BREEDING PROGRAM FOR GENETIC IMPROVEMENT OF BEGAYIT CATTLE BREED

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Begayit Cattle Breed

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Foreword

Agriculture continues to be among the key development agenda of the government of Ethiopia. In the present GTPII period, one of the four strategic issues set to achieve the higher level objectives of the agricultural development sector is increasing livestock production and productivity. To this effect, the Ethiopia's agriculture sector policy and investment framework (PIF) document clearly shows that the milestone idicators for growth in livestock production and productivity are set at 8% and 4%, respectively.

Ethiopia claims to have 57 million heads of cattle herds while its annual beef carcass weight equivalent production has not exceeded 385.9 thousand metric ton. In contrast, Australia keeps almost half of the Ethiopia's population (28.8 million heads of cattle herds) and is able to produce 2.3 million metric ton of carcass annually. These facts vividly show that there is a long way to go to modernize livestock production in Ethiopia and enhance its productivity to become competitive in domestic and export markets. Such a process requires to rely on sustainable supply and use of improved livestock technologies. Therefore, there is a need to intensify the existing livestock technology generation process by integrating the conventional and the new bioscience research approaches.

Recently, a roadmap document was prepared by the Policy Study and Research Center of Ethiopia to guide the country's move towards modernization of meat animal development and reseach. Following the roadmap, an implementation plan was prepared for improving Begayit cattle breed of Tigrai Region in particular. Series of consultative meetings were conducted with the facilitation of the Ethiopian Agricultural Research Council Secretariat and in the process the regional state of Tigrai has shown its keen interest to support the initiative for its implementation. To this effect, a memorandum of understanding was signed between Tigrai Agricultural Research Institute (TARI), Ethiopian Institute of Agricultural Research (EIAR) and Ethiopian Agricultural Research Council Secretariat (EARCS) to jointly work for the implementation of the initiative.

It is felt necessary to follow an integrated multidisciplinary approach for enhancing improvement of Begayit cattle breed by establishing nucleus herd at Maiweyni Ranch in Humera area. To guide the implementation of Begayit cattle breed improvement program, there is a need to prepare technical manual in each discipline (animal breeding and genetics, animal reproductive biotechnology, animal feeds and nutrition and animal health) that helps the undertakings to follow standard scientific principles and procedures. Hence, this manual is prepared to guide the breeding practice for genetic improvement of Begayit cattle breed through building nucleus herd at Maiweyni ranch.

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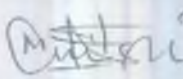

Chief Coordinator of EARCS

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1. Introduction

Livestock play significant role in poverty alleviation and improving livelihoods of the rural households in Ethiopia. The traditional livestock production systems support 98% of the total milk supply and the pastoral areas, in particular, cover 90% of the meat export (carcass and live animal) of the country. The indigenous cattle breeds are the principal sources of meat, milk and other socio-cultural functions (FAO, 1999; Wondwosen, et al 2013).These breeds are diverse with unique genetic attributes such as adaptation to heat and drought, tolerance to diseases, utilization of low-quality forages and desirable quality elements of their products.

Despite the ever mentioned multi faceted benefits obtained from livestock, Ethiopia has not yet able to tap the economic worth of the sub-sector to the level of expectation as compared to that of other African countries. For instance, the current national average beef yield per animal of 108.4 kg for Ethiopia is by far less than 121 kg for the Sudan, 130 kg for east Africa, 146 kg for Africa, 163 kg for Kenya, and 200 kg for the world (FAO STAT, 2004).Ethiopia,in contrary to having the highest cattle population in Africa,has the lowest level of beef in terms of volume of the output, which is 27 and 7% lower than east Africa and the continent of Africa, respectively. The gap between demand and supply of livestock products in the country is expected to be widened because of high elasticity of demand for livestock products and increase in urbanization. Attainment of self-sufficiency in livestock products can only be achieved if livestock productivity is increased consistently by about 4% per annum.

