHWs	

Each of the priority problems are briefly described in subsequent sections:

1. Animal Feed Shortage

Animal feed shortage is among the top five livestock production constraints in all studied production systems. Its main causes included recurrent drought, erratic rainfall, shortage of grazing land, rangeland degradation, water shortage, and great scarcity of available feed resources (crop residues) in the areas. In response, the production and productivity of livestock declined, such as weak and emaciated body conditions, loss of resistance and exposition to diseases. Following this, the majority of the livestock owners shifted from being livestock herders to other livelihood strategies, such as crop production.

Required Intervention Preferences and Research Tips

Digging out underground water and creating easy access to motor pumps and fuel can enable the community to produce forage for their livestock. In addition, providing training and creating awareness about proper utilization of existing feed resources and conservation techniques is essential. Introducing, demonstrating, and cultivating improved forages and, cultivating sorghum and maize for the purpose of animal feed can also help address feed shortage problems. It is also crucial to develop forage intensification programs to address feed shortage problems on sustainable basis. Disseminating and helping the community adopt the improved forage varieties across the whole region is still one of the fundamental strategies to be engaged to address the feed shortage problem. In addition, knowledge-based technology dissemination through leaflets, manuals, mass media, farmer field days and community organizations should be adopted. Furthermore, transformation of the traditional livestock production to modern livestock production system through

establishment of range land restoration and development, establishment of feed production and processing plants, genomic selection, crossing, upgrading, conservation clustering, market led production systems are also options to address feed shortage problem. Better awareness creation and training on concentrate feeding technologies (nugecake, sesame, wheat bran, molasses, etc.) are also paramount importance to address the feed problem.

2. Livestock Diseases

Livestock trans-boundary bacterial and viral diseases were highly prevalent because of the fact that some of the study areas are geographically located close to Ethio-Somali border where free livestock trafficking does exist and in fact the spread of trans-boundary livestock diseases is highly practicable. Insufficient animal health delivery systems and less skilled man power have also contributed to poor control of the diseases. Furthermore, inadequate operational budget for animal health services compared to the magnitude of the disease problems in the study areas is aggravating livestock health deterioration.

Consequently, livestock diseases occurrence effected to direct losses including increased morbidity and mortality, reduced feed intake, changes in digestion and metabolism there by resulting to decreased rates of reproduction, weight loss and milk production decline. Moreover, the debilitating effects of livestock diseases in the study areas could contribute to the low costs of animals in the local and international markets due to their poor body conditions.

Despite these, the availability of high resources of underground water, good infrastructure, international market proximity, huge range land, and presence of huge and diverse livestock species and breeds could be favorable opportunities to utilize. Existing SoRPARI research centers that can support in providing improved forage seeds, the high commitment of the agro-pastoralist and

indigenous knowledge on feeding, and existing government offices such as livestock, crop, and DRM, as well as NGOs in the region are also available potentials that can be utilized to address livestock health problems on sustainable basis. Moreover, the government's commitments to promote livestock production for improving the farming community's living standards are good opportunities in line with the emergence of commercial livestock farmers. The increases in demand for relevant technology and input supply delivery systems by the community and all the stockholders, and the farmers' indigenous knowledge in livestock husbandry and ethno-veterinary medicines could also contribute to the interventions.

Research tips, Developmental Focus and Policy Recommendations

As one of the recommendations, field studies of veterinary vaccine effectiveness that are in use including controlled clinical evaluation of veterinary vaccines are highly needed in the study areas to assess the performance of livestock vaccination programs. Moreover, investigating rational use of drugs in veterinary medicine which has numerous benefits (such as increasing efficacy, decreasing the potential adverse effects, reducing risk of drug residue and combating development of microorganism's drug resistance) is highly required.

Animal health service delivery system to functionalize district veterinary health posts and undertaking regular livestock disease surveillances in the area should also be improved on sustainable basis. To do so, adequate resources should be allocated in terms of the required budget, veterinary inputs and well trained and qualified manpower. Likewise, adequate veterinary input supplies including diagnosing, treatments and veterinary drugs should be deployed with due considerations of their safety uses in diseased

animals. Provision of regular upgrading, short trainings, refresher courses and continuous professional trainings to animal health professionals in the woredas is also highly commendable.

Policy makers should also give more emphasis on water development activities, rangeland development (conservation and restoration), establishment of feed development technologies, and expansion of community-based breeding strategies, development of clear motivational policies on livestock investment and market-oriented livestock production. To ensure sustainable supply of improved forage seeds to the community, it is highly essential for policy makers to encourage private investors engage in the production and supplies of diversified forage seeds adaptable to the agro-ecology of the region.

