



Ethiopian ATA
Agricultural Transformation Agency
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National Beef Cattle Breeding Strategy



2018 -2030

National Beef cattle Breeding Strategy

2018 – 2030

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Foreword

In the years ahead agriculture awaits a daunting task of feeding burgeoning population in a resource constraint world and under the influence of climate change while keeping society and environment safe. Livestock development would undoubtedly play a key role within the agriculture to fulfil its task, particularly in ensuring food and nutrition security and environmental safety. Nevertheless, the contribution of the sub-sector compared to its potential is disproportionately low. Lack of national legal framework and absence of well-established and functional breeding programs, inadequate support and lack of commitment and institutional set up to support breeding programs are among the major constraints hampering the development of successful breeding programs and were among the major bottlenecks limiting the success of livestock genetic improvement and conservation efforts in the country. In order to solve the problems, the Ministry of Agriculture in collaboration with development partners developed a national livestock breeding policy that has been approved by the Council of Ministers of the Federal Democratic Republic of Ethiopia.

This national breeding strategy was therefore drawn within the context and in conformity with the need and evolving national and global emerging trends while taking the advantage of the current and emerging opportunities. The strategy is developed within a framework of addressing both development and research aspects at national level. It covers the analysis of the existing situation, identifies challenges and opportunities with regard to breeding of beef cattle, and evaluates the institutional arrangements and address the variation in terms of agro-ecology and production system as well as the biodiversity within the species populations of the country. The strategy is framed in alignment with, among others, the national Livestock Master Plan; and Livestock Genetic Improvement Roadmap, and Livestock Breeding Policy.

Hence, the strategy is believed to guide development of tailored beef cattle breeding program by resolving the current disorganized breeding initiatives, which would improve the efficiency and effectiveness of genetic improvement initiatives; transformation of ongoing fragmented, project-based and research-based breeding activities into sustainable breeding programs; increase in the economic contribution of adapted indigenous beef cattle genetic resources through conservation based genetic improvement and minimization of irrational crossbreeding activities; integration of research and development institutions to work towards the same breeding goal; and creation of job opportunities for small businesses delivering improved genetics through involvement of the private sector in genetic improvement.

The current breeding strategy was developed by the Ministry of Agriculture (MoA) through the facilitation of the Agricultural Transformation Agency (ATA). Various federal and regional stakeholders from the public and private sectors were integral to the development of the strategy.

Indeed, laying down a 12 years plan seems a time too distant to accurately predict. However, by scanning and analysing the national and global trends, and possible future scenarios and signals we believe that we have captured the coarse portrait of the future. Despite this, we by no means claim that

it is a complete document. Rather, the assumption is that, the strategy will serve as a live document to develop breeding programs and remain dynamic to respond to newly emerging problems that can be revised subsequently as necessary.

On behalf of the MoA and my own, I would like to extend my sincere appreciation and thanks to ATA for the financial support, coordination and technical contribution starting from planning to finalize the beef cattle breeding strategy. Moreover, my enormous gratitude goes to Dr. Million Tadesse and Seyoum Bediye (EIAR), Dr. Tesfaye Alemu (OARI), Dr. Yoseph Mekasha and Dr. Yitaye Alemayehu (ATA); and Welay Hadgo (MoA) who were actively involved in the process of developing this breeding strategy document.

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Acronyms

AI	Artificial Insemination
ARDU	Arsi Rural Development Unit
CRGE	Ethiopia’s Climate Resilience Green Economy
CSA	Central Statistical Authority
DAGRIS	Domestic Animal Genetic resources Information System
EARC	Ethiopian Agricultural Research Council
EIAR	Ethiopian Institute of Agricultural Research
EIB	Ethiopian Institute of Biodiversity
ESAP	Ethiopian Society of Animal Production
FAO	Food and Agricultural Organization
GTP	Growth and transformation plan
HLI	Higher Learning Institute
ILRI	International Livestock Research Institute
LMP	Livestock Master Plan
MoAL	Ministry of Agriculture and Livestock
NAGII	National Animal genetic improvement institute
RRI	Regional Research Institute

Executive summary

The strategy is meant to serve as a strategic guide of research for development in genetic enhancement, conservation, multiplication and sustainable utilization of beef genetic resources. Preparation of the strategy was based on review of pertinent literature, assessment of the internal and external environments and lessons learned from the evaluation of past strategies, programs, projects and institutions pertaining to beef cattle genetic enhancement, conservation, multiplication, and utilization. Guided by the vision, mission, goal, objectives and key principles, the strategy serves as a blue print to guide research for development directions and priorities in national beef cattle breeding strategy during the plan period of 2019 to 2030.

The scope of the current strategy addresses wider perspectives in delivery of improved genetics (technology, institutions, policy and legal frame work) and wider targets (smallholders/pastoralists, commercial farmers, processors and exporters). In terms of rationale for this strategic document, several issues can be mentioned among which: the wide gap between current status and the ambitious targets set in the perspective plans (GTP II, Climate Resilient Green Economy (CRGE) and Road Map for modernization of meat animals production System); presence of global knowledge, technologies and possibilities for using late comers advantage; and presence of wider institutions and possibilities for effective coordination, linkage and actors' convergence towards national goal are quite important.

The strategy document the current situation of beef cattle breeding in terms of development goals, breeding strategies and program, institutional and policy frame work and technical evaluation of strategies and programs are analyzed. Key conclusions drawn from technical evaluation includes:

- Characterization of cattle breeds/populations carried out so far were not comprehensive enough and far from complete.
- Effort in ggenetic enhancement of indigenous by selection was limited to Borana breed and this attempt suffered from short duration and limited number of animals to lead to the desired objectives.
- The crossbreeding engagement at Haramaya University also suffered from the aforementioned limitations.
- Analysis of institutional landscape indicated presence of quite an array of institutions engaged in animal genetics and breeding but none had a focused activity on beef genetics and breeding. The existing institutions also suffer from lack of capacity, absence of effective linkage and actors' convergence towards national goal.
- It is under scored that the emerging institutional innovations i.e the National Agricultural Research Council and the National Animal Genetic Improvement Institute are emerging opportunities for enhancing innovations in delivery of improved beef genetics
- The approval of the long years awaited animal breeding policy frame work is also a plus for guiding development and sustainable use of improved beef genetics.

The strategy provides analysis of strategic issues of beef cattle breeding strategy/ from the perspectives of the external and internal factors in key thematic areas under general issues (human and physical capacity, beef cattle genetics and breeding and cross cutting issues encompassing gender and climate smart green economy. The strategic issues presented are synthesized by filtering out key aspects which require research for development, conservation, multiplication and sustainable utilization of improved beef cattle genetic resources.

