ግብርና ሚኒስቴር
MINISTRY OF AGRICULTURE

የእንስሳት ልማት ኢንስቲትዩት
Livestock Development Institute



NATIONAL CAMEL BREEDING PROGRAM (2026-2035)

April , 2026
ADDIS ABABA



The LFSDP's support in preparing and printing these policy documents establishes a definitive "genetic roadmap" for Ethiopia's livestock and fisheries transformation. These formalized strategies act as vital safeguards against disorganized breeding, preventing inbreeding, the erosion of indigenous traits, and the inefficient use of resources. Without such frameworks, a nation is essentially driving in the dark; these manuals provide the "headlights" and "GPS" required to reach a productive, climate-resilient destination. By institutionalizing these guidelines, the Ministry ensures livestock resources are managed with scientific precision and sustainable foresight. Ultimately, these documents bridge the gap between traditional smallholders and a modern, commercialized industry, guaranteeing inclusive and enduring growth.

MESSAGE

Livestock plays a vital role in Ethiopia's socio-economic development, food and nutrition security, employment creation, and resilience of rural livelihoods. With its vast and diverse livestock genetic resources, Ethiopia holds a unique comparative advantage to sustainably develop the livestock sector and enhance its contribution to national economic growth and transformation.

Despite this potential, livestock productivity remains below achievable levels due to long-standing challenges related to genetic improvement, feed and feeding systems, animal health services, and limited adoption of modern technologies. Rapid population growth, urbanization, changing consumption patterns, and the increasing impacts of climate change further underscore the need for a more coordinated, systematic, and forward-looking approach to livestock development.

In response, the Government of Ethiopia is implementing comprehensive livestock policies, strategies, and programs that emphasize the sustainable utilization, conservation, and improvement of animal genetic resources. Central to these efforts is the design and implementation of well-structured breeding programs that are aligned with national development priorities, responsive to diverse production systems, and grounded in scientific evidence while respecting indigenous knowledge and community preferences.

This national livestock breeding strategies and programs provides a strategic framework to enhance productivity, efficiency, and competitiveness across livestock species through planned genetic improvement, performance recording, community-based and nucleus breeding approaches, and the responsible application of modern reproductive and biotechnological tools. It also places strong emphasis on institutional coordination, capacity development, private-sector engagement, and the conservation of indigenous genetic resources to ensure long-term sustainability.

Successful implementation of this program requires the collective commitment of all stakeholders, including federal and regional government institutions, research and academic organizations, development partners, the private sector, and livestock producers.

Through effective collaboration and shared responsibility, this program will contribute to improved livelihoods, increased incomes, enhanced food and nutrition security, and greater resilience of the livestock sector to climate and market shocks.

The Ministry remains fully committed to providing the necessary policy guidance, institutional support, and coordination to ensure the effective implementation of this strategies, and programs. I call upon all partners to work together to translate this strategic framework into tangible and long lasting impact for livestock producers and for the nation as a whole.



Fikeru Regassa (PhD)

State Minister for Livestock,

Ministry of Agriculture

FOREWORD

Ethiopia, with its vast livestock genetic diversity and significant variation both **between and within breeds** in economically important traits, holds great potential to utilize these genetic resources for the benefit of society. The **current livestock productivity** remains below potential due to limited utilization of the genetic capabilities of indigenous breeds and types. Meanwhile, **demand for livestock and livestock products** is increasing globally, and particularly in Ethiopia, driven by **population growth, urbanization, and rising incomes**.

To bridge the widening gap between demand and production, **enhanced investment** by both the government and the private sector in **animal feed and feeding systems, genetic improvement, and animal health services** are recommended. These priorities are reflected in the **revised livestock policies, national breeding and research strategies,** and the **Ethiopian Livestock Master Plan**. Furthermore, **sector-specific policies, strategies, and programs** are essential for achieving sustainable livestock development.

To address these problems, the **Ethiopian Council of Ministers** has enacted **revised agriculture and rural development policies** that emphasize the proper **utilization, conservation, and improvement of genetic resources**. Translating these policies into practice requires the design and implementation of **systematic breeding programs**.

In line with this, the **Livestock Development Institute (LDI)** has developed a **national camel breeding program**. This program serves as a foundation for designing **trait-specific breeding strategies** targeting economically important characteristics. The national camel breeding program has been developed in accordance with the **national context and global emerging trends**, capitalizing on current and future **opportunities in camel production** to enhance productivity and ensure sustainable development of the sector.

On behalf of the **Livestock Development Institute (LDI)**, I would like to extend my sincere appreciation to **Professor Kefyalew Alemayehu** from the **Ethiopian Agricultural Transformation Institute (ATI)**, **Dr. Yosef Taddese** of **Haramaya University**, and **Ato Seife Mamo** of

LDI for their active and valuable contributions to the development of this Camel Breeding Program document. Their technical expertise, commitment, and collaboration were instrumental in the successful preparation of this important national program.



Asrat Tera (PhD) ,

Director General,

Livestock development Institute (LDI)

Contributors:

Technical Writers: The primary authors who organize complex data and translate it into clear, simple language Technical Manual

- Kefyalew Alemayehu (Prof., ATI, coordinator)
- Yosef Tadesse(Dr.) Haramaya University
- Seife Mamo (LDI),

Reviewers / Editors: who proofread content for clarity, grammar, and alignment with organizational style standards.

No.	Name of Contributors	Organization	Position	Role in the manual
1	Dr Thomas Cherenet	MoA/ LFSDP	National LFSDP coordinator	Reviewers / Editors
2	Dr Dagnachew Beyene	LDI	DDG of LDI	Reviewers / Editors
3	Addisu Abera	MoA/ LFSDP	Animal Breeding & Genetics Specialist	Reviewers / Editors
4	Dagnachew Muluneh	LDI	Animal Breeding & Genetics	Reviewers / Editors

Table of contents

MESSAGE i
FOREWORD iii
LIST OF TABLES viii
LIST OF ACRONYMS x
Executive Summary xi
1. THE INSTITUTIONAL MANDATES AND RESPONSIBILITY 1
2. BACKGROUND AND JUSTIFICATION 2
3. DESCRIPTION OF THE CAMEL BREEDS AND THE PRODUCTION SYSTEMS 4
3.1. Camel Production Systems 4
3.1.1. Pastoral Systems: 4
3.1.2. Agro-Pastoral Systems: 6
3.1.3. Urban and Peri-Urban Systems 7
4. CAMEL BREEDS AND THEIR CHARACTERISTICS IN ETHIOPIA 7
4.1. Diversity and Adaptation: 7
4.1.1. Major Camel Breeds in Ethiopia 7
4.1.2. Adaptations to Ecological Conditions 9
5. CAMEL GENETIC IMPROVEMENT TRENDS, STATUS AND PROSPECTS 10
5.1. Genetic Improvement Interventions 11
5.1.1. Selection Programs: 11
5.1.2. Crossbreeding: 11
5.1.3. Use of biotechnological Tools 14
6. BREEDING OBJECTIVES OF CAMEL BREEDS IN ETHIOPIA 15
6.1. Increasing Productivity 15
6.2. Genetic Improvement 15
6.3. Conservation of camel Genetic Resources 15
7. DESIGNING CAMEL BREEDING SCHEMES 15
7.1. Objectives of Breeding Schemes 15
7.2. Types of proposed Breeding Schemes 16
7.2.1. Community-Based Breeding Programs (CBBP) 16
7.2.2. Central Nucleus Breeding Scheme 17
7.2.3. Cross breeding Programs 18
7.3. Line breeding 21
7.4. Community based breeding program 24

7.5. Straight breeding /pure breeding....25
8. IDENTIFICATION AND PERFORMANCE RECORDING....26
9. MONITORING AND EVALUATION....28
9.1. Monitering....29
9.2. Evaluation Approaches....30
10. ROLES AND RESPONSIBILITY OF INSTITUTION....30
11. IMPLEMENTATION ACTION PLAN....37
12. ESTIMATED FINANCIAL REQUIREMENT....38
13. REFERENCES....39

LIST OF TABLES

Table 1. Proposed cross breeding scheme.....21

Table 2. Proposed line breeding scheme/selection.....23

Table 3. Proposed community-based breeding scheme 25

Table 4. Proposed straight breeding program 26

LIST OF FIGURES

Figure 1. Community based breeding scheme of camels breeding 17

Figure 2: Proposed nucleus breeding program of camel 18

Figure 3. Crossbreeding design for indigenous and exotic breeds.....19

LIST OF ACRONYMS

AI	Artificial Insemination
CBBP	Community-Based Breeding Programs
CNBS	Closed Nucleus Breeding System
EMDIDI	Ethiopian Meat and Dairy Industry Development Institute
ET	Embryo Transfer
ILRI	International Livestock Research Institute
LDI	Livestock Development Institute
MOA	Ministry of Agriculture
NAGII	National Animal Genetic Improvement Institute
OARI	Oromia Agricultural Research Institute
ONBS	Open Nucleus Breeding System
SoRPARI	Somali Region Pastoral and Agro pastoral Research Institute
TOT	Training of Trainers
VBC	Village Based Center
YPDRC	Yabelo Pastoral and Dryland Research Centre

EXECUTIVE SUMMARY

Camels are among the most resilient livestock species, highly capable of utilizing marginal areas in arid and semi-arid regions. They can thrive and remain productive under harsh environmental conditions where other livestock species struggle to survive. In Ethiopia, the camel population is estimated at over 8.14 million, predominantly comprising the one-humped dromedary camel (Camelus dromedarius) found across the pastoral and agro-pastoral areas of the country.

