Ministry of Agriculture, Animal Industry and Fisheries

Guidelines procedures and protocols for genetic evaluation and certification of breeding bulls and dams in Uganda