In spite of the long term research and development efforts,the focus on improving local breeds of livestock was very minimalin this country. However, it is recently noticed that giving due attention to the local breeds of livestock for improving the total factor productivity helps to enhance their contribution for increasing the export earnings of the country, apart from sustaining livelihoods of the rural households.Furthermore, this concern also aids to rescue numerous indigenous cattle breeds that are endangered of extinction for example Sheko breed in south western Ethiopia and Fogerabreed in north western Ethiopia.

In response to the prepared roadmap document of modernizing meat animal production, there is a need to practically engage in the genetic improvement of the indigenous breeds of livestock through establishing open nucleus breeding scheme being assisted by modern

biotechnologicalinterventions. Such kind of breeding program highlights the importance of implementing structured genetic improvement programmes by involving farmers, breeding organizations and marketing agents to generate desirable genotypes particularly for meat animal development in Ethiopia. Hence, the main objective of this manualis to show the developedbreeding goal,selection criteria and other procedures to serve as a guideline for the implementation of the genetic improvement program tailored to Begayit cattle breed.

2. Indigenous cattle breed improvement program

The main objective of genetic improvement of local breeds of livestock generally revolves arroundincreasing efficiency of production or improving the quality, quantity as well as profitability of farm animals. Effective genetic improvement and management systems limit gene exchange among the breeds or populations, minimize inbreeding and preserve unique or special characters of each population. Livestock productivity can be improved by enhancing the genetic potential of indigenous cattle breed and their production environments while protecting the environment. Keeping large number of unimproved low producing local cattle worsens the problem of land degradation, feed shortage, green housegas emission and global warming.

There are different breed improvement options such as selection, crossbreeding and development of synthetic breed. Choosing the most appropriate breed (s) and breed improvement program to use in a given production system should be the first step when initiating a breeding program and due attention must be given to the adaptive performance. The appropriate approachfor any breed improvement program would, therefore, be to set suitable breeding goals, which match the production system, farmers objectives and government development goal.

Open nucleus breeding program:-Livestock production in Ethiopia is characterized by small herd/flock sizein mixed crop-livestock systems, by medium to large herd sizein pastoral production, communally shared grazing lands, uncontrolled mating, and the absence of pedigree and performance recording. Moreover,in Ethiopia as the case in many developing countries, AI is not a widespread breeding technique applied to cattle except for herds held by governmentfarms, which are in most cases small in size. Furthermore, herds under systematic recording are generally not available. These characteristics limit the implementation of effective genetic improvement programs. Under this circumstance, the preferred strategy for genetic improvement is the use of open nucleus breeding program using herds held by government farms (research and development). In this breeding scheme, genetic improvement is centrally organized in a population maintained in research institutes or government farms and it is suitable for within breed selection improvement. For herds of government farms to function as nucleus, the involvement of progressive farmers is necessary. The nucleus will be the top of breeding program as a produceof selected breeding stock to supply elitsto base farms or village herds.

3. Begayit cattle breed improvement and conservation

3.1. Physical description of the Begayit cattle breed

According to Gebretnsae et al. (2017),Begayit cattle are the composite cross-breds of Barka (Dowhen sub-strain) and Rofaah (Butana) cattle types. Locally, the Barka cattle is classified into two, namely Dowhen and Erashalcattle types (Rezen, 2007). The Erashal type has a long narrow head, with a markedly convex profile, usually have black and white coat colour, and sloping rump with average live body weight up to 350 kg during good seasons. Whereas the Dowhen type is characterized by long ears, less developed hump, concave back, straight head and mostly greyish brown coat colour. They have average live weight of 420 kg and primarily kept for meat production, with milk production and draught power as secondary features.

Rofaah cattle type is recognized as higher milk producer, heavier body size but shorter than Dowhen, very docile, slow trekking ability, and very short or polled horn size(Gebretnsae et al., 2017). Maule (1990) confirmed that Rofaah cattle have typical dairy characteristics with established history of active selection for milk production. They are characterized by well-developed dewlap, relatively large humps, possess small and black horns but some animals are polled, and red or dark red coat colors (Maule, 1990; Abdel-Rahman, 2007). Rofaah cows have the capacity to produce 3012 kg milk in 330 days (Abdel-Rahman, 2007).