Ethiopian camels are distributed mainly in the Somali, Afar, Oromia, Amhara, and parts of the Tigray regions, where most of the population practices nomadic pastoralism. Despite their importance, the genetic potential and breeding capacity of Ethiopian camels have not been well characterized. Camel breed improvement, along with its organizational and institutional aspects, has not yet received the same level of attention as animal health, nutrition, and feed resource development.

Given the large herd size and diverse genetic pool of camels in the Horn of Africa, including Ethiopia, systematic genetic improvement and selective breeding deserve special emphasis.

The overall objective of the National Camel Breeding Program is to increase camel productivity and enhance the quality of camel products and services through genetic improvement and selective breeding, supported by the application of modern biotechnological tools, in alignment with the goals of the Livestock Development Institute (LDI).

To achieve this, the Livestock Development Institute (LDI) has developed this National Camel Breeding Program (2025–2030). The program is based on the revised livestock policy, the National Livestock Breeding Policy and Strategy, and serves as a strategic framework to improve the nation's camel production and productivity through planned genetic improvement and selective breeding approaches.

1. INSTITUTIONAL MANDATES AND RESPONSIBILITY

In the development of any **livestock breeding program**, it is essential to consider the **national livestock policies, breeding and research strategies,** and **breeding policies**, as these provide the **strategic framework and guidance** for setting directions and ensuring effective implementation. These policy documents play a critical role in offering the necessary insights to **guide, monitor, and evaluate** breeding programs, enabling the measurement of **production and reproductive performance** over time.

Accordingly, the **development of this camel breeding program** serves as a key instrument to **implement, monitor, evaluate, and measure** the progress and achievements of Ethiopia's **national camel breeding initiatives** throughout their lifecycle.

The former **National Animal Genetic Improvement Institute (NAGII) which was established under Regulation 422/2018** is one of the major components that now forms part of the **Livestock Development Institute (LDI**) had previously prepared **breeding strategies** for five major commodities: **dairy, beef, poultry, small ruminants,** and **camel**. Following these strategies, NAGII also developed **specific breeding programs** for **Fogera cattle, Doyogena and Horro sheep,** and **Horro chicken**.

Similarly, the **Ethiopian Meat and Dairy Industry Development Institute (EMDIDI**) developed **strategies** for **meat, milk, honey,** and **beeswax** production. Subsequently, **NAGII** and **EMDIDI** were **merged** to form the **Livestock Development Institute (LDI)**.

The **LDI** is a newly established federal institution, created under **Regulation No. 1263/2021**, issued by the **Council of Ministers** pursuant to **Sub-Article 2 of Article 47** of the **Proclamation on the Definition of Powers and Duties of the Executive Organs of the Federal Democratic Republic of Ethiopia**. According to this regulation, the LDI is mandated to **prepare livestock breeding programs**, provide **training**, deliver **advisory, research, and consultancy services**.

In line with this legal framework, the **formulation of a national camel breeding program** is a **mandatory task** under **Proclamation No. 1263/2021**, aimed at fulfilling the objectives of the institute. Therefore, this **camel breeding program** has been prepared based on the principles and guidelines outlined in the **Revised Ethiopian Agriculture and Rural Devel-**

opment Policy (2016, Section 4.2.4(1)), as well as the **national livestock breeding policies and strategies** specific to the camel subsector.

2. BACKGROUND AND JUSTIFICATION

Camel breeding is practiced as a livestock enterprise in many countries across the world, with the primary objectives of producing meat, milk, wool or leather, and for sport, tourism, and transportation. The global camel population is estimated at over 35 million animals (FAOSTAT, 2020; Doyo Kena, 2022). Notably, five neighboring countries—Somalia, Ethiopia, Kenya, Sudan, and Djibouti—account for about 84% of Africa's camel population and over half of the world's total (Kibebew et al., 2021). These countries also possess the highest proportion of one-humped camels (Camelus dromedarius) globally (Othieno et al., 2022).

The drylands of Sub-Saharan Africa are characterized by low and erratic rainfall, high climate variability, and limited suitability for crop cultivation, making livestock rearing the most viable livelihood option. Within this context, the camel (Camelus dromedarius) stands out as the most climate-resilient livestock species, uniquely adapted to thrive in harsh environments where other species cannot (Doyo Kena, 2022).

In Ethiopia, the camel population is estimated to exceed 8.14 million head (Kena, 2022; CSA, 2021). The dromedary camel represents a vital economic resource and livelihood asset for pastoral and agro-pastoral communities, particularly in arid and semi-arid regions (Alemnesh et al., 2020; Faraz et al., 2021a). This multi-purpose animal serves as a pack animal and provides milk, meat, fiber, hide, and transportation services, in addition to holding cultural and socio-economic significance as a symbol of wealth and social status (Mirkena et al., 2018; Shegaw Ambel & Birara Tade, 2022).

Moreover, the export of live camels contributes significantly to foreign currency earnings (Amanuel, 2019; Doyo, 2022). Camel milk is an especially valuable product: daily milk yields range from 3 to 10 kg, with a lactation period of 12 to 18 months, and the annual production in Ethiopia is estimated at 247,100 metric tons (FAOSTAT, 2010). Camel meat is also nutritionally beneficial, with lower fat and cholesterol content compared to other livestock species, making it a healthier alternative that may reduce the risk of cardiovascular diseases associated with saturated fat intake (Alani, 2004; Dawood & Alkanhal, 1995; Giese, 1992).

Despite these advantages, the production and reproductive performance of indigenous Ethiopian camels remain low compared to improved breeds in other countries (Tadelle Mirkena, 2018). This underperformance is largely attributed to the limited attention given to genetic improvement programs. Currently, selection of breeding camels is primarily based on observable traits, such as milk yield, meat production, and work performance.

Therefore, considering these facts, it is imperative to develop a structured camel breeding program that provides a comprehensive framework for the genetic improvement of milk and meat production traits. Such a program will enhance productivity, support the livelihoods of pastoral communities, and contribute to the broader livestock sector transformation goals of Ethiopia.

GENERAL OBJECTIVE

To develop a camel breeding program that enhances production and productivity, thereby contributing to food and nutrition security, poverty reduction, and improving the livelihoods of camel producers in Ethiopia..

Specific objectives

1. Revitalize the Camel Genetic Improvement Program.

Strengthen and modernize the national camel genetic improvement system through pure breeding (within-breed selection) to enhance genetic efficiency, maintain breed diversity, and optimize the conservation and sustainable use of indigenous camel genetic resources.

2. Enhance Milk Production and Productivity

Improve the milk yield and quality of camels to meet the growing domestic demand for camel milk and milk products by implementing organized and consistent breeding programs—including line breeding, pure breeding, and crossbreeding—tailored to various production systems.

3. Improve Meat Production and Productivity

Increase camel meat production and carcass quality to satisfy national market demand through systematic genetic improvement programs, applying selection, line breeding, pure breeding, and crossbreeding strategies adapted to different ecological and production contexts.

4. Developing Climate-Smart Breeding Technologies

Promote the use of climate-smart breeding approaches and reproductive biotechnologies (such as artificial insemination, embryo transfer, and genomic selection) to develop resilient and high-performing camel breeds capable of thriving under changing climatic conditions.

3. DESCRIPTION OF THE CAMEL BREEDS AND THE PRODUCTION SYSTEMS

3.1. Camel Production Systems

Camel production systems in Ethiopia (and similar arid and semi-arid regions) can generally be categorized into pastoral, agro-pastoral, and urban/peri-urban systems. Each system differs in management intensity, resource use, and production objectives, but all capitalize on the camel's unique adaptability to harsh environments.