Strategic interventions for critical issues along the time horizon of 2019-2030 (short, medium and long terms) with their respective expected outputs and implementation strategy with special emphasis to roles/ responsibilities of institutions have been explained. Accordingly, it describes proposed frame work of the strategy addressing breed groups and suggested breeding programs based on dominant beef production systems in Ethiopia. The proposed breeding program includes indigenous beef cattle improvement through selection for pastoral and agro-pastoral system, cross breeding for mixed crop-livestock system and cross breeding/ selection within specialized beef breeds targeted for commercial beef producers. The chapter also provides highlights of the breeding programs and application of biotechnological tools in genetic enhancement, conservation and multiplication of beef genetic resources. Aspects of assisted reproductive biotechnological tools (Estrus synchronization, MOET, and IVF), molecular genetics with special emphasis to marker assisted selection and mapping whole genome for feed conversion efficiency, GHG emission and disease resistance are highlighted.

The beef cattle strategy document highlights issues of organization and implementation of breeding programs with due emphasis in planning and implementation of open-nucleus breeding scheme organized at three tiers i.e, Nucleus herd (Tier 1), sub-nucleus (Tier 2) and base herd (Tier 3). The strategy is expected to benefit the smallholder small ruminant breed keepers, commercial companies, women and jobless youth.

1 Introduction

1.1. Background

Ethiopia has the highest cattle population and diverse gene pool suitable for meat production. A total of 59.5 million cattle population (CSA, 2016) and 27 distinct cattle breeds (DAGRIS) are noted to exist which can be used for beef or milk production. The cattle breeds identified so far are categorized into seven major categories i.e. Small East African Zebu (Adwa, Ambo, Bale, Goffa, Guraghe, Hammer, Harer, JamJam, Jijiga, Mursi, Ogaden zebu, Smada), Sanga (Aliab Dinka, Anuak, Danakil, Raya-Azebo), Zenga (Arado, Fogera, Horro), Large East African Zebu (Arsi, Begait, Ethiopian Borana, Murle), Humpless Long horn (Kuri), West African Zebu (Red Fulan) and Humpless Shorthorn (Sheko). In line with the general livestock production systems existing in the country, the major beef cattle production systems could be broadly classified into mixed crop-livestock production system, pastoral production, and intensive/semi-intensive production systems.

Despite huge population and diverse gene pool, the Ethiopian beef production, productivity and product quality lagged behind the regional, continental and world average as a result of which per capita consumption remained one of the lowest and competence in the global market is seriously challenged. Additionally, neither the community engaged in cattle production nor the country have been benefiting from the resource base. This scenario is a result of multiple factors among which the genetic base is of paramount importance. Over the years, the Ethiopian cattle remained un-improved and there is no specialized beef breed developed so far for meat production. Additionally, because of frequent drought and climate change particularly in the pastoral and agro-pastoral set up, the most productive animals within the herd are lost every year and some of the potential beef breeds are under severe threat approaching extinction. Lack of specialized beef breed in Ethiopia was not only a result of technical issue but lack of strong and specialized institution committed for long term for genetic enhancement, conservation and sustainable utilization of indigenous breeds. Additionally, lack of institutional capacity (human and physical) in using state of the art technology for genetic enhancement is also a challenge in making best use of the gene pool the country is endowed. The few attempts in beef cattle genetic improvement have

also suffered from the piece meal approach, lack of long term commitment and actors convergence towards common goal. Ultimately, absence of comprehensive strategic directions, institutions and implementation capacity were among the key challenges for putting in place the required genetics targeted for beef production in Ethiopia.

Despite the aforementioned challenges quite a range of opportunities currently exist in Ethiopia for improving the genetic base of beef cattle. From policy perspectives at macro level, the GoE accords special emphasis for the livestock sector especially meat sub-sector due to vested interest pertaining to export led economic growth, nutritional security of food of animal origin and development of agro-industrial parks towards industrialization. Policy directives on market led economy and commercialization with special emphasis to private sector as an engine of economic growth also offers unique opportunity for private sector engagement in development and delivery improved genetics. Technically, presence of desirable genes accounting for productive and adaptive traits of indigenous breeds and gens which could contribute for special taste of meat are unique opportunities for branding Ethiopian beef and enter into global market. Additionally, presence of state of the art technologies globally for better understanding and advancing the genetic base of beef cattle offers unique opportunity to make best use of late comers' advantage in a fast track approach. From institution point of view, the presence of various research and higher learning institutions engaged in livestock research and an umbrella national institution for effective coordination of agricultural research including livestock sector are the emerging golden opportunities towards creating institutional pluralism and effective engagement in genetic improvement of indigenous breeds within their production system.

1.2. Rationale for developing the strategy

The GoE has set a vision of putting the country among the lower middle income countries by 2025 and the livestock sector is expected to contribute to the overall economic/ social transformation, livelihood improvement and environmental sustenance. Among livestock commodities the meat sub-sector particularly beef offers unique opportunity in export led economic growth, nutritional security and livelihood improvement of the community. Within

the livestock sector against base year of 2015, a target of increasing beef production from 989,000 ton to 1,467,000 (increment of 478, 000 tons) and productivity increment of 107 kg to 138 kg per animal (national average increment of 31 kg/animal) is set by 2020 The Ethiopian Ministry of Industry in its strategic plan towards industrialization has also set strategic directions of organizing integrated agro-industrial parks and livestock commodities particularly beef is among the key commodities of interest. Additionally in its policy directives of modernization of meat animals' production system, the GoE has set a target of entering into EU market by 2025. These ambitious targets demands application of state of the art technology enhanced institutional capacity and actor's convergence in delivery of improved genetics of beef cattle. Over the years, productivity and per capita consumption of beef in Ethiopia has remained quite lower than regional and world averages because of various factors among which genetic inefficiency is a key concern. Absence of strategic thoughts/ focus, lack of appropriate institutions and weak actors' convergence are among the major limitations encountered in beef cattle genetic improvement. The climate change and frequent drought in some production system particularly in the pastoral and agro-pastoral setup have also negatively impacted on beef cattle genetic resources calling for effective in-situ and ex-situ conservation and proper utilization of beef genetic resources. The aforementioned gaps demand strategic thoughts on technical domains and institutional configurations for positioning Ethiopia at the status it deserves in the regional, global and niche markets of beef. Thus, this strategic document of national beef cattle genetic improvement is developed to serve as a blue print to guide research for development directions and priorities in beef cattle genetic enhancement, conservation, multiplication and utilization during the plan period of 2019-2030.

1.3. Vision

By 2030, to see the beef cattle subsector transformed into a sustainable supplier of products of sufficient quantity and standard quality to the domestic and export market, consumer and the community.

1.4. Mission

To make efficient utilization of the beef cattle genetic resource base of the country through sound genetic enhancement, breed conservation and sustainable utilization for the betterment of the livelihood of producers and increased contribution to the national economy.

1.5. Goal

To enhance beef cattle production and productivity for ensuring food and nutrition security and poverty reduction in the country and ensure better life livestock keepers in Ethiopia.

1.6. Objectives

The general objective of the strategy is to guide the future genetic improvement, conservation and sustainable utilization of the beef cattle sector along with transforming existing fragmented genetic improvement initiatives into organized, rationalized, scientific and sustainable breeding programs through institutional and technical reforms.