Roles of Different Stakeholders

Integration of different development organizations/institutions such as regional and federal research institutes, Universities, Bureau of Agriculture and extension programs, NGOs and international organizations is highly required to address livestock-based problems of the region on sustainable basis. Integration could be in various ways including provision of technical and financial supports. Strategic integration of stakeholders across livestock value chain is required to address the root causes of problems, improve livelihoods of the community and enhance the country's economic and export earnings.

CHAPTER 7
CONCLUSION AND WAYS FORWARD

The farming systems of diverse agro-ecologies in Fafan zone exhibited ranges of features, practices, dynamisms and constraints. The findings have figured out that the farming system is experiencing a number of changes over time, which are both improvements and challenges. Among the major changes include increased drought occurrence, increasing agricultural land, decreasing range lands, increasing natural resources degradation, decreasing livestock population (by about 40% in the last decade), increasing food insecurity (more than 80% of the population).

Among the positive changes, expansion of telecommunication networks has revealed an improvement over time helping the farmers (men, women and youths) to have access to mobile phones. Since most of the mobile phone apparatus is fitted with radio application, it is also a favorable opportunity for the regional government and development partners to introduce and promote some developmental programs, such as digital extension services. The regional government has also introduced improved technologies, such as improved crop varieties, improved forage crops and natural resources conservation practices. Most of the technologies were introduced with subsidy supports of the regional government to encourage the farmers and enhance their economic capacity. The effort of the regional government in introducing mechanization services (especially tractors and combine harvesters) was also helpful in enhancing the efficiency of agricultural production and productivity.

In spite of positive changes in the farming systems, there were also a number of challenges identified during the study. Introduction of improved technologies did not keep pace with the demand from the farming community. While the supply of improved varieties should have been continuous and sustainable, this was not the case. The introduced improved seeds become mixed and lose quality over time, the reason why supply should have been sustainable every season. While Somali region grows diverse crops of cereals, pulses and oilseeds, improved varieties were only introduced for a few crops, mainly sorghum, maize and wheat. No improved varieties were yet introduced for other cereals, such as barley and oats, and almost all of the pulses and oilseeds. In addition to this the improved varieties introduced were accessible to only some farmers while more than 80% of the farming households did not yet get access. Even though Somali Region Seed Enterprise has been established, it was not yet able to meet the improved seed demands of the farming community in the region. Most of the farmers did not also have access to inorganic fertilizers, without which improved varieties will not perform to their potential. Consequent to moisture stress from recurrent drought, long-maturing varieties are getting out of production in the farming systems.

While Somali region is home to huge livestock resources, it was only a few varieties of forage (mainly Sudan grass) and artificial insemination practices that were introduced for a few farmers. Even these technologies were not extensively scaled-up and disseminated. Breed improvement, feeds and nutrition, improved health management, and improved livestock technologies were not yet introduced to the land of livestock in Somali region.
The rural community is not also obtaining adequate services of agricultural extension, education, health and rural roads

infrastructure. Addressing these problems a priori and creating favorable conditions in the first place is essential to facilitate implementation of other development interventions for impactful positive changes.

The study has proposed a number of recommendations that help address the identified problems. Overall, the regional government needs to increase its commitment for the development of agriculture sector. Different administrative hierarchies spanning from region to woreda levels should demonstrate their dedication to agriculture and service sectors by allocating not only adequate financial but also human and material resources. The region has untapped water resources, a large area of cultivable land and other potentials. It is also strategically located at close proximity to export markets. Therefore, enhancing the development of agriculture sector in the region means catalyzing the development other sectors, such as processing, trade, manufacturing and industry. It is not only the regional government structure that should be responsible for the development of agriculture and service sectors, but also other non-governmental and international development partners, private sectors and associations. There should be integration of all these stakeholders for joint consultation, planning, implementation, and, monitoring and evaluation which is a fundamental step for addressing diverse and intertwined problems of the community. One of the mechanisms to re-enforce the integration could be establishing an agriculture stakeholder platform. This platform could meet either annually or bi-annually and its purposes will be joint planning, monitoring of implementations, evaluation of plans and achievements, sharing of experiences and good practices, setting plans for future considerations, and sharing responsibilities among stakeholders as per their mandates. Platform members will draw resources and

share costs to finance the platform. Looking for donor supports could also be another option to obtain supplementary resources to run the platform on sustainable basis.

The regional government should also strengthen a monitoring and evaluation, and accountability mechanism. Regional Bureaus, Zonal and Woreda Offices and Administrations should bear accountability for their responsibility. Unless a strong accountability mechanism is installed in place, it would be hardly possible to utilize regional resources efficiently and expect impactful development achievements.

The constraints identified from the agro-ecologies in Fafen zone and the recommendations proposed can also be applicable to similar other agro-ecologies across Somali Region.

CHAPTER 8
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