3.1.1. Pastoral Systems:

The pastoral camel production system is a traditional and extensive form of livestock rearing practiced mainly in arid and semi-arid regions, where crop farming is largely unfeasible. These areas are characterized by low and erratic rainfall, sparse vegetation, and extreme temperature fluctuations. In such ecosystems, camels are the dominant livestock species due to their exceptional ability to survive and produce under harsh conditions.

Key Characteristics of Pastoral Camel Production

1. Dependence on Natural Grazing

Camels rely primarily on native vegetation, including shrubs, thorny bushes, and dry grasses—many of which are unpalatable or inaccessible to other livestock species such as cattle and sheep (Asim et al., 2022). They can feed on over 300 plant species and thrive on minimal water and nutritional inputs (Seyoum et al., 2018).

2. Mobility and Transhumance

Pastoralists often practice seasonal migration to access grazing and water resources. This mobility helps reduce overgrazing, maintain rangeland sustainability, and ensure resilient herd management.

3. Low-Input Management System

External inputs such as feed supplements, veterinary services, and housing are limited. Herd health and productivity are managed primarily through indigenous knowledge and traditional practices (Robert et al., 2021).

4. Cultural and Socio-Economic Roles

Camels hold significant economic and cultural value among pastoral communities:

Milk Production: A primary source of daily nutrition.

Transport: Essential for moving people, goods, and water across long distances.

Meat Production: Consumed occasionally, especially during festivals or emergencies. Additionally, camels serve as symbols of wealth, prestige, and social status.

5. Environmental Adaptation

Camels exhibit remarkable physiological adaptations, such as efficient water conservation, heat tolerance, and the ability to survive long periods without drinking. They can rehydrate quickly by drinking large volumes of water and store fluids within body tissues, enabling survival in extreme aridity.

Characteristics of Pastoral Camel Production

Natural Grazing Dependence

Camels graze on a wide variety of native vegetation such as shrubs, thorny bushes, and dry grasses, many of which are inedible or unavailable to other livestock species like cattle and sheep (Asim et al., 2022). They are capable of feeding on over 300 plant species and can thrive on minimal water and low nutritional inputs (Seyoum et al., 2018).

Pastoral and Transhumant Practices

Pastoralists commonly follow migratory and transhumant patterns, moving camel herds in search of water and pasture, especially during dry seasons. This seasonal mobility reduces pressure on grazing areas, helps prevent overgrazing, and supports the sustainable use of rangeland resources.

Low-Input Management System

Camel production in pastoral systems relies on minimal external inputs. Supplemental feeding, housing, and veterinary services are limited. Instead, pastoral communities depend mainly on indigenous knowledge and traditional practices to manage herd health and productivity (Robert et al., 2021).

Cultural and Economic Importance

Camels play a multifunctional role in pastoral societies:

- Milk production: A vital and regular source of nutrition, especially in arid areas.
- Transport: Used to carry goods, water, and household items over long distances.
- Meat: Provides protein, particularly during ceremonies, drought periods, or emergency situations.

In addition, camels symbolize wealth, prestige, and social status in many pastoral communities. Environmental Adaptation:

Camels are exceptionally well adapted to harsh, arid environments. Their physiological characteristics enable them to:

- Conserve water efficiently
- Tolerate extremely high temperatures
- Survive several days without drinking
- Consume large volumes of water when available, storing it in body tissues

These adaptations make camels one of the most resilient livestock species in desert and semi-desert ecosystems.

3.1.2. Agro-Pastoral Systems

Agro-pastoral systems represent a hybrid approach to farming that integrates crop cultivation with camel production. This system is widely practiced in semi-arid and arid regions, where environmental conditions allow limited crop production alongside extensive live-

stock management. In this context, camels play a vital role because of their high adaptability to harsh conditions and their multiple functions, including milk production, transport, and draft power. The integration of crops and livestock helps diversify livelihoods, improve food security, and enhance the efficient use of land and natural resources.

3.1.3. Urban and Peri-Urban Systems

Urban and peri-urban camel production systems are modern approaches to livestock management located in or around urban centers. These systems aim to meet the growing demand for camel products, particularly milk, and expanding urban markets. Unlike traditional pastoral systems, they are characterized by higher levels of input, improved housing, better veterinary care, and more intensive feeding and management practices. Production is primarily market-oriented, with a strong focus on quality, hygiene, and consistent supply.

Overall, urban and peri-urban camel production systems represent a significant shift toward modernization and commercialization in camel farming. Although they require greater investment, technical knowledge, and management skills, they offer an effective and sustainable way to supply urban consumers with camel products while improving productivity and income opportunities for producers.

4. CAMEL BREEDS AND THEIR CHARACTERISTICS IN ETHIOPIA

4.1. Diversity and Adaptation:

Ethiopia is home to several camel breeds that have evolved to survive and perform under the country's diverse and often harsh ecological conditions. These breeds display distinct physical and productive traits, which make each of them suitable for specific environments and production purposes. Their ability to withstand extreme heat, limited water availability, and poor-quality forage highlights their importance in Ethiopia's arid and semi-arid areas.

4.1.1. Major Camel Breeds in Ethiopia

Afar Camel

Ecological zone: Mainly found in the arid and semi-arid areas of the Afar Region in northeastern Ethiopia.

Physical characteristics: Medium-sized with a relatively light body frame, well adapted to long-distance movement.

Primary uses:

- Milk production: Afar camels are reliable milk producers and provide a regular supply for pastoral households.
- Transport: Due to their strong endurance, they are commonly used for carrying goods across vast desert landscapes.

Adaptations:

- High resistance to heat and drought stress
- Ability to survive on sparse, thorny, and low-quality vegetation

Borena Camel

Ecological zone: Predominantly reared in southern Ethiopia, especially in the Borena Zone of Oromia Region.

Physical characteristics: Large-bodied and robust, with strong legs and a well-developed chest.

Primary uses:

- Mainly used for transport and subsistence-level milk production
- Highly valued for their hardiness in pastoral communities

Adaptations:

- Strong resilience to harsh terrains and variable climatic conditions
- Ability to survive for long periods with minimal water

Somali (Ogaden) Camel

Ecological zone: Commonly found in the Somali Region, particularly in the Ogaden area.

Physical characteristics: Medium to large-sized, with females having a well-developed udder.

Primary uses:

- Dual-purpose breed (milk and meat)
- High milk yield makes it an essential source of food and nutrition in the region

Adaptations:

- Well adapted to arid environments with very low water and feed requirements
- Efficiently converts low-quality feed into energy for milk and meat production

Liben Camel

Ecological zone: Mainly distributed in the southern parts of the Somali Region, especially in Liben Zone.

Physical characteristics: Large, muscular body structure, making it highly suitable for meat production.

Primary uses: Primarily reared for meat, with good carcass yield potential

Adaptations:

- Excellent tolerance with high temperatures
- Ability to graze on a wide range of vegetation types

4.1.2. Adaptations to Ecological Conditions

Extreme Heat Resistance

Ethiopian camels possess unique physiological adaptations that enable them to maintain hydration under extreme temperatures by minimizing water loss through sweating and urine excretion.

Efficient Forage Utilization

These breeds are capable of consuming a wide variety of vegetation, including thorny shrubs and dry, fibrous grasses that are generally unpalatable to other livestock species.

Disease Resistance

Indigenous camel breeds demonstrate a relatively high tolerance to common local diseases and parasites compared to exotic or imported breeds, making them well adapted to Ethiopia's environmental conditions.

High Mobility

Camels play an essential role in Ethiopia's nomadic and transhumant production systems, as they can efficiently travel long distances in search of water and pasture without significant loss of productivity.

5. CAMEL GENETIC IMPROVEMENT TRENDS, STATUS AND PROSPECTS

Recent work done by Haramaya University, the Ethiopian Somali Region Pastoral and Agro pastoral Research Institute (SoRPARI), and the Yabelo Pastoral and Dryland Research Centre (YPDRC) of the Oromia Agricultural Research Institute (OARI) are contributing to a better understanding of the genetic characteristics of indigenous camel breeds. The genetic improvement of camel breeds in Ethiopia is focused on selection and breeding within the local breeds.

Despite their importance and potential, camels' genetic improvement remains neglected in research and development initiatives in Ethiopia (CSA,2021). Investment in camel production and genetic improvement are also limited. Considering the regional importance of camels, greater investment is urgently needed to unlock the unrealized genetic potential that camels have for improving livelihoods and food security in the face of climate change (Megrsa et al.,2024).