Specifically, the beef cattle breeding strategy is to outline the detailed directions in:

- developing and implementing well-organized and consistent beef cattle genetic improvement programs for different production systems;
- applying different breeding tools including biotechnology (genomic and reproductive technology); and developing elite breed and conserve beef cattle genetic resources
- enhancing the capacity for the research system, development institutions, private sector and small holders in different production systems; and
- developing climate smart beef cattle technologies and innovation to mitigate and adapt to climate change/variability.

1.7. Scope of the strategy

The beef cattle breeding strategy is developed within a framework of addressing both development and research aspects at National level. It covers the analysis of the existing situation, identifies challenges and opportunities with regard to breeding of beef cattle, and evaluates the institutional arrangements and address the variation in terms of agro-ecology and production system as well as the biodiversity within the beef cattle population of the country. A time line of 12 years (the remaining two years of GTP 2 and the full duration of GTP 3 and 4) is envisaged in revamping existing breeding research and development programs, identifying priority for new ones and developing a framework for the breeding programs.

1.8. Guiding principles

Towards accomplishing the aforementioned mission the following basic and unwavering principles shall be followed:

- The national beef cattle genetic improvement shall be an integral part of the national research for development efforts and guided by basic principles put forward in the road map of the national master plan.
- All the activities shall be founded on the policies and priorities set in road map for national genetic improvement strategy for beef cattle in the Livestock master Plan embracing the notions of cost-effectiveness, technical efficiency and responsiveness to stakeholders in both the public and private sector
- In the process of project formulation and implementation, real participation and engagement of the community shall be ensured. The national beef cattle genetic improvement activities shall follow participatory approach and ensure sufficient degree of client orientation
- Through its impact path way, the national beef cattle genetic improvement shall ensure its research for development outputs will contribute to macro level goals of economic/ social transformation, sustenance of environment and livelihood improvement
- During project formulation and implementation the required ethical, social and environmental impacts shall be ensured
- In the national beef cattle genetic improvement engagement special emphasis shall be given to capacity building, institutionalization of integrated approach, institutional pluralism and effective engagement of partners and stakeholders on the basis of comparative advantage
- Due attention shall also be given to inclusiveness in terms of diversity and equal opportunity for all encompassing gender-sensitive approaches in its research for development engagement
- In all of its deliberations, the national beef cattle genetic improvement shall ensure commitment to excellence, knowledge sharing and access to information

- In the national beef cattle genetic improvement engagements, monitoring mechanisms and evaluation criteria from inception of its projects and activities shall be ensured
- The national beef cattle genetic improvement activities shall be free from all forms of malpractices and shall ensure transparency, accountability and devotion to ethical standards of all concerned actors at all levels

2. Situation analysis

2.1. Development goals of beef sub-sector

At macro level the GoE has set development goals and targets pertaining to beef sub-sector. The following are the major development goals of the beef sub-sector (Table 1).

Table 1. Development goals and targets of the beef sub-sector in Ethiopia

No	Goal	Unit	Target			
			2015	2020	2025	2030
1	Beef production	Tons	989,000	1,467,000		
2	Productivity of beef cattle	kg per animal	107	138		
3	Live animal export	Number of animals	252895	515718		
4	Export earnings	Millions (USD)	156.8	319.7		
5	Market diversification	Target market	Middle East		EU market	
6	Reduction of GHG emission level of cattle in pastoral set up and feedlots by 10 MtCO ₂ per year by 2030					

2.2. Current development and research strategies and programs

2.2.1 Development of strategies and programs

Research and development organizations were engaged on beef cattle genetic enhancement for the last five decades on breed identification and characterization, crossbreeding and conservation. In terms of beef cattle breed identification and characterization among a total of 27 cattle breeds/populations, phenotypic characterization has been carried out for most of the breeds/populations, while in-depth characterization at molecular level was carried out for only

8 breeds (Boran, Fogera, Horo, Sheko, Abigar (Nuer), Gurage, Ambo and Afar). The genetic enhancement attempted on beef cattle so far was the cross breeding initiative carried out at Alemaya in the early 1960s in which world known breeds such as Hereford, Angus, Charolais, Brahman and Santa Gertrudis were crossed with Borana. Genetic improvement of Ethiopian beef cattle via selection is limited to the attempt at Abarnosa ranch on Borana breed in the early 1960s.

Additionally as a part of beefgenetics through crossbreeding, some aspects of performances of crossbred animals pertaining to reproductive and growth performance of male animals have been carried out at Holetta, Werer, Adamitulu and Bako research stations. Likewise, maintenance of germ-plasm of Brahman breed was also carried out at NAIC.

2.2.2. Institutional and policy framework

Institutional land escape on beef cattle genetic enhancement dates back to the early 1960s at Abernosa ranch pertaining to selection of Borana breed and crossbreeding Borana cattle breed with specialized beef breeds (Hereford, Angus, Charolais, Brahman and Santa Gertrudis) engagement at Alemaya..Additionally, NAIC was engaged in maintenance of germ-plasm of Brahman breed meant for beef production. In terms of conservation the Abernossa, Did Tiyyura, Gobe, Metekel and Mayweini ranchs were engaged in conservation of indigenous breeds of importance to their respective localities. Recently, the Abernosa and Gobe ranchs have been sold to private investors.

Currently, quite a range of institutions are engaged in beef cattle genetic enhancement, conservation and multiplication in various capacities. At federal level the Ministry of Agriculture, livestock and Fisheries have the national responsibility to oversee the policy, regulation and technical domain. NAGII serves as an umbrella institution for improvement and continual supply of improved beef genetic resources. Moreover, NAGII is in charge of preparation of national breeding policy, programs and strategies, and implement the same upon approval of the government. Technical institutions such as EIAR, Biotechnology Institute and Ethiopian Institute of Biodiversity shall engage in their respective technical domains at a

national level towards delivery of improved genetics, conservation and sustainable utilization. Regional Bureaus of Agriculture, livestock and Fisheries, Regional research institutions, higher learning institutions shall engage in genetic enhancement, conservation and sustainable utilization of beef cattle genetic resources of high importance specific to their region and production systems.

The long year's awaited national livestock breeding policy of Ethiopia was issued in 2016. With respect to meat animals the policy recognizes key tasks of identification, systematic characterization, conservation, genetic enhancement through selection or crossbreeding, multiplication and sustainable utilization of genetic resources.

2.2.3. Technical evaluation of strategies and programs/projects

Phenotypic characterization of indigenous cattle breeds encompassed only 8 out of 27 breeds/populations, while molecular characterization have been undertaken on very limited indigenous beef cattle breeds. Generally, the cattle breeds/populations identification and characterization carried out so far were not comprehensive enough and far from complete. The only attempted genetic enhancement by selection was limited to Borana breed and this attempt suffered from short duration and limited number of animals to lead to the desired objectives. The crossbreeding engagement at Haramaya University also suffered from the aforementioned limitations.

Generally, research engagement in beef cattle breed characterization was not complete or comprehensive enough and the genetic characterization was limited to few studies calling for in-depth and comprehensive initiatives supported by state of the art technologies.

2.2.4. Strengths, weaknesses, opportunities and challenges (SWOT analysis)

Summaries of the strengths, weaknesses, opportunities and challenges assessed from the perspectives of the external and internal factors are presented in Table 2 below.