3.2. Description of the production system

Begayit cattle are one of the important local breedsfound in northern Ethiopia. The total population of Begayit cattle breed is estimated at 280,000 heads and provides multi-functionsmainly for sustaining subsistence based livelihoods of the local community. Female animals account for 69% of the total cattle population while the male animals account for 29% only. Breeding cows represent 48% of the total population while female calves (less than 6 months), growing heifers (6 months to 1-year age) and mature heifers (1-3 years age) make 8%, 5.4% and 5.5% of total population, respectively.

The Begayit cattle are kept on extensive lowlands of north western Tigrayat smallholderand commercial farm levels. The usual practice is to keep large herd size. Although, there were differences across production systems, relatively higher herd size (41), higher proportion of breeding cows to adult male's ratio (3.2:1) and relatively shorter CI (14months) characterize the

production as reported by Gebretnsae et al. (2017).Milking was practiced once a day after stimulating milk let-down made by calf suckling. However, new-born calves arelet to suckle twice per day until one month of age.According to Gebretnsae et al. (2017) all of the large-scale farmers and most of small-scale farmers (92.5%) are accostomed to practice pure breeding system while few (7.5%) of the small-scale farmers were practicing both pure and cross breeding system between Begayit and Aradocattle breeds using Begayit Bull. There was no report on the experiences of controlled mating system. Bulls run with cows throughout the year. Random mating system is common in both small-scale and large-scale production systems. The same author indicated that farmers practiced selection of breeding animals based on their observations. Breeding bulls that have relatively larger body size, aggressive, long body length, longer height at withers, thin neck and small head size are preferable next to milk yield performances of their dams. Likewise, preferred traits of breeding cows for Begait breed are reported to be milk yield, body conformation, body size and calving interval in respective order of importance.There is a great variation on milk production potential of Begayit cattle breed: under scenario of feed scarcity they produce on average 2.5 kg per day, while under scenario of adequate feed availability 5.5 kg of milk can be obtained per day per cow (Gebretnsae et al., 2017). From the available literature,performance of Begayit cattle for milk, growth and reproduction traits in different research and development ranches in Ethiopia are indicted in Table 1.

Begayit cattle are often raised on extensive rangelands and being herdedwith asmall herd size. Under such circumstances, it is very difficult to conduct within breed selection program. On the other hand, if the selection program is made to fully rely on AI for running the breeding program associated with milk recording of the whole population, it will require a huge amount of money, infrastructure and expertise. Therefore, an open nucleus breeding program (without recording scheme for the whole cattle population) seems an appropriate approach to follow in this case.By virtue of the already established ranch at Maiweyni, implementation of the Begayit cattle breeding program (open nucleus) can be started with the exsisting infrastructure at the ranch. The location is believed to be home tracts of the Begayit cattle breed.

Table 1. Production performance of Begayit cattle compared to some indigenous cattle breeds

	Begayit	Horro	Boran	Fogera
Birth weight	22	18.3	24	21
6-month weight	99	84	115	
Yearling	116	112	156	125
Daily gain				
Pre-weaning	420	360	415	292
Post weaning	100	130	135	
AFC in months	46	42	43	
Calving interval	458	494	443	716

Sources;BeyeneKebede(1992), Hailu (2003); AddisuBitew (1999), Goshu et al. (1983, 2003)

3.3. Definition of the breeding objectives

The Begayit cattle breed improvement program majorly aims at the combination of maximizing genetic gain in dual traits of beef and milk production, with restriction on increase in level of inbreeding in the population. In general,five goal traits were determined as important economic traits to improve Begayit cattle breed for dual purpose (beef and milk). The goal traits/selection criteria identified are;

- Yearling weight (kg) for body size
- Milk yield (kg) for lactation milk yield
- Age at first calving (AFC) for fertility
- Calving interval (CI) for fertility
- Survival to yearling (SURV) for calf survival to yearling measured on dam

The information sources for selection included information on individual itself, sibsdams and progeny.