In General, Camels are moving from descriptive population genetics to applied genomics: reference genomes, WGS and GWAS are identifying trait loci and selection signatures, but adoption of large-scale genomic selection is still limited by sparse phenotype databases, reproductive technology constraints, and pastoral production realities.

High-level trends: Camel genetic improvement is shifting from simple diversity studies to advanced genomic tools (WGS, SNPs, GWAS) with increasing focus on specialized traits for milk, meat, and racing.

Status: Although reference genomes exist, large-scale breeding programs and national databases are rare. Reproductive technologies remain weak, while local genetic diversity and climate resilience are still very important.

Key challenges: Pastoral production systems, poor records, limited technologies, small

reference populations, and the risk of losing adaptive traits are major constraints.

Prospects & opportunities: Community-based nucleus herds, expanding genomic data, improving reproductive technologies, and rising market demand offer strong potential for future genetic improvement.

5.1. Genetic Improvement Interventions

Camel genetic improvement interventions focus on enhancing camel production and productivity through targeted breeding programs: It requires combining **community-based selection**, **good recording**, **modern genomics**, **reproductive technologies**, **conservation of local diversity**, and **strong market linkages**.

5.1.1. Selection Programs:

1. Breed/ecotype prioritization: Focus on ecotypes adapted to local agro-ecologies and production systems, considering community preferences and key traits.

2. Systematic trait selection: Target economically important traits such as milk yield, meat quality, and disease resistance.

3. Identification of superior individuals: Select high-performing animals within local breeds based on production and health traits.

4. Elite herd development: Establish elite herds from top-performing indigenous ecotypes to serve as nucleus populations for breeding programs.

5.1.2. Crossbreeding:

Crossbreeding involves mating animals from two different breeds or ecotypes to combine desirable traits from both parents. In camels, crossbreeding is generally applied to improve productivity traits (milk, meat), disease resistance, and adaptability to harsh environments. This will help rapid improvement in traits like milk or meat yield and express heterosis (hybrid vigor) which can improve survival, growth, and reproductive performance.

Cross breeding approaches:

1. Identify superior breeds/ecotypes:
    - Select local camels for adaptation traits (heat tolerance, disease resis-

tance).

- Choose exotic or other local breeds for production traits.

2. Define crossbreeding scheme:
    - Two-breed cross: Mate a high-producing male (exotic or improved local) with local females.
    - Three-breed cross: Sometimes used when multiple traits need enhancement.
3. Evaluate offspring:
    - Assess for growth, milk yield, fertility, survival, and adaptability.
    - Select the best individuals for future breeding.

Crossbreeding controlling mechanisms are management, genetic, and institutional measures used to regulate crossbreeding programs, ensuring that hybrids retain desired traits without compromising local adaptation or causing genetic dilution of indigenous populations.

Key Controlling Mechanisms

A. Breeding Policies and Guidelines

- National or regional breeding policy: Define which breeds/ecotypes can be crossed and under what conditions.
- Target traits: Specify the traits to improve (milk yield, meat, disease resistance) to avoid random crosses.
- Population structure: Control the proportion of exotic genes in the local population.

B. Controlled Mating Systems

1. Artificial Insemination (AI)
    - Ensures specific sire genes are introduced.
    - Reduces uncontrolled mating in the field.
    - Useful for spreading superior genetics rapidly.

2. Controlled Natural Mating
    - Assign selected males to specific herds.
    - Keep male-to-female ratios optimal to prevent unwanted crosses.

C. Herd or Population Segregation

- Purebred herds: Maintain local or elite lines separately.
- Hybrid herds: Manage F1 and backcross animals separately.
- Prevent accidental mating between hybrids and purebreds unless intended.

D. Selection and Culling

- Selection of superior individuals at each generation for traits like milk, growth, and disease resistance.
- Culling unwanted genotypes or poorly performing hybrids to avoid diluting desired traits.

E. Genetic Monitoring

- Use pedigree records or DNA-based markers to track breed composition.
- Ensure crossbreeding goals are met (e.g., maintain 25% exotic genes in backcross population).
- Detect accidental introgression of undesirable traits.

F. Farmer Training and Awareness

- Train pastoralists and farmers on:
    - The purpose of crossbreeding.
    - Identifying superior animals.
    - Avoiding uncontrolled mating.
- Engage farmers in participatory breeding programs.

G. Institutional Support

- Government or project-led breeding centers to supply elite males.
- Veterinary and extension support to manage mating, AI, and health.
- Regulations to prevent uncontrolled importation or hybridization.

H. Monitoring and Evaluation

- Regular assessment of crossbreeding outcomes:
    - Productivity (milk, meat, growth)
    - Adaptability (heat tolerance, disease resistance)
    - Genetic diversity
- Adjust breeding strategies based on performance data.

5.1.3. Use of biotechnological Tools

The application of biotechnological tools in camel breeding programs represents a transformative approach for accelerating genetic improvement. These tools enhance the precision, efficiency, and scalability of breeding processes, enabling the rapid propagation of desirable genetic traits across camel populations. Advanced technologies such as artificial insemination, estrus synchronization, and embryo transfer significantly shorten generation intervals and amplify genetic gains, thereby improving productivity, disease resistance, and adaptability in camels.

Artificial Insemination (AI)

AI involves collecting semen from genetically superior male camels and manually depositing it into the reproductive tract of females during their fertile period. This allows for the rapid spread of desirable traits, such as high milk yield or disease resistance, without the need to transport males over long distances. AI also enables selective breeding, reduces inbreeding, and improves reproductive efficiency in camel herds.

Estrus Synchronization

Estrus synchronization involves controlling or aligning the reproductive cycles of female camels so that they come into heat at the same time. This allows for planned breeding, efficient use of genetically superior males or AI, and concentrated calving periods. It improves reproductive management, increases the success of artificial insemination, and accelerates genetic improvement within herds. It helps to facilitate breeding outside the natural reproductive season, which is especially useful in areas with harsh climatic con-

ditions.

Embryo Transfer (ET)

Embryo transfer involves collecting embryos from genetically superior donor females and implanting them into recipient females for gestation. This technique allows multiple offspring from elite females within a single year, accelerating genetic improvement. ET helps propagate desirable traits such as high milk yield, growth performance, and disease resistance, and supports the conservation of rare or endangered camel breeds.

6. BREEDING OBJECTIVES OF CAMEL BREEDS IN ETHIOPIA

These objectives are to create a robust camel breeding program that enhances productivity and supports the livelihoods of communities.

6.1. Increasing Productivity

- Enhance the overall productivity of camel breeds in terms of milk, meat, and other products.
- Focus on improving the reproductive performance and growth rates of camels.

6.2. Genetic Improvement

- Implement systematic genetic improvement programs to enhance desirable traits such as milk yield, meat quality, and adaptability to harsh environments.
- Utilize both traditional breeding methods and modern biotechnological tools for genetic enhancement.

6.3. Conservation of camel Genetic Resources

- Identify and conserve unique indigenous camel breeds to maintain genetic diversity.
- Develop conservation strategies for endangered camel breeds to ensure their survival.

7. DESIGNING CAMEL BREEDING SCHEMES

7.1. Objectives of Breeding Schemes

Defining clear breeding goals that aligned with the institute's vision, the country's revised

agricultural and rural development policy, the institute's development and research strategies, and community needs are essential to obtain a clear and shared direction. The breeding program mainly focuses on improving milk production, meat production, disease resistance, and adaptability to diverse and harsh environments.

7.2. Types of proposed Breeding Schemes

The proposed camel breeding schemes include selective (pure) breeding to improve indigenous breeds, crossbreeding to enhance productivity, community- and village-based programs for local participation, open nucleus herd systems for rapid genetic gain, use of assisted reproductive technologies (AI and ET), and conservation-based breeding to protect valuable local genetic resources. These approaches aim to improve milk and meat production, disease resistance, and adaptability while ensuring sustainability.

7.2.1. Community-Based Breeding Programs (CBBP)

- Involve local pastoralists in the selection and breeding process.
- Foster community ownership and ensure that breeding objectives meet local preferences.
- Select superior camel breed based on the breeding objectives and community needs.

Four Community-Based Breeding Programs (CBBPs) will be established to serve as nucleus herds, with additional CBBPs created based on capacity and target population needs. Breeding will initially rely on natural mating until superior sires are identified within the CBBPs. Selected sires will be used within the CBBPs, and the next best males will be distributed to surrounding camel production units. Nearby households will be organized into producer cooperatives and mating groups, where communal bulls will be rotated among members.