Table 2. Summary of the strengths, weaknesses, opportunities and challenges pertaining to the different thematic research areas

Theme	Strengths	Weaknesses	Opportunities	Challenges
General				
Human capacity		- Lack of qualified and skilled manpower, critical mass and desired disciplinary mix - Lack of tailor made livestock extension system (beef)	- National focus on modernization of meat production by improving enabling environments human capacity - Expansion of higher education (Universities) to address human capacity gaps tailor made to various agro-ecologies - possibilities for curriculum revision and fast track approach in human capacity development	- Lack of specialized Universities/institutions which would cater as center of excellence for building human capacity to specialize in meat quality and value addition - In-adequate budgeting for genetic improvement and capacity building - Limited focus for long-term training
Physical capacity		Lack of required infrastructure and facilities to undertake beef research and development at a required level (ranch, barns, labs, irrigation, modern equipment and facilities including ICT)	National focus on modernization of meat production by improving physical capacity	In-adequate budgeting for genetic improvement and capacity building
Beef cattle Genetic enhancement		Absence of well-established and sustainable breeding program and schemes	Presence of genetic diversity among indigenous cattle for beef production	Un-integrated research and development effort among the stake holders (Research, Universities, MoA, CGIAR, NGO's,)
		Absence of national database and recording systems targeted for beef cattle genetic resources	Experience from Dairy Cattle National data base (NAIC)	
		Lack of application of modern breed improvement tools to promote beef cattle production and productivity	Global experience on state of art technology on breeding and genetics	Inbreeding and its deleterious effects
	Limited effort by Haremaya University and different	Absence of utilization of crossbreeding scheme in indigenous cattle for traits of	- Global experience on crossbreeding for beef cattle - Approval of animal breeding policy	

Theme	Strengths	Weaknesses	Opportunities	Challenges
	research stations	economic importance		
		Absence of breeders' association/society for beef cattle improvement and active engagement of private sector in delivery of improved genetics targeted for beef cattle	- Animal breeding policy encourage involvement of private sector - Presence of global experience on participation of breeder association and private sectors	Lack of proper understanding and national guidance on importance of germ-plasm maintenance engagements of private sector in genetic enhancement, conservation and sustainable utilization
	Limited Capacity in NAIC (Sheko and Borana semen)	Limited effort to conserve endangered indigenous cattle breeds	- Presence of Biotechnology laboratory at HARC and biotechnology tools - Presence of institute for conservation of livestock gene (biodiversity)	
		Lack of application of biotechnological tools for breed improvement, conservation and multiplication of improved breed	- Global experience on state of art technology on biotechnology application - Presence of Biotechnology laboratory at HARC and biotechnology tools	Inbreeding and its deleterious effects
Multiplication of improved breeds	- Limited government ranches for some breeds - Availability of diverse gene pool and land suitable for ranch	- Ranches put in isolation from the community - Absence of client orientation and mistrust between ranch and the community - Absence of strong linkage between research and multiplication units for sustainable and effective delivery of improved beef cattle genotype	- Presence of public owned ranches during the former regime - Reconfiguring institutional linkage between research, universities, community and the ranches towards effective delivery - Use of improved technologies for multiplication of improved genotypes	- Absence of strategic direction for delivery of improved beef cattle genotype - Absence of multiplication units committed for delivery of improved beef cattle genotype - Lack of confidence by the community
Conservation of genetic resources	Presence of policy and strategy frame work for	- Lack of strong monitoring frame work and capacity - Lack of due emphasis and timely action for conserving	Presence of workable frame work (Global) for conservation and sustainable utilization of beef cattle genetic resources	Lack of focus, emphasis and institutional capacity committed for conservation of beef cattle genetic resources

Theme	Strengths	Weaknesses	Opportunities	Challenges
	conservation of animal genetic resources	endangered breeds	• Presence of generic institute for biodiversity conservation	
Institutional set up of animal genetic enhancement, multiplication, conservation and sustainable utilization of beef cattle genetic resources		• Absence of focused institution for effective coordination of genetic enhancement, multiplication, conservation and utilization of improved beef genotypes •	• Presence of national policy and strategy directives pertaining to animal genetic resources • Presence of diverse institutions for creating institutional pluralism towards improvement and sustainable use of genetic resources • Policy support for private sector and possibility for using public private partnership	• Absence of strong institution for effective coordination of institutions engaged in research, multiplication and conservation of animal genetic resources
Crosscutting issues	Presence of document on gender mainstreaming and working group	• Lack of gender equity in on farm breed technology generation, demonstration and feedback information	• Presence of government directives	
	Presence of strategic directions in building climate smart green economy	• Lack of attention in targeting climate change and mitigation strategies in beef commodity • Lack of tailor made livestock extension (beef)	• Global and national focus given to climate change and green economy • Institutional interest to engage on studies of climate change pertaining to agriculture	

2.3. Strategic issues of beef cattle breeding strategy

The strategic issues presented and discussed under this section are synthesized by filtering out key aspects which requires research and development attention in delivery and sustainable utilization improved beef cattle genetic resources. Those issues which are outside the domain of national research and development team, as important as they are for the success of the sub-sector, are not included in this section. The strategic issues selected are organized in one disciplinary theme (genetic enhancement, multiplication, conservation, institutional set up) and one capacity building and cross cutting issues topics.

2.4. Benchmarking

Brazil has (Table 4) well developed beef cattle breeding program (example Nellore cattle) and made significant progresses in beef cattle breed improvement. Brazil is considered as benchmarks to follow their best practices and transform the Ethiopian beef cattle breed improvement research and development into a regionally and globally competent subsector by 2030.

Table 3. Beef cattle performance comparison using Brazil as bench mark

Parameters	Brazil	Maximum attained in Ethiopia	Difference	Difference in %
Birth weight in kg	32	26.6	5	20
Weaning age in months	7	6	1	
Body weight at weaning	180	157	23	15
Yearling weight in kg		258		
200 days body weight in kg	232.7	185	48	26
Slaughter age in months	32.6	36	0.6	
Body weight at Slaughter in kg	421	253	168	66

3. Strategic interventions

In GTP II and beyond the export led economic growth and industrialization are the focal areas. Beef cattle breed improvement has significant contribution towards these goals in terms of offering improved genetics for export led economic growth. By-products of beef (abattoir by-

products, hide and manure) shall also serve as raw materials for the agro-industries engaged in leather industry, animal feed, fertilizer which would also have catalytic effect in job creation and social transformation. Aligned to these macroeconomic goals and targets of livestock and fisheries sub-sector in GTP II and beyond, national beef cattle breeding strategy is believed to benefit pastoralists, agro-pastoralists, commercial farmers, macro-processes, traders and others involved in the value chains and the nation at large. The research for development themes are built on five major key thematic areas as briefly discussed hereunder and the strategic interventions, designed for each of the strategic issues described below in Table 4.