3.4. Development of selection criteria

The computer program SelAction (Wagenengen University, 1997) was used to determine selectioncriteria. SelActionis a computerprogram that predicts response to selection and rates of inbreeding for practical livestock improvement programs. The program uses deterministic simulation and requires little computing time; it can be used as an interactive optimization tool. SelActionmakes the existing theory on breeding programs available as a user-friendly tool for breeding companies and scientists. Prediction of response to selection is based onadvanced selection index theory. Prediction of the rate of inbreeding is based on the long-termgenetic contribution theory. SelActionuses a hierarchical mating structure wheredams are nested within sires and random mating of selected animals is applied.SelAction considers reduced genetic variance due to selection (Bulmer effect) and inbreeding.

For each trait, the index may contain the following information sources: a) own performance,b) pedigree information, c) average phenotypic performance of full sibs, d) averagephenotypic performance of half sibs,and e) average phenotypic performance of progeny. Allinformation sources are optional. A maximum of 20 distinct full-sib, half-sib and progenygroups can be used in the program. Pedigree information consistsof the estimated breeding values (EBV) of the sire and dam and the mean EBV of the damsof each half-sib group. Including EBVs of parents as information sources in the selectionindex enables prediction of response to selection (Marc et al 2001)

Inputs of SELACTION include

- Number of traits, names of traits and economic values of traits
- Phenotypic variance, heritability, common environment, genetic correlations, phenotypic correlations and common environmental correlations for all traits
- Number of selected sires, number of selected dams, number of selection candidates per dam, selected proportions
- Available groups of relatives (FS, HS and progeny) that provide information for breeding value estimation among the selection candidates
- Available information sources for each trait for each sex-age class

Outputs of SELACTION are the following:-

- Bulmer equilibrium genetic parameters for all traits
- Selection response per unit of time for all traits, in trait units and in economic units
- selection response due to selection among sires and due to selection among dams
- Contribution (%) of each sex and each trait to the total selection response
- For multi stage selection, selection response after each stage, in trait units, economic units, separate for sires, dams and total
- Accuracy of selection and index variance for sires and dams in each age class
- The number of selected sires and dams from each age class
- The rate of inbreeding in case of discrete generations

3.4.1. Selection paths/ groups

Two units, breeding unit (nucleus) and production unit (pre-nucleus and base population), consisting of six selection groups were defined. Generation and dissemination of genetic gain occur in the breeding and production unit, respectively.

The selection groups are defined as:

1. bulls to produce breeding bulls where bull selection occurs to improve the bulls used in the nucleus breeding unit,
2. bulls to produce breeding cowswhere bull selection occurs to improve the cows used in the breeding unit,
3. cows to produce breeding bulls where cow selection occurs to improve the bulls used in the breeding unit,
4. cows to produce breeding cows where cow selection occurs to improve the cows used in the breeding unit,

3.4.2. Genetic parameters and economic value

Table 4 shows selection criteria used in calculating the selection index and the economic values as well as genetic and phenotypic parameters used. The estimates of genetic and phenotypic parameters (Table 4 and 5) were from literatures mainly from Ethiopia and other tropical countries (Haile-Mariam and Kassa-Mersha, 1995; Kebede et al., 1991; Banjaw et al., 1994). While population parameters used as input in SelAction computer program are presented in Table 6. These parameters were derived from herd projection.

Information on economic values of important traits for all indigenous cattle is lacking in the country. In the present study for Begayit cattle breed,relative economic weight for each trait was determined from survey work conducted in 2017 to determine farmers breeding objectives. But,economic value for each trait was computed by standardizing the economic weight with the additive genetic standard deviation (σ_A). However, it should be borne in mind that these values are only approximation but still can serve as fair economic estimates where information is totally lacking as in the present case.