Upgrading of female dairy camels will continue until a stabilized breed with 75% improved blood level is achieved. Participating herds will also serve as the basis for performance recording, with pre-nucleus females selected based on milk yield and other economically important traits. The level of genetic improvement among farmers will depend on access to inputs and proximity to major towns. Accordingly, selected districts and kebeles within

5 km of Jigjiga, Semera, Babille, and Yabelo will be organized under a semi-specialized production system.

In this breeding program, it can be followed the following schemes (Figure)

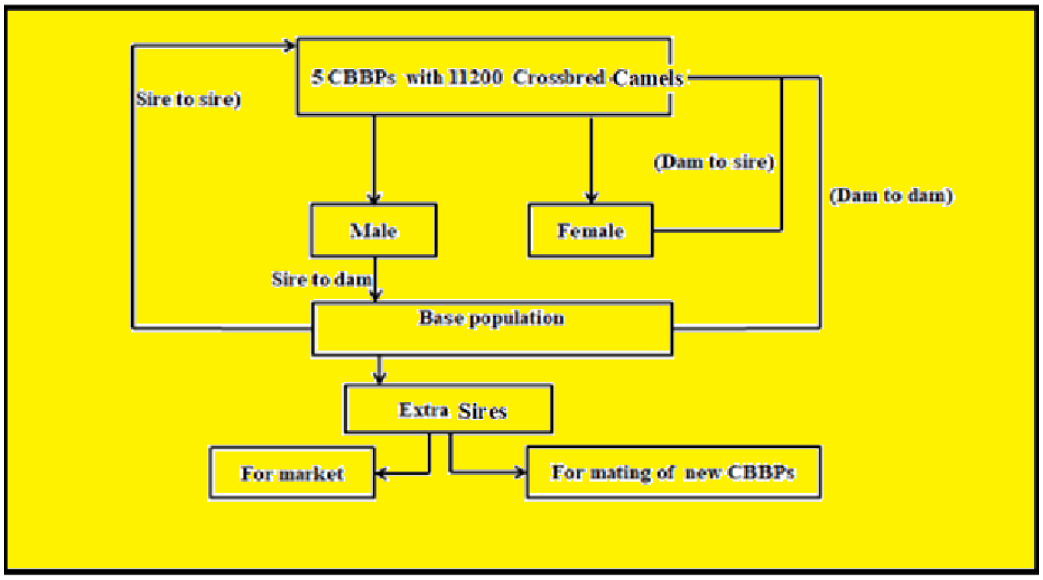

Figure 1. Community based breeding scheme of camels breeding

7.2.2. Central Nucleus Breeding Scheme

A Central Nucleus Breeding Scheme is an organized genetic improvement system in which superior animals are selected, evaluated, and bred in a central, well-managed nucleus herd or flock. The best-performing males (and sometimes females) from this nucleus are then distributed to multiplier herds and community or commercial farms to improve the overall genetics of the wider population. The scheme relies on accurate performance recording, controlled mating, and strict selection to accelerate genetic progress while maintaining desirable traits such as productivity, adaptability, and disease resistance. It is a structured breeding system that uses a small group of genetically superior animals (the nucleus herd) to improve the overall genetic merit of a breed. Selected animals are performance-recorded for key traits such as milk yield and body weight, and genetic progress from the nucleus is disseminated to multiplier and community herds, benefiting pastoral, agro-pastoral, and commercial producers.

There are two main types: Closed Nucleus Breeding System (CNBS) and Open Nucleus Breeding System (ONBS). ONBS is often preferred because it helps reduce inbreeding and

can achieve higher genetic gains compared to closed systems, while CNBS can be effective if strong monitoring and evaluation mechanisms are in place.

Key actions include:

- Establishing a central nucleus herd for genetic selection
- Selecting superior females from community herds based on community preferences
- Conducting rigorous selection of elite males and females within the nucleus
- Implementing controlled mating using the best bulls
- Disseminating improved superior bulls to the community for use in either open or closed systems, as needed

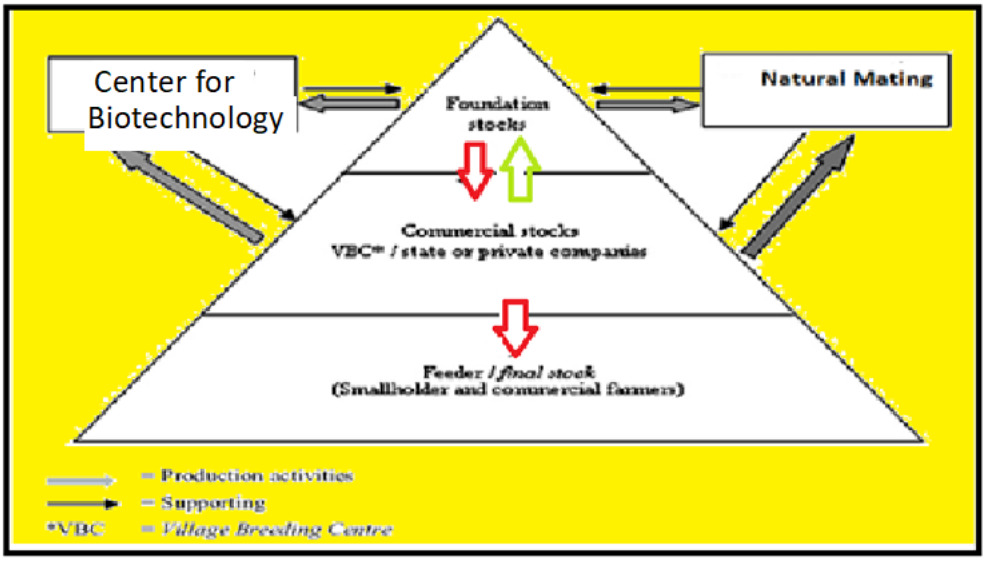

Figure 2: Proposed nucleus breeding program of camel

7.2.3. Cross breeding Programs

Crossbreeding is a powerful tool for genetic improvement in camel populations when implemented responsibly. By combining the productivity advantages of exotic or selected indigenous breeds with the resilience and adaptability of local camels, crossbreeding can produce animals that are more productive, economically valuable, and better suited to local environments. However, careful planning, continuous monitoring, and strong community involvement are essential to ensure the long-term success and sustainability of

such breeding programs (Figure 3).

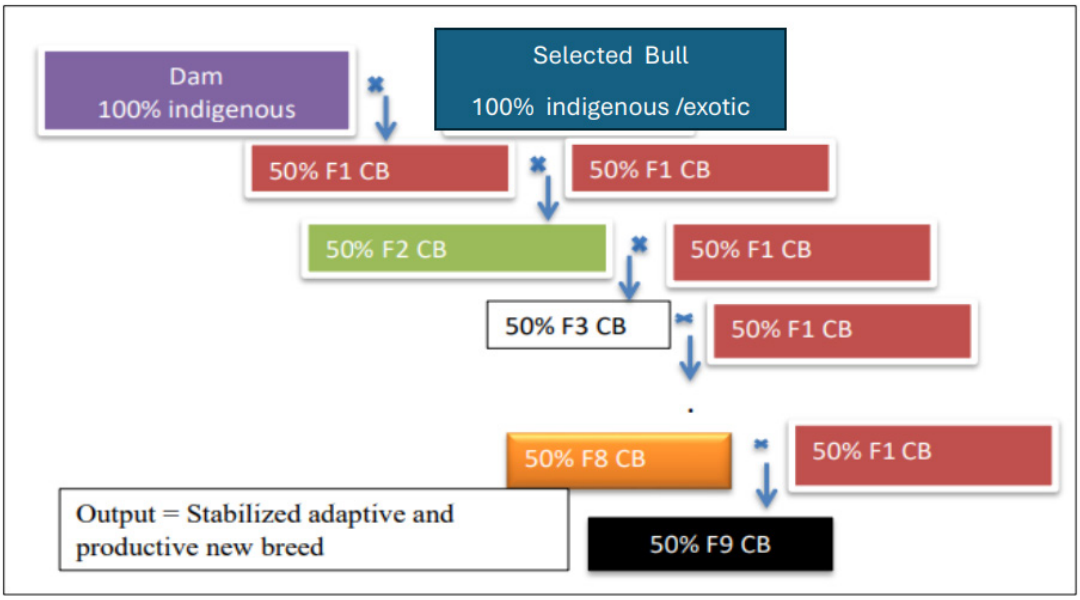

Figure 3. Crossbreeding design for indigenous and exotic breeds

Key Actions required

- ✓ Implement crossbreeding among selected indigenous breeds and with exotic breeds to enhance specific traits.
- ✓ Develop synthetic breeds that combine desirable characteristics from both local and exotic genotypes (Table 1).