3.1. Beef cattle genetic enhancement

In the years ahead, the national beef cattle research and development envisions genetic improvement of indigenous cattle via selection, cross breeding or synthetic breed development as deems necessary. This will involve stronger integration of well-designed breeding strategies of diverse indigenous cattle genotype with modern tools and methods of biotechnology, molecular markers, genomics and related fields. Improving data access and management will be another area of focus to optimize genetic efficiency. To keep pace with this approach of state of the art techniques i.e. SNIPs, MOET, MAS, etc shall be employed for rapid delivery of the desired targets in characterization and beef cattle genetic improvement. Additionally, aspects of genetic contribution for quality enhancement and reduction of methane shall be an integral component of genetic improvement.

3.2. Multiplication of improved breeds

Effective multiplication of improved beef cattle genotypes is an essential component of genetic enhancement and sustainable utilization of the beef cattle genotypes. With the current policy of the GoE, this can be managed by public, private or public-private partnership.

The strategy will generally seek to accelerate beef cattle productivity improvement by using both conventional and modern methods and technologies that make it possible to increase traits of desired genetic material and to select with greater precision. This will involve stronger

integration of well-designed breeding program of diverse indigenous cattle genotype with modern tools and methods of biotechnology, molecular markers, genomics and related fields.

Reproductive biotechnological tools relevant to apply in a breeding program

- Estrous synchronization/artificial insemination
- Multiple ovulation and embryo transfer
- In-vitro embryo production (IVF)
- Cloning
- Transgenic

Molecular genetics

- Marker assisted selection
- Mapping of whole genomics for feed efficiency, GHG emission and disease resistance

3.3. Conservation of genetic resources

Conservation of animal genetic resources is a key component towards sustainable use of beef cattle genetic resources. In the forth coming years because of climate change particularly in pastoral set up, conservation of animal genetic resources with unique adaptive characteristics is critical for sustainable use of animal genetic resources.

3.4. Institutional set up of genetic improvement

Focused technical institutions are key pillars for genetic enhancement, multiplication, conservation and sustainable utilization beef cattle genetic resources. Genetic resources are critical for national sovereignty i.e economic independence and thus germ-plasm and improved genetics is by and large public good. Lack of working experience on market led economy under Ethiopian context has led to privatization of some the ranches and this was disincentive to long term animal genetic enhancement. As market led economy develops there are rooms for engaging the private sector i.e companies, breeders' society and or cooperative in genetic enhancement and multiplication of beef animal genetic resources. Thus, multiple institutions

and optimization of actors' convergence are important towards sustainable use of improved genetic resources (Fig 1).

3.5. Capacity building and Cross-cutting issues

Ethiopia's GTP II projects that the meat sub-sector particularly beef is a key driver of economic and social transformation. For this to happen, use of improved technology particularly improved genetics is critical. Thus, it is critical to have national beef cattle breeding strategy to ensure delivery of these targets. Beyond technology the research for development on beef cattle genetic improvement should also focus on two important capability areas (i) strengthening of human resources (i.e., the researchers and experts engaged in beef cattle breeding and genetics should be equipped with cutting age science), (ii) state of the art facilities (i.e. barn and field facilities, facilities for central data bank, modern lab and equipment including biotechnology and satellite labs) for research centers engaged in beef research for development.

Fig 1. Institutional set up of genetic improvement

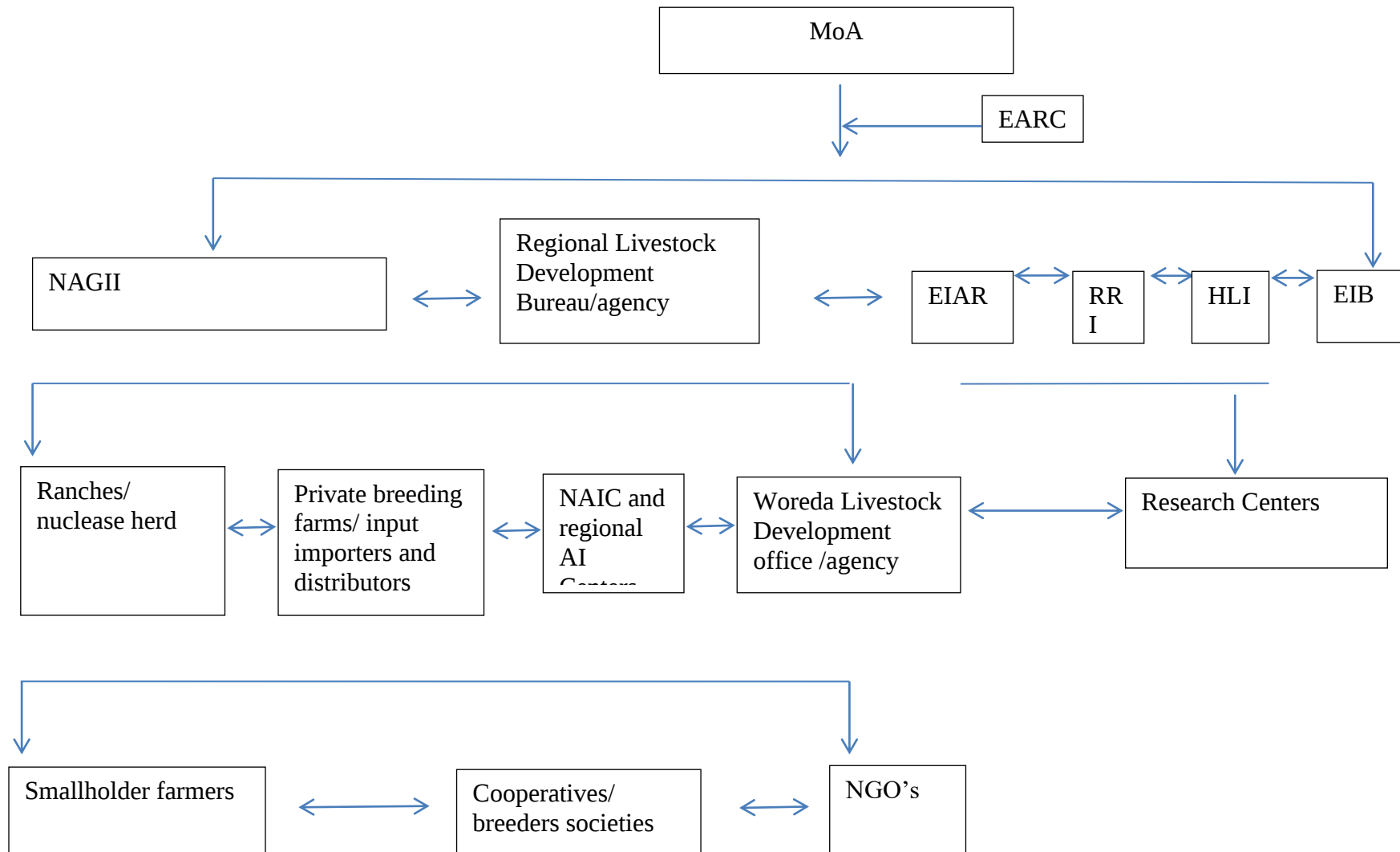


Table 4. Strategic interventions planned to address critical issues facing the national beef cattle genetic improvement in the short-, medium- and long- terms