Table 4.Goal traits, selection criteria and their relative economic weights, phenotypic variance (σ_P^2) and genetic standard deviations(σ_A)

	Objective traits	Unit	σ^2_P	σ^2_A	h^2	Economic weight	Economic value (econ.weight/ σ_A)
1	Yearling weight of bull and dam	Kg	1083.27	324.973	0.30	24	1.331
2	Lactation milk yield of progeny	Kg	7282.06	1966.124	0.27	32	0.722
3	Age at first calving of progeny & dam	Months	20.68	1.239	0.06	13	11.680
4	Calving interval of dam	Months	18.58	0.743	0.04	10	11.601
5	Survival to yearling progeny	%	3.46	0.311	0.09	14	25.090

Table 5. Phenotypic (upper triangle), genetic (lower triangle) correlations and heritability (diagonal, in bold) of the traits

Variables	YWt	MiY	AFC	CI	SURV
YWt	**0.30**	0.20	0.00	0.00	0.09
MiY	0.10	**0.27**	0.01	0.07	0.04
AFC	0.00	0.05	**0.06**	-0.21	0.00
CI	0.00	-0.11	0.09	**0.04**	0.00
SURV	0.04	0.15	0.00	0.00	**0.09**

YWt= yearling weight; MiY= Milk yield; AFC = Age at first calving; CI=Calving interval; SURV=Survival to yearling

Table 6. Input parameters for simulation of breeding plan/program using SelAction computer program

Parameters	Nucleus	Pre-nucleus	Base population
Population parameters			
Population size (female/breeding cows)	1739	19132	191320
Number of selected parent			
Male	20		
Females	371		
Proportion of bulls selected	0.05		
Proportion of female selected	0.64		
Number of male offspring per dam	0.4		
Number of female offspring per dam	0.4		
Number of half sibs group 1 (yearling weight)	26		
Number of half sibs group 2 (yearling weight +others traits)	14		
Number of half sibs progeny group 1(yearling wt)	21		
Number of half sibs progeny group 2 (yearling wt +others traits)	9		

3.4.3. Selection outcome estimates

Average genetic gain per unit time is positive and higher for milk yield per lactation and yearling weight followed by CI and survival to yearling (Table 7). Negative genetic response was estimated for calving interval.Genetic gain per generation for selection traits are indicated in Table 8. The bull selection group also had the longest generation interval compared to the cow group (6.5 vs. 4.5 years) because bulls are selected on progeny testing. Average genetic gain per year is positive and higher for milk yield per lactation of 1.75liter and yearling weight of 1.06 kg per year followed by CI and survival to yearling. Genetic gain in calving interval was nearly zero which is desirable. Estimate for inbreeding per generation was 0.946 which is considered to be not bad.

Table 7.Genetic gain per unit time/generation from SelAction output

Breeding goal traits	Unit	Male	Female	Total
yearling weight	in trait unit	8.542	1.565	10.107
	in economic unit	11.37	2.083	13.453
	% of total response	**36.966**	**6.774**	**43.74**
Milk yield per lactation	in trait unit	14.234	5.083	19.317
	in economic unit	10.277	3.67	13.947
	% of total response	**33.412**	**11.932**	**45.344**
AFC	in trait unit	0.07	0.027	0.097
	in economic unit	0.821	0.311	1.132
	% of total response	**2.668**	**1.012**	**3.68**
CI	in trait unit	-0.003	-0.002	-0.005
	in economic unit	-0.035	-0.02	-0.055
	% of total response	**-0.114**	**-0.066**	**-0.18**
Survival to yearling	in trait unit	0.068	0.023	0.091
	in economic unit	1.706	0.575	2.281
	% of total response	**5.547**	**1.87**	**7.417**

Table 8.Genetic gain per year for breeding goal traits

Breeding goal traits	Selection path					generation interval	genetic gain per year
	SS	SD	DS	DD	Total		
yearling wt	8.542	8.542	1.565	1.565	20.214	19	1.063895
Milk	14.234	14.234	5.083	5.083	38.634	22	1.756091
AFC	0.07	0.07	0.027	0.027	0.194	22	0.008818
CI	-0.003	-0.003	-0.002	-0.002	-0.01	22	-0.00045
Survival to yearling	0.068	0.068	0.023	0.023	0.182	19	0.009579
Accuracy	0.535		0.513				
var index	568.911		522.97				
inbreeding per generation %							0.946%