If crossbreeding is adopted as the main breeding strategy:

- ✓ Establish breeding communities/cooperatives and either import exotic sires or use selected superior local bulls for milk, meat, or racing traits.
- ✓ Develop crossbred bulls (Exotic/Indigenous × Superior Indigenous) under on-station conditions.
- ✓ Disseminate crossbred males as follows:
    - 50% exotic blood level to community producers
    - 62.5% exotic blood level to specialized producers
    - 75% exotic blood level to commercial producers

- ✓ Identify, license, and strengthen breeding communities/cooperatives.
- ✓ Identify prerequisites for the importation of exotic sires or semen and facilitate importation.
- ✓ Conduct research and optimize the use of camel reproductive biotechnologies (AI, sexed semen, etc.).
- ✓ Select superior dams (for milk, meat, or racing) and cross them with imported exotic sires or elite local bulls to produce improved progeny.
- ✓ Multiply camels with 50%, 62.5%, and 75% exotic blood levels for milk, meat, and racing purposes.
- ✓ Build the capacity of camel producers and breeding communities/cooperatives in improved camel breeding and management practices.

Table 1. Proposed cross breeding scheme (when necessary)

Proposed Breeding Program Design	Camel Breeds/Populations	Traits to be selected	Agro-ecology the breed type found	Existing Production System	Proposed production system
CROSS BREEDING	Exotic/different indigenous Bull Milk Type X Indigenous Milk type (Dam)	Milk type	As per the requirement	Pastoral/ Agro pastoral	Pastoral/agro pastoral
	Exotic/different indigenous Bull Meat Type X Indigenous Meat type (dam)	Meat type		Pastoral/ Agro pastoral	Pastoral/Agro pastoral
	Exotic/different indigenous Bull race type X Indigenous Race type (Dam)	Sport type		Pastoral	Pastoral

7.3. Line breeding

Line breeding in camels is the planned mating of related animals to intensify the influence of an exceptional ancestor while avoiding excessive inbreeding, with the goal of improving and stabilizing important traits in the herd. It is a breeding technique that involves mating animals that share a common ancestor but are not as closely related as in intensive inbreeding. The main goal of line breeding is to preserve and strengthen specific desirable traits within a breed while avoiding the negative effects of close inbreeding.

Line breeding activities will be implemented for three generations to safeguard identified superior indigenous camel breeds from inbreeding depression while maintaining their unique genetic qualities. During the initial phase, line breeding will be applied to the Jigjiga, Hoor, Gelleb, Amibara, and Mille indigenous camel breeds. This process will require

the careful selection and development of superior sires (bulls).

Assessing whether the population is closed or affected by migration is critical. In cases where the population is closed, controlled bull dissemination will be applied. Where populations are open or mixed, a community-based breeding program will be employed. The use of reproductive biotechnological tools such as artificial insemination (AI), sexed semen, and related technologies will enhance efficiency and improve results.

Table 2. Proposed line breeding scheme/selection

Proposed Breeding Program Design	Camel Breeds/Populations	Traits to be selected	Agro-ecology the breed type found	Existing Production System	Proposed production system
LINE BREEDING (IN-BREEDING CONTROL)	Jigjiga Camels X Jigjiga type Fik Camel	Milk type	Jigjiga and Fik (using breeding bull from different or closed population or from unrelated clan)	Pastoral/agro pastoral	Pastoral/agro pastoral
	Gode Hoor Camels X AfderHoor	Milk Type	Gode (using breeding bull from different or closed population or from unrelated clan) and Afder (using breeding bull from different or closed population or from unrelated clan clan)	Pastoral/agro pastoral	Pastoral/agro-pastoral
	Gode Hoor X KebrideharHoor	Milk type	Gode (using breeding bull from different or closed population or from unrelated clan) and Kebridehar (using breeding bull from different or closed population or from unrelated clan)	Pastoral/agro pastoral	Pastoral/agro-pastoral
	AfderHoor X KebrideharHoor	Milk type	Afder and Kebridehar (using breeding bull from different or closed population or from unrelated clan) and Kebridehar(using breeding bull from different or closed population or from unrelated clan)	Pastoral/agro-pastoral	Pastoral/agro-pastoral
	GodeGelleb X AfderGelleb	Meat type	Gode and Afder (using breeding bull from different or closed population or from unrelated clan) and Kebridehar (using breeding bull from different or closed population or from unrelated clan)	Pastoral/agro-pastoral	Pastoral/agro-pastoral
	GodeGelleb X KebrideharGelleb	Meat type	Gode and Kebridehar (using breeding bull from different or closed population or from unrelated clan) and Kebridehar (using breeding bull from different or closed population or from unrelated clan)	Pastoral/agro-pastoral	Pastoral/agro-pastoral
	AfderGelleb X KebrideharGellab	Meat type	Afder and Kebridehar (using breeding bull from different or closed population or from unrelated clan) and Kebridehar (using breeding bull from different or closed population or from unrelated clan)	Pastoral/agro pastoral	Pastoral/agro pastoral
	Awash-GewaneAmibara X Burre-mudaitu-AfamboAmibara	Milk	Awash to Gewane in the north and Bure-mudaitu and Afambo(using breeding bull from different or closed population or from unrelated clan) and Kebridehar (using breeding bull from different or closed population or from unrelated clan)	Pastoral	Pastoral
	Mille-Chifra "Mille Type" X Dubti-Dawe "Mille Type"	Milk/race	from Mille to Chifra to the West and Dubti to the North, Dalifage and Dawe districts) of Afar region up to Tigrai and up to Batiamhara region	Pastoral	Pastoral

7.4. Community based breeding program

A Community-Based Breeding Program (CBBP) in camels is a participatory approach in which local pastoralists and agro-pastoralists collectively select, breed, and manage camels based on agreed breeding objectives (such as improved milk yield, growth, or disease resistance). The program uses indigenous knowledge combined with scientific recording and selection methods. Superior males selected within the community are shared for controlled mating, while poor-performing animals are gradually culled. This approach improves genetic performance, conserves local breeds, strengthens community ownership, and enhances livelihoods in a sustainable way.

Community-based breeding programs (CBBPs) improve the productivity and profitability of indigenous camel breeds while preserving their resilience and genetic integrity. This participatory, low-cost approach is led directly by farmers and is often more sustainable than conventional nucleus or exotic crossbreeding programsCommunity-based breeding programs (CBBPs) are a sustainable alternative to conventional camel breeding methods that involve:

- Training farmers: Farmers are taught to improve selection methods, such as retaining fast-growing heifers for breeding.
- Pooling community flocks: Community flocks are combined to create a larger gene pool for breeding.
- Setting up special herds: A main group is created with chosen female camel, plus excellent bull.
- Choosing and overseeing animals: A group of local community members choose and oversee these animals, paying attention to their best qualities.
- Providing scientific support: Farmers are given information on different breeding options.
- Collecting data: Data is collected to monitor how well individual animals perform.

Table 3. Proposed community-based breeding scheme

Proposed Breeding Program Design	Camel Breeds/Populations	Traits to be selected	Agro-ecology the breed type found	Existing Production System	Proposed production system
COMMUNITY BASED BREEDING	Hoor	Milk	Ethiopian Somali Region	Pastoral/Agro pastoral	Pastoral/Agro pastoral
	Gelleb/liben	Meat		Pastoral/Agro pastoral	Pastoral/Agro pastoral
	Amibara	Milk type	Afar and Amhara Regions	Pastoral	Pastoral
	Borena	Dual type	Oromia region	Agro pastoral	Agro pastoral
	Kunama	Draft	Tigrai	Agro pastoral	Agro pastoral

7.5. Straight breeding /pure breeding

Straight (pure) breeding is the mating of animals within the same breed to maintain genetic purity while progressively improving desirable traits such as milk yield, growth rate, adaptability, and disease resistance. It relies on accurate pedigree and performance records, controlled mating, and the culling of inferior animals. This approach conserves indigenous genetic resources and produces uniform, predictable offspring, making it especially suitable for sustaining well-adapted local camel breeds.

Straight breeding can have several benefits, including:

- Simplicity: Straight breeding is the simplest breeding system to operate.
- Uniform characteristics: Straight Breds tend to have more uniform visible characteristics than crossbreds.
- Self-replacing herds: Straight breeding programs can produce both replacement females and sale animals, so herds can be self-replacing.
- Genetic superiority: Straight breeding programs can provide superior genetics to the commercial beef industry. However, inbreeding can occur over time in any breed, which can reduce performance. To address this, a linebreeding system can be used, which involves carefully planned matings to elevate the influence of a genetic line or individual (Table 4).