Themes	Strategic intervention		
	Short term (2019-2020)	Medium term strategy (2021-2025)	Long term strategy (2026-2030)
Genetic enhancement			
Absence of strategic directions, well organized and focused breeding program targeted for Ethiopian condition	• Development of sound strategic direction and implementable breeding program	• Implementation of breeding program for selected breeds	• Evaluation of breeding programs and designing corrective majors towards attaining the set targets
Absence of national database and recording systems on beef cattle genetic resources	• Piloting of animal identification and recording system	• Application of beef cattle Identification and recording system at national level • Networking of identification and recording system data base,	• Continue application of beef cattle Identification and recording system at national level • Evolution and upgrading of identification and recording system. • Networking of identification and recording system data base, evaluation and feedback,
Lack of application of biotechnological tools for breed characterization, improvement, conservation and multiplication of improved genetic resource.	• Characterization of available breeds/ types at molecular level	• Application of marker assisted selection in beef cattle genetic resource.	• Continue application of marker assisted selection in beef cattle genetic resource.
Absence of well-established and sustainable indigenous cattle breed improvement through selection	• Identification of potential beef breed,	• Initiate nucleus beef breed genetic improvement scheme • Apply modern genetic improvement	• Establishment of new candidate nucleus breeding shame. • Continue application of Progeny testing

Themes	Strategic intervention		
	Short term (2019-2020)	Medium term strategy (2021-2025)	Long term strategy (2026-2030)
	bio-physical and socio-economic characterization of the production system. Strengthen ongoing beef genetic improvement initiatives.	tools such as Progeny testing scheme on nucleus breed, - Setting up and expand community-based beef cattle breeding schemes - Establishing strong multiplication units for enhanced delivery of improved genotype. - Explore possibility and modality of engaging private sector in delivery of improved genotype	scheme on nucleus breed - Setting up and expand community-based beef cattle breeding schemes - Establishing strong multiplication units for enhanced delivery of improved genotype. - Engaging private sector in delivery of improved genotype
Absence of utilization of crossbreeding scheme in indigenous cattle for traits of economic importance	Initiate a well-designed crossbreeding scheme	- Continue implementation of crossbreeding scheme - Undertake selection among crossbreds - Initiate new synthetic beef cattle breed development - Establishing strong multiplication units for enhanced delivery of improved genotype. - Explore possibility and modality of engaging private sector in delivery of improved genotype	- Continue selection among crossbreds - Continue synthetic beef cattle breed development - Establishing strong multiplication units for enhanced delivery of improved genotype. - Engaging private sector in delivery of improved genotype
Multiplication of improved breeds			
Ranches put in isolation from the community and research system	Development of strong linkage between research, ranches and the	Strengthening linkage	Monitor and evaluate the effectiveness of the linkage and put in place corrective majors

Themes	Strategic intervention		
	Short term (2019-2020)	Medium term strategy (2021-2025)	Long term strategy (2026-2030)
communities			
Conservation of beef cattle genetic resources			
Inability to conserve endangered indigenous beef cattle genetic resources	Identification of endangered breeds	- Establishment of well-organized in situ conservation - Establishment of modern ex situ conservation	- Strengthen existing conservation program and continue establishment of new in-situ conservation - Strengthen existing conservation program and continue establishment of ex-situ conservation
Institutional frame work beef cattle genetic enhancement, multiplication and conservation			
Absence of strong national coordination and effective plate form	Putting in place effective national coordination	Strengthening national coordination	Evaluation of effectiveness and putting in place corrective measures for national coordination
	Creating plate form for genetic enhancement, multiplication and conservation of beef cattle genetic resources	- Strengthening plate form - Explore opportunities in use of public-private partnership for multiplication of beef cattle genetic resources	Evaluation of effectiveness in institutional innovation or institutional pluralism in genetic enhancement, multiplication and conservation of beef cattle genetic resources
Absence of breeder association/society for beef cattle improvement	- Bench marking of good practices on the role of breeders' society in genetic enhancement of beef cattle - Initiate breed society formation	Establishment of beef cattle breed association for potential beef breeds	Strengthening existing associations and continue establishment of new beef cattle breed association for potential beef breeds
Absence of Public private partnership in beef cattle improvement and multiplication	Bench marking of good practices on the role of breeders'	Establishment of beef cattle breed association for potential beef breeds	Strengthening existing associations and continue establishment of new beef

Themes	Strategic intervention		
	Short term (2019-2020)	Medium term strategy (2021-2025)	Long term strategy (2026-2030)
	society in genetic enhancement of beef cattle Initiate breed society formation		cattle breed association for potential beef breeds
Capacity building and Cross cutting issues			
Lack of skilled human power in key disciplines for enhancing national beef production, productivity and product quality analysis	Short term training in animal breeding and genetics	- Experts, researchers and technicians trained or specialized in application of modern tools for genetic improvement - Long term training (MSc and PhD level) on beef cattle genomics, quantitative genetics	- Experts, researchers or technicians trained or specialized in application of modern tools for genetic improvement - Long term training (MSc and PhD level) on beef cattle genomics, quantitative genetics
Lack of gender equity (woman and youth) with respect to on-farm breed technology generation, demonstration, scaling up and feedback information.	Training and awareness creation for ensuring participation of women & youth along the path of genetic enhancement of beef cattle.	Full scale implementation of women and youth in genetic enhancement of beef cattle.	Strengthen participation of women and youth along the path of genetic enhancement of beef cattle.
Lack of attention in addressing climate change and mitigation strategies in beef cattle genetic improvement.	Generate information on GHG emission for beef cattle breeds.	- Determine the role of beef cattle breed improvement on GHG emission mitigation - Climate change adaptation.	
Lack of tailor made beef cattle extension system.	Establishment of beef cattle genetic resources extension system	Implement tailor made beef cattle extension system	Strengthen the new approach of beef cattle extension system.

4. Strategy for designing and implementing breeding programs

There are three pathways of genetic improvement: improvement of local breeds through purebred selection, breed substitution (by other local breeds or, more frequently, by exotic breeds), and systems of crossbreeding (terminal crosses, rotations, and formation of synthetic lines). Whichever pathway to follow, choice of the most appropriate breed or breeds to use in a given environment or production system should be the first step when initiating a breeding program and due attention must be given to the adaptive performance of the breeds

The appropriate strategy for any breeding program would therefore be to set suitable selection goals, which match the production system rather than ambitious performance objectives that cannot be reached under the prevailing environment. Area-specific approach utilizing the existing resources and taking into account the prevailing constraints appears to be the only reasonable sustainable solution. Such approach would also enable *in situ* conservation of farm animal genetic resources, the only viable and practical conservation method in less developed countries compared to *ex situ* or cryopreservation approaches.

In Ethiopia over 100% of the beef produced comes from traditional subsistence production system using indigenous cattle types/breeds. The cattle genotype of Ethiopia has evolved largely as a result of natural selection mainly influenced by environmental factors. Under these circumstances the selection favored stock that can withstand water & feed shortages, disease challenges and harsh climates. Among various cattle breeds in Ethiopia, potential breeds for beef production includes, Borana, Fogera, Horro, Begait, Arsi, Afar, Raya-Azebo, Shorthern zebu, Ogaden, Beef cattle genetic enhancement is dictated by production system and suggested options are indicated in table 5.