3.5. Breeding planfor Begayitcattle genetic improvement

For genetic improvement of the Begayit cattle breed,three tier open nucleus breeding scheme is proposed as preferable option in which the Begayitcattle herd at Maiweyniranch can serve as nucleus; progressive private commercial farms around Humera area will be selected to serve as pre-nucleus/test herd and the Begayit cattle population found in north west Tigraycan be taken as a base population. The breeding program will be organized into three tier open nucleus breeding scheme as indicated bellow;

Tier 1. (Central nucleus): Tier 1is the nucleus herd which is considered as main breeding unit where elitebreeding animals from the base population are selected and mated. Progeny born in this herd will be subjected to performance testusing data generated at nucleus and pre-nucleusherds. The best performing bulls will be maintained to produce the next generation of bulls and the best females also maintained for internal replacement.

Tier 2: Sub-nucleus:These herds will be organized under the nucleus herd by selecting progressive farmers, commercial farmers with large herds, breeder society/cooperatives that will also be part of the pre-nucleus herd if any. They produce their own breeding females but obtain semen from the nucleus herd. These herds will serve as test herds where candidate bulls from

thenucleus herd will be tested for their performance in these herds. Detail information on performance of the candidate bulls(in the nucleus) and relatives (in the nucleus and sub-nucleus) will be recorded.

Base population: Base population is the herd of the whole Begayit cattle population kept by smallholder and commercial farmers around north western of Tigray region. The herd is established by producing its own breeding females or purchasing breeding females from market/other farms, and by practicing natural mating with own bulls. Gene from selected bull (semen) in the nucleus will be transmitted via females' offspring and gradually replaces the population.The selected bulls can serve as sources of breeding bulls for base population, in addition to the nucleus and pre-nucleus.

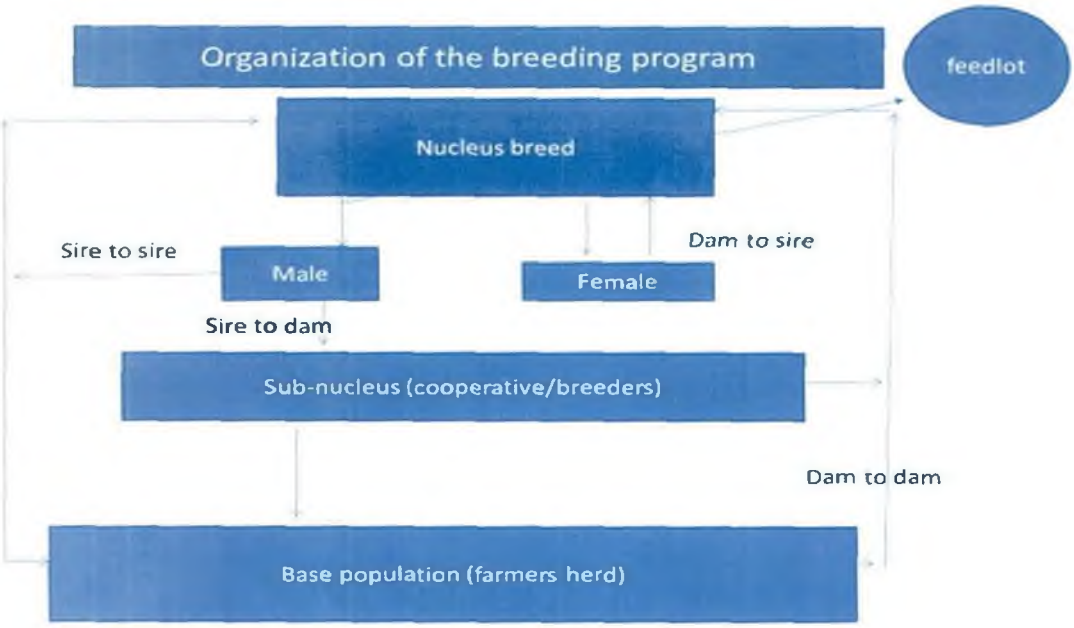

Figure 1.Schematic diagram for organization of the breeding program

A total cow population of 191,320 breeding females in base population is assumed with average herd life of 5-6 lactations. This implies that 15-20% of the cows need to be replaced annually. With female reproductive rate of less than 1 calf per year, this implies that at least 50% of new born females need to be kept as herd replacement.