Table 4. Proposed straight breeding program

Proposed Breeding Program	Camel Breeds/Populations	Traits to be selected	Agro-ecology the breed type found	Existing Production System	Proposed production system
STRAIGHT BREEDING (SELECTION)	Jijiga Camel	Milk	Jigjiga and Fik (ESRS)	Agro-p/ pastoral	Agro-p/ pastora
	Hoor Camel	Milk	Gode, Afder, and Kebridahar zones (ESRS).	Agro-p/ pastoral	Pastoral
	Gelleb Camel	Meat/Dual	Gode, Afder, and Kebridahar zones (ESRS)	Pastoral	Pastoral
	Amibara Camel	Milk	Awash to Gewane in the north and Bure-mudaitu and Afambo	pastoral	Pastoral
	Mille and Asaita	Race	Mille to Chifra to the West and Asaita	Pastoral	Pastoral
	Liben/Borena	Meat	Liben and Borena,	Agro pastoral	Agro pastoral
	Shinile Camel	Draft	Shinille Zone and eastern Oromiya region).	Pastoral	Pastoral
	Kunama Camel	Milk type	Shire zone Shiraro district	Agro-pastoral	

8. IDENTIFICATION AND PERFORMANCE RECORDING

Animal identification assigns a unique lifetime number to each animal, ensuring accurate tracking of growth, reproduction, health, and performance for breed improvement. In camels, such a system supports genetic improvement but is challenging in pastoral settings due to migration and extensive management. It is more feasible in market-oriented, ranch- or barn-managed systems where performance recording and registration can be properly implemented.

Identification and performance recording are essential for:

- Selecting superior breeding animals
- Avoiding inbreeding with pedigree tracking
- Monitoring improvement over time
- Supporting CBPPs & nucleus herds

- Planning distribution of improved genetics
- Supporting research and policymaking

Identification is the process of assigning a unique identity to each camel so that pedigree, performance, and health data can be accurately tracked over its lifetime.

Common Identification Methods

- Ear tagging – Most widely used; contains a unique number/code
- Branding (hot/cold) – Permanent but less preferred due to animal welfare issues
- Microchipping (RFID) – Accurate and modern; useful for large or commercial farms
- Neck tags or collars – Temporary identification for field conditions
- Photographic identification – Useful for special studies and breed documentation

Information Recorded in Identification

- Unique ID number
- Sex
- Date of birth (or estimated age)
- Breed/strain/ecotype
- Parentage (sire and dam if known)
- Location or herd name
- Owner/farmer name

Performance Recording in Camel Breeding

Performance recording involves systematically measuring and documenting important traits related to production, reproduction, growth, and health. This data is essential for selection and genetic improvement.

Major Types of Performance Records

a) Production Records

- Daily or weekly milk yield
- Milk quality (fat, protein – if facilities are available)
- Body weight or body condition score
- Fiber (hair) yield (if relevant)
- Meat/carcass yield (for slaughter animals)

b) Reproductive Records

- Age at first mating / first calving
- Calving interval
- Services per conception
- Pregnancy length
- Male fertility and semen quality (if using AI)

c) Growth Records

- Birth weight
- Weaning weight
- 6, 12, and 24-month weight
- Average daily gain (ADG)
- Body measurements (heart girth, height, length)

d) Health and Survival Records

- Disease incidence
- Treatments and vaccinations
- Mortality and culling reasons
- Adaptability and stress tolerance

9. MONITORING AND EVALUATION

Data collection and performance evaluation are key components of camel breed improvement programs. Enumerators, livestock development agents, and extension experts will

manage site and herd selection, organize producer cooperatives, collect data, and support related activities such as culling and marketing. To ensure feasibility, data will be collected from 10–25% of sample households rather than entire herds.

9.1. Monitoring

Monitoring: The continuous process of collecting and analyzing information on activities, outputs, and outcomes to ensure the program is on track.

Objectives of M&E in Camel Breeding Programs

1. Track progress of breeding objectives (milk, meat, reproductive performance).
2. Assess the effectiveness of breeding strategies (CBPPs, AI, crossbreeding, selection).
3. Identify problems and bottlenecks in implementation.
4. Ensure efficient use of resources (finance, feed, manpower).
5. Provide feedback on decision-making and policy planning.
6. Evaluate the impact on livelihoods and sustainability.

Key Indicators for Monitoring and Evaluation

a) Genetic Improvement

- Number of animals evaluated and selected for breeding
- Increase in milk yield, growth rate, or meat quality
- Reproductive performance (age at first calving, calving interval)
- Pedigree accuracy and maintenance

b) Program Implementation

- Number of CBPPs established and functional
- Number of artificial insemination sessions conducted
- Farmer participation and training coverage
- Mortality and morbidity rates

c) Economic and Social Impact

- Increase in household income from camel products
- Improvement in food security and nutrition
- Adoption rate of improved management and breeding practices

d) Health and Welfare

- Disease incidence and vaccination coverage
- Body condition scores and overall camel health

F) Data Collection Methods

- Field visits and inspections
- Performance recording sheets (milk, growth, reproduction)
- Farmer interviews and surveys
- Focus group discussions
- Digital tools (mobile apps, databases for large herds)

9.2. Evaluation Approaches

- Evaluation: The systematic assessment of a program's effectiveness, efficiency, impact, and sustainability at certain points in time.
- In camel breeding programs, M&E ensures that genetic improvement, productivity, and management goals are being met. Evaluation can be:
- Mid-term Evaluation: Conducted during the program to identify gaps and make corrections.
- Final Evaluation: Assesses overall program impact and sustainability.
- Comparative Evaluation: Performance of improved herds versus control or baseline herds.

10. ROLES AND RESPONSIBILITY OF INSTITUTION

Ministry of Agriculture (MOA)

- Restructuring/integrating and/or coordinating breeding resources
- Re-developing different polices and strategies to accelerate genetic improvement
- Creating institutional linkage
- Both financial and technical support to regions.
- Assist genetic improvement programs as opportunity for small businesses
- Leads, coordinates and regulates the breeding program.
- Provide training of trainers (TOT) as well as long and short term scholarship for CBBP.
- Collaborative international organizations (like ILRI)
- Gives support and follow up all the activities of the breeding programs
- Monitors and evaluates the breeding programs.

Livestock Development Institute (LDI)

- Institutionalizing/coordinating breeding initiatives
- Aligning research and development strategies
- Revamping and (re)structuring ongoing genetic improvement initiatives
- Developing new breeding programs and new breeds
- Standardization of genetic resources nomenclature and documentation
- Coordinating & scaling up community-based breeding activities/projects
- Creating institutional linkage
- Leads, coordinate and regulate all the national animal genetic improvement programs
- Disseminate improved genetic materials.
- Support and follow up of different activities in Community based breeding program (CBBP).
- Provide training of trainers (TOT) as well as long and short term scholarship

for CBBP.

- Capacity development
- Monitor and evaluate the breeding programs.
- Establishing database system.
- Over all coordination of breeding program
- Provision of logistic and material for breeding activities
- Developing report format and compiling the reports

Somali, Afar, Oromia Tigray and Amhara Bureau of Agriculture and livestock Bir-ros

- Give technical support for the implementation of the breeding program in the zone, woreda and kebele level.
- Strategy for accelerating genetic improvement.
- Restructuring/integrating and/or coordinating breeding resources.
- Creating institutional linkage.
- Support of community actions by extension agents.
- Disseminate different breeding inputs to the Zone's and woreda's level
- Genetic improvement programs as opportunity for small businesses.
- Develop training manuals regarding to the breed improvement program
- Multiplication and dissemination of breeding animals.
- Collecting basic data.
- Providing training of trainers (TOT).
- Follow up, support and reporting the activities.
- Preparation and presentation of annual physical plan and budget
- Report progress of the project every quarter

Zonal Agriculture department and livestock nominal office in the aforementioned regions

- Technical Support for in woreda and kebele level.
- Disseminate different breeding inputs to the woreda's and kebele's.
- Implementing different policies and strategies.
- Disseminate different breeding inputs to the woredas.
- Give training for woreda experts and DA's.
- Monitor evaluate and reporting the activities.
- Compiling reports in the breeding program

Woreda agriculture and Livestock nominal office in the aforementioned zones

- Give technical Support for different activities at kebele levels.
- On-job training of farmers and DAs.
- Disseminate different breeding inputs to kebeles.
- Implementing different policies and strategies regarding the breeding program
- Collection of breeding data.
- Follow up, support and reporting of the activities.
- Selection of peasant association and farmers
- Hiring enumerators
- Technically support enumerators
- Monitoring and evaluation
- Compiling reports in the breeding program

Cooperative offices in the aforementioned districts

- Organizing the community in different cooperative units at the woreda and

kebele level

- Training on cooperatives, financial saving, credit and market activities.
- Strengthening the existing and establishing new cooperatives.
- Identifying the participants and organizing the cooperatives.
- Linking with micro-finance support particularly targeting cooperatives.
- Preparing and Implementing guide line and bylaws of cooperatives.
- Creating institutional linkages, creating linkage between cooperatives and market niches.
- Provide inputs for the cooperative units
- Follow-up and support the cooperatives.
- Organizing the farmers in cooperative ,
- legalizing the established cooperative
- Management of finance. Hence, provide training for necessary committees,
- Audit their financial flow,
- Ensure that the cooperatives earn dividends annually.