Table 5. Suggested technical options for genetic enhancement of beef cattle improvement

Production system	Objectives of production system	Suggested Breed improvement strategy	Breeding program/system
Pastoral/Agro-pastoral	Sources of food, meat and milk	Indigenous cattle improvement	Selection within local using Open nucleus/Community based
Mixed crop livestock system	Draft, Milk and meat	Crossbreeding Indigenous breed with exotic beef cattle	Crossbreeding/ Synthetic breed (F1, 75%, synthetic/rotational, terminal crossbreeding)
Commercial beef production	Meat	Pure exotic and high grade animals	Crossbreeding program and Selection within exotic

4.1. Design options for selection programs

4.1.1. Prioritization of breeds

Prioritization of breeds is required since resources are limited and breeding programs cannot be developed for all breeds. The prioritization could be at national or regional level. Prioritization will be based on different aspects: the preferences of the communities keeping the breeds, the merits and demerits of the breeds, the production environment, the significance of the breeds at national and community level. Consultation on the breed literature and stakeholders workshops are required for the prioritization. The percentage of each criteria's that we consider in prioritization of each breed shall be decided with multi-stakeholders consultation. However, tentative percentages in prioritizing of breeds are depicted as follows.

- Population size (10%)
- Genetic uniqueness and attributes of the breed (15%)
- Contribution to livelihood (income and nutrition) of producers (25%)

- Contribution to export trade (25%)
- Contribution to local supply (25%)

4.1.2. Designing breeding programs

The designing process should be participatory and need to get approval from the different stakeholders including and mainly the livestock keepers.

4.1.2.1. Definition of breeding goal

Breeding programs need to be designed to address both the objectives of the breed keepers and the national strategy including the market requirements. Definition of breeding objectives include identification of traits and their economic values. Economic values can be estimated through participatory consultation of livestock keepers and end markets. This approach is suitable for community-based programs where selection programs on scientific index selection based on breeding values may not be feasible. For central nucleus programs, bio-economic models (in combination with participatory approach could be adopted to define breeding goals. Traits with higher economic values are considered the breeding goal traits.

4.1.2.2. Relative economic weights of traits

For formulating selection indexes economic weights of breeding-objective traits are required. Relative weights can be derived using participatory approaches by asking farmers to allocate pebbles or seeds to the traits according to their preferences for traits. However, this method provides only relative weights, not relative economic weights. Thus, use of Bio-economic models to derive relative economic weights is paramount important. Bio-economic models can be constructed on Microsoft Excel spread sheets to derive economic values of traits, considering both tangible (direct regular cash income from sale of milk, surplus heifers, male calves, culled animals and manure) and intangible benefits (insurance and financing benefits) of rearing beef cattle.

- A bio-economic Excel Tool can be found at ResearchGate website. Another tool, less suited for smallholder systems is ECOWEIGHT.

4.1.2.3. Design of breeding schemes

The breeding structure need to be defined based on sound breeding principles. The design need to address a significant proportion of the breed population. The scheme to be designed need to address the population targeted. That is the genetic gain generated need to be able to be disseminated to the whole population. Two main types of schemes/breeding structures can be considered, but there are different variations of each scheme.

Community-based breeding scheme: This could be a one-tier scheme where villagers organize and implement selective breeding to improve their own herds. However, when designing village programs at scale addressing a large proportion of the breed population, a two tier village program need to designed. This involves establishing cooperative breeding villages strategically across the breeding tract. These will be where genetic gain is generated, which will be disseminated to the rest of the herds. The strategy for opting a breeding scheme/structure would depend on the need for accelerating genetic progress and the need for conserving the adapted resources.

Central nucleus scheme/structure: this involves establishing a nucleus herds at government ranch or a private commercial farm. Selection is conducted in this herd and genetic gain is disseminated to village herds through bulls or through AI. The central nucleus scheme has not been tested yet and research initiatives on this matter are limited and needs to be improved and perfected. Choice of schemes for designing new breeding programs should depend on information generated from previous and upcoming research as well as bio-economic and operational feasibility studies specific to each situation. Central-Nucleus based schemes could complement to accelerate progress of village programs and could be linked to village-based scheme to jumpstart and accelerate genetic progress. It is also applicable where large scale commercial farms exist.

4.1.2.4. Pre-evaluation of breeding schemes

The breeding program need to be evaluated before implementation for its genetic and economic feasibility using appropriate tools. The selection of schemes would be based on their return to investment and operational feasibility and other criteria such as the need for conservation (for instance community-based breeding programs are suitable for in situ conservation strategy).

4.1.3. Organization and operation of breeding programs

4.1.3.1. Recording scheme and database system

A recording scheme is designed based on the type of breeding scheme chosen. Intensive recording is required in the tier where selection is conducted and genetic gain is generated. For community-based programs, this is mainly in the dispersed village nuclei. If the central nucleus scheme, recording is restricted in the central nucleus flock, but minimal recording is also necessary if the design links the central nucleus with the village nuclei. A database system is established for each breeding program.

4.1.3.2. Institutional arrangements

See Section 3.4

4.1.3.3. Other organizational considerations

- The geography of the breeding program need to be delineated. The geographic description includes the districts, kebeles, the sheep/goat population, the number of participants need to be recorded.
- Awareness creation is required among the communities and other stakeholders in the program.
- Consultative meetings with communities and stakeholders, a fully participatory approach throughout the period of the program need to be followed.

- Training of communities and experts on animal breeding principles and methods.
- Selection of villages and organization of cooperative breeding groups is required for community-based programs.

4.1.3.4. Annual breeding plan

Both the life of program plan and annual breeding plan need to be developed. However, the detailed plan will be for the annual planning. This may include annual budgeting, selection, breeding activities (selection activities and mating activities), establishment of cooperative villages, number of improved rams/bucks generated; and dissemination range within the program boundary each year.

4.1.3.5. Monitoring and evaluation

The annual plan and the life-of-program plan is detailed in a logical framework. A monitoring and evaluation plan is set and strictly followed. A key component of the M and E is genetic progress achieved (genetic gain) and the expansion of the scope of the program (dissemination improved genetics to communities).

4.2. Design options for crossbreeding programs

Crossbreeding of *Bos indicus* cattle breed to *Bos taurus* breeds has been used as a means of increasing meat production via proper combination of adaptive and productive traits towards enhanced productivity, and product quality. These traits have been noted for the significant contribution in improving and expanding beef cattle population in tropical environment. However, in certain circumstances, crossbreeding programs involving temperate breeds are often not successful due to incompatibility of the genotypes with farmers' breeding objectives and the production systems. Furthermore, these poorly adapted exotic genotypes often require greater capital investment, thereby increasing the economic burden to farmers, leading to less enthusiasm towards crossbreeding programs. Despite these limitations of crossbreeding

programs in many countries, examples can be found of effective programs that have emerged from well-structured crossbreeding programs in Asia.