To inseminate these number of cows, about20-39breeding bulls are required assuming that one bull will serve on average 4000 cowsusing AI. In order to produce the required number of breeding bulls, we need to test 570 young bulls. These570 young bulls have to be generated by test mating. For this, at least 1159 births are requiredfor undertaking the performance test. To get this, about 1739elite matings are required assuming 50% sex ratio and allowing 20% for mortality and early culling of young bulls. Hence, it means that1739 elite cows are needed for the nucleus. These 1739 elite females will be mated with 20proven sires.Hence the Begayit cattle breed nucleus herd will have a total of 1739 females as starting stock to be purchased from farmers herds.Suitable breeding animals can also be selected from Maiweyni ranch using similar criteria.

For the nucleus population:- it is assumed that 517 bulls will be tested on yearling weight, conformation and on first lactation milk yield of 9 daughters each in the nucleus and pre-nucleus population. Each of these 517 bulls then will be expected to have on average 30 mates in pre-nucleus per production year. Out of 517 bulls'performancetested, the top 20 will be selected to produce the next generation of the 517bulls in the nucleus.

For the sub-nucleus population:- Assuming10% of the base females (19132females) are suitable based on their milk production, health status, body conformation (udder structure, leg etc), these females will be selected from commercial private farms around north west Tigrayto serve as pre-nucleus farm, they provide the capacity for progeny testing. The 517 bulls produced at nucleus will be mated with pre-nucleus females using AI and detailed informationwill be recorded by pre-nucleus farm. These records on performance of animals will be used for selection of the best bullsat the nucleus. In the pre-nucleus there will be 30mates per bull annually.

The genes from selected bulls in the nucleus will be transmitted via females' offspring only and are thus gradually replaced by genes from males recruited from the nucleus populations. The pre-

nucleus can serve the function of multiplication unit so as to provide base/production herds with breeding bulls for natural mating

3.6. Selection of nucleus females from village herds

There is a need to purchase female cattle from village herds for establishment of the nucleus. Since no records are kept by herd owners, the selection will be on the basis of inspection, together with perhaps some on the spot measurement of milk output. A team composed of breeder, animal health specialist, animal reproduction specialist and farmers representative from each village/cluster will undertake animal selection. Since a large elements of judgement to be involved in the selection/screening, it is essential that consistency be maintained in the judgement exercise. In each village, cows need to be inspected as they move out to graze or drink water in the morning. The team will identify a few cows (perhaps up to 10 cows) which they regard as the best, and during the day would make contact with the owner of these cows. As the herd returns in the evening, the team could pre-set at the milking of these particular cows, and measure the milk produced. Some objective measurement (e.g wither height, body length, rumen depth etc.)can also be taken. Based on all information available, the team will purchase the best cows. In making these selection, attention will be given on cows in the first three lactations. In operating this scheme, there are several imponderables. Since the selection is largely a matter of judgement, it is difficult to predict how effectively it will identify superior cows. In this scheme it is important to make some agreement with herd owners in each village to sell their best cows for nucleus, and herd owners need to be aware and agree with the objectives of the breeding program in advance.

3.7. Animal Evaluation

3.7.1. Recording and measurement

Phenotypic information on animals and their relatives from the nucleus and pre-nucleus population will be collected and be used to estimate breeding value for breeding goal traits using BLUP computer software. Information on selection traits is measured and recorded for individual animal and relatives. Selection index procedure will be used to select best bulls by combining all breeding goal traits and their economic values into one value.