Research centers in the respective regions

- Conducts researches for the improvement of the breeds.
- Developing new breeding programs and new breeds.
- Identification of major diseases, developing strategic disease control, delivery of health services.
- Coordinating and transforming/scaling-up of breeders' cooperatives.
- Encourage/support cooperatives to be actively involved in camel marketing.
- Genetic improvement in nucleus flock.
- Develop and transfer different technological package.

- Supporting linkages among various organizations and experience sharing
- Design of programs
- Recording systems
- Collect, analyze and interpret genetic data.
- Awareness creation and especial support for cooperative breeding program.
- Document the process and analyze the data for package preparation, proceedings and policy decision making.
- Capacity development and training (on-job and formal training) of experts and enumerators for community based breeding program.
- Evaluation of on-station and on-farm performance of the camel breeds
- Support and follow-up the community based breeding program activities.
- Monitoring and evaluation of the on-going breeding program.

Universities

- Technical advisory service
- Consultation and validation.
- Technical supporting the local community in
- Training and education for different level of experts.
- Different research works on the specific breed in collaboration with research center and regions

NGO's

- Support the breeding activities both in financial and technical issues.
- Provide or supply different inputs.
- Dissemination of breeding animals.
- Prepare training of trainers and scholarship for experts.
- Importing breeding inputs.

Commercial farms

- Multiplication and dissemination of breeding animals.

Ethiopia Biodiversity institute

- Conservation and regulation of animal genetic resources and financial support.

Government support

- Financial support
- Development of conducive policy environment
- Infrastructure development
- Capacity development
- Monitoring and evaluation

Enumerators

- Data collection
- Proper identification of animals
- Other technical assistance
- Compiling reports

Links with other projects/activities

Piecemeal approaches to development interventions are undesirable and are usually more costly in the long run. Thus, it is of paramount importance to follow a holistic development approach for sustainable development of communities, necessitating integration and coordination. Linkage of the CBBP will be formed with NGOs and other developmental organization to support the activity and hasten the genetic improvement.

11. IMPLEMENTATION ACTION PLAN

Action plan (For 10 years)

No	Activities	Years									
		2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	Establishment of performance recording system for nucleus and sub-nucleus herd										
2	Establishing animal identification and recording system										
3	Training of experts in breeding data collection, analysis										
4	Establishment of nucleus and sub-nucleus herds										
5	Production of candidate bulls for progeny testing at nucleus and sub-nucleus herd										
6	Data recording on yearling weight on yearling calves										
7	Data recording on milk yield, growth rate and reproductive traits from half sibs and half sib's progeny group										
8	Selection of proven bulls and replacement females										
10	develop selection criteria for nucleus herd										
11	establishment of data recording system at sub-nucleus herd and link to nucleus										
12	selection and establishment of sub-nucleus herd										
13	Training on fattening/ milk production										
15	Establishment of culling criteria for aged female camels and aged and less productive bulls										
16	Data analysis and report writ up										

12. ESTIMATED FINANCIAL REQUIREMENT

Financial requirement

No.	Activities	Unit	Quantity	Unit price (ETB)	Total (ETB)
1	Data recording facilities/ tablet	No	25	70,000	1,750,000
2	training of experts and farmers	Birr	180 individuals	120,000	21,600,000 for 10 years
3	Per diem for regular monitoring	Birr	90	19500/individual	1,755,000
4	medicament purchase and transport	Birr		800,000	800,000
5	Birth, weaning and yearling weight weighing balance		5	300,000	1,500,000
6	Stationary	No		1,000,0000	1,000,0000
7	Salary for enumerators	Birr	15	15,000	225,000/per individual
8	Motorbike	No	15	200,000	3,000,000
9	Sub total				30,830,000
10	Contingency (10%)				3,083,000
11	Total budget				33,913,000

13. REFERENCES

1. የኢትዮጵያ ፌዴሬሳዊ ዲሞክሩሲያዊ ሪፐብሊክ .የግብርናና ገጠር ልማት ፖሊሲ . ሚያዝያ 2016 ዓ.ም .አዲስ አበባ
2. Kena, D. Review on camel production and marketing status in Ethiopia. Pastoralism 12, 38 (2022). https://doi.org/10.1186/s13570-022-00248-2
3. Faye, Bernard. (2020). How many large camelids in the world? A synthetic analysis of the world camel demographic changes. Pastoralism. 10. 10.1186/s13570-020-00176-z.
4. Kibebew Babege, Sale Wandara and Latamo Lameso. "Potential of camel production and management Practices in Ethiopia: Review." Journal of Dryland Agriculture 7, no. 5 (2021): 67-76.
5. Othieno J, Njagi O, Masika S, Apamaku M, Tenge E, Mwasa B, Kimondo P, Gardner E, Von Dobschuetz S, Muriira J, Adul B, Mwongela L, Hambe HA, Nyariki T and Fasina FO (2022) Knowledge, attitudes, and practices on camel respiratory diseases and conditions in Garissa and Isiolo, Kenya. Front. Vet. Sci. 9:1022146. doi: 10.3389/fvets.2022.1022146
6. Kena, Doyo. (2022). Review on camel production and marketing status in Ethiopia. Pastoralism. 12. 10.1186/s13570-022-00248-2.
7. Wondimu, Yoseph & Gebre, Yoseph & Guya, Mitiku & Kurtu, Mohammed. (2023). Camel Husbandry Practices in Borana Zone of Oromia Regional State, Ethiopia. 7. 73-86.
8. CSA (2021). Agricultural sample survey, volume II, livestock and livestock characteristics, Central Statistical Agency (CSA), Addis Ababa, Ethiopia.
9. Faraz, A., Younas, M., Pastrana, C.I. et al. Socio-economic constraints on camel production in Pakistan's extensive pastoral farming. Pastoralism 11, 2 (2021).
10. Ambel, Shegaw & Tade, Birara. (2023). Role of Camel for livelihood of poor pastoralist in Ethiopia.
11. Kena, Doyo. (2022). Review on camel production and marketing status in Ethiopia. Pastoralism. 12. 10.1186/s13570-022-00248-2.
12. FAO (2010) Food and Agriculture Organization of the United Nations. Production yearbook 56: 432
13. Bekele Megersa, Kebede Amenu, Theo Knight–Jones and Wudu T Jemberu.(2024).The

one–humped wonder ethiopias camels in focus..global burden of animal disease(G-BADs) ,International livestock research institute

14. Yirda, Alemnesh & Guya, Mitiku & Woldeyes, Kibebew. (2020). Current Status of Camel Dairy Processing and Technologies: A Review. Open Journal of Animal Sciences. 10. 362-377. 10.4236/ojas.2020.103022.
15. Mohamed Tharwat1 , Tariq I. Almundarij1, , Madeh Sadan1,, Faten Khorshid, and Ayman Swelum.(2023). Is camel's urine friend or enemy? Review of its role in human health or diseases.
16. Mirkena Tadele, Elias Walelign, Nega Tewolde, Getachew Gari, Getachew Abebe & Scott Newman (2018). Camel production systems in Ethiopia: A review of literature with notes on MERS-CoV risk factors. Pastoralism, 8:30
17. Amanuel Ayele (2019). A review on livestock marketing in Ethiopia: Opportunities and challenges. Journal of Marketing and Consumer Research,59: 1-8.
18. FAOSTAT. (2010). Production Statistics. Live Animals. FAO Statistics Division. Rome: Food and Agriculture Organization of the United Nations (FAO) [Accessed 20 February 2013
19. ICAR (International Committee for Animal Recording). 2014. ICAR recording guidelines an international agreement on recording practices approved by the General Assembly held in Berlin, Germany. ICAR.