Some countries without having known meat breeds of animal have attained increased growth rate within short period of time through crossbreeding their indigenous breed with exotic breeds. Similarly, in our country increased growth rate and early maturity can be obtained by crossbreeding indigenous breed with exotic meat breed for beef. Since this is the strategy that enables increased production in short period, this approach has to be strengthened effectively utilized in environments/production systems suitable for crossbreeding.

In beef cattle crossbreeding program the following elements need special attention:

- Maintenance of pure indigenous and exotic breed at nucleus site
- Pure breed selection of indigenous breed for crossbreeding and importation of exotic semen as option
- Crossbreeding selected indigenous breed (dam) with exotic breed bull/semen (F1) production
 - Two breed rotational crosses/terminal crosses two breed, three breeds etc based on combination of traits preference.
 - Development of synthetic beef cattle breed (inter se mating among crossbred (F1 male with F1 females) every generation supported by selection among F1 males
 - Production and utilization of semen from selected crossbred bulls

5. Roles and responsibilities of institutions

The national beef breeding strategy and program shall be implemented by the following set of public and private institutions with the roles and responsibilities summarized in table 6.

Table 6. Roles and responsibilities of institutions to be involved in implementation of national Beef cattle breeding strategy

Institution	Role/ responsibilities
Ministry of Agriculture and Animal Resources	Approval of the national beef cattle breeding strategy and program
	Oversee and guide the National Animal Genetic Improvement Institute (NAGII)
	Approval of guide line for registration and regulation of import and export of beef cattle genetic resources
National Agricultural Research Council	Coordination of the national beef cattle breeding strategy and program
	Engage in implementation of the national beef cattle breeding strategy and program
National Animal Genetic Improvement Institute	Preparation of national breeding policy, programs, strategies
	Engagement in research/study of beef cattle genetic improvement
	Capacity building of the Institute
Ethiopian Institute of Agricultural Research	Engagement in research/study of beef cattle genetic improvement at national level using cutting edge science
Biotechnology Institute	Engage in application of high level biotechnological tools in breed identification, characterization and genetic improvement of indigenous beef cattle
Ethiopian Meat and Dairy Industry Development Institute	Engage in capacity building of private sector
Biodiversity Institute	Lead and engage in breed identification, characterization and conservation of beef cattle genetic resources
Regional Research Institutes	Engagement in research/study of beef cattle genetic improvement of a particular breed of regional importance
Higher learning Institutions	Involve students in characterization and analysis of long term data set generated in genetic enhancement of beef cattle breed in their respective production system
	Critical review of the existing curriculum and design alternatives in creating qualified human resource suitable to local situations
	Involve in capacity building of human resources specializing in beef cattle genetics and breeding
	Be part of the regional team in implementation of genetic improvement of beef cattle
Regional states, Bureaus and respective institutions accountable to the Bureaus	Oversee and guide implementation of research for development engagements in beef cattle (identification, characterization, genetic enhancement, multiplication, conservation and sustainable utilization) of beef cattle genetic resources in their respective production systems
	Allocate necessary resources for implementation of beef cattle (identification, characterization, genetic enhancement, multiplication, conservation and sustainable utilization) breeding strategy
	Administrative support in implementation of beef cattle breeding strategy
Private institutions/Breeders' associations and	Engage in introduction of beef cattle germ-plasm upon approval
	Engage in multiplication of improved beef cattle genetic resources
Communities	Engage in implementation of national beef cattle breeding strategy

6. Expected out puts

- The strategy is expected to resolve the current disorganized breeding initiatives which would improve the efficiency and effectiveness of genetic improvement initiatives
- Ongoing fragmented, project-based and research-based breeding activities will be transformed into sustainable breeding programs
- Conservation-based genetic improvement through scientific selective breeding programs of the adapted indigenous livestock genetic resources would increase their economic contribution to their keepers and their survival as breeds. Irrational crossbreeding activities will be minimized
- The research and development institutions will be integrated and work towards the same breeding goal
- Involvement of the private sector in genetic improvement will increase and job opportunity created for small businesses delivering improved genetics

7. Target group and beneficiaries

The major beneficiaries of national beef breeding strategy are

- Pastoralists, agro-pastoralists, commercial farmers
- Macro-processes, traders and others involved in the value chains and the nation at large

8. Cross cutting issues

Livestock production particularly beef is a high value commodity involving labor at various stages of the value chain. Along the chain, it absorbs significant labor pertaining to women and youth. Thus, gender sensitive information and technology has to be generated at various levels for ensuring economic and social transformation in beef dominated production systems. Additionally, impact of climate change on beef cattle production and mitigation strategies will be captured for sustainable beef genetic improvement. Thus, research and development on gender dimension and climate change as related to beef production shall be captured under this thematic area.

9. Monitoring and Evaluation

Progress made and achievements of outputs shall be monitored and evaluated periodically using participatory approach. Due attention shall be given to development and effective implementation of tailor made breeding programs and effectiveness of institutional framework (actors' convergence, coordination etc). Additionally the following major deliverables with the respective target time of delivery shall be monitored and evaluated (Table 7).

Table 7. Actionable points for monitoring and evaluation

Deliverable/Targets	Time
Development and validation of beef cattle breeding strategy and program	2018
Implementation of breeding programs for selected breeds	2019
Capacity built resulting in well-qualified research and development experts equipped with modern techniques	2025
Well-equipped laboratory, barn, with modern equipment and ICT facilities built and made fully functional	2025
Information on phenotypic and genetic characteristics, production, population status and future prospects of beef cattle genetic resources of the area will be availed	2021
Village herds and station breed improvement centers established and made fully functional	2021
Nucleus breeding program for potential indigenous beef cattle breeds established and existing cattle breed improvement strengthened	2022
Beef cattle breed improvement enhanced through application of Biotechnological tools such as (MAS, MOET, IVF)	2022
Beef cattle breeder association established for known beef cattle breeds	2022
Crossbred beef cattle for important beef traits developed (F1, 75% crosses) and used by farmers	2025
An apex body for national coordination livestock genetic enhancement, multiplication, conservation and sustainable utilization established and made fully functional	2018
Stakeholders platform for beef cattle genetic enhancement, multiplication, conservation and sustainable utilization established and made fully functional	2019
At least three improved beef breeds developed via selection and availed for public use	2035
At least three endangered indigenous beef breeds conserved using in-situ and ex-situ methods	2025
At least four multiplication ranches established and made fully functional to the satisfaction of all stakeholders	2024
At least one center of excellence committed for beef cattle genetic enhancement targeted for major production systems established and made fully functional	2022
Basic information on methane reduction, feed conversion efficiency and disease resistance generated by application of mapping genomic regions contributing for these	2030

traits and genetic improvement of beef cattle	
Role of gender identified and the information disaggregated in to key disciplines to guide development of technological interventions targeted for enhancing beef cattle productivity	2021
Influence of climate change on adaptation mechanisms of beef breed documented and mitigation options integrated in to breed development and sustainable utilization	2023
Tailor made extension system targeting sustainable utilization of beef cattle breed developed and applied	2025
Attainment of bench marked beef cattle productivity and product quality targets	2035

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