Recording:- all animals will be identified with ear tag identification system and the following data types will be recoded for each animal:-

- Pedigree records; animal id, dam id, sire id will be recorded for each animal
- Growth rate and body weight will be taken using weighing scale from individual animal every 15 days starting from birth until one-yearof age
- Carcass composition for potential breeding animals will be determined from slaughtering sibs of selection candidate or ultrasonic measurement of body composition on live animals and or potential breeding animals
- Milk production record is collected from dam and daughter using test day procedure (every 30 days) twice per day morning and afternoon for each lactating animal
- Reproduction records such as date and time of the onset of heat, date of insemination, sire used, date of pregnancy diagnosis, date of conception, calving date,parity will be taken for each animal in the nucleus and pre-nucleus
- Age at first calving and calving interval is measured on females (dam and daughter)
- Survival to yearling is measured on dams as number of progeny survived to yearling age per dam

Carcass composition for potential breeding animals will be determined from slaughtering sibs of selection candidate or ultrasonic measurement of body composition on live animals and or potential breeding animals.

3.7.2. Genetic evaluation

Progeny testing scheme will be used to select bulls. This procedure refers to the use of information on progeny in the selection of sires. Selection will be based on estimated breeding values for both male and females. Bulls with highest estimated breeding values will be used as proven bulls to breed dams and or sires. Before being tested, young bulls will be tested on own performance and growth in the nucleus.Nucleus females will be evaluated and selected based on their own and relative performances of yearling weight, milk yield, age at first calving, calving interval and survival to yearling of progenies.

4. Dissemination of Genetic Superiority

Dissemination of gene from selected bull in the nucleus to village herd for one generation is indicated in Table 9. It takes about 6 years to get complete information on selection traits from candidate bulls born in the nucleus. Information on yearling weight of a bull itself and half sibs can be available in first year, but it takes about 6 years to get information on milk yield of progeny of a bull. At the end of 6th year 20 bulls will be selected and ready for semen collection and dissemination to nucleus, sub-nucleus and village herds.

Table 9 Genetic superiority dissemination for one cycle selection

Year	Year						
	1	2	3	4	5	6	6-7
	148	275	382	517	517	517	
1	71	132	184	248	248	248	
2	Information on yearling weight of a bull itself						
3			Bull mated with female				
4				Progenies of bull born			
5					Information on yearling weight of progeny of bull available		
6						Progeny of bull mated with female	
6-7							Information on first lactation milk yield of daughter 20 bulls selected for AI

5. Reference

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Annex 1. Recording format for Begayit cattle nucleus and sub-nucleus herds

GROWTH RATE RECORD

Animal ID. No----------

Dam----------

Sex----------

Sir----------

Birth Date----------

Farm----------

Recording year			Monthly weight (kg) and Age (Days)											
		January	February	March	April	May	June	July	August	September	October	November	December	Remarks
1	Date													
	Weight													
	Age													
2	Date													
	Weight													
	Age													
3	Date													
	Weight													
	Age													
4	Date													
	Weight													
	Age													
5	Date													
	Weight													
	Age													
6	Date													
	Weight													
	Age													

Summary

	Age	Weight	ADG	Remark
Birth			xxxxxxxxxxxxxxxxxxxxxxxx	
30 Days				
60 Days				
90 Days				
180 Days				
Yearling				

Disposal Date;----------

Reason for disposal;----------

Remark;----------

MILK PRODUCTION RECORD

Weekly milk yield record sheet

Date from----------to----------

Cow Id. No.	parity	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Teat milked
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	
Total																

MILK PRODUCTION RECORD

Monthly milk yield record sheet

Cow ID. No: ----------

Dam: ----------

Birth date: ----------

Sire: ----------

Farm: ----------

Recording year	Lactation No	Calving date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total milk

REPRODUCTION RECORD

Cow ID. No;----------

Dam----------

Birth date;----------

Sire----------

Farm----------

Parameters	Lactation No							
	1	2	3	4	5	6	7	8
Service date[1]								
Sire used								
Service per conception								
Calving date								
Gestation length (days)								
Calving interval (days)								
Total milk production (kgs)								
Drying off date								
Lactation length (days)								
305 days milk (kgs)								
Fat %								
Calf no								
Calf sex								
Calf birth weight milk (kgs)								
Calf weaning weight (kgs)								
Calf yearling weight (kgs)								
Remark								

[1]last or effective service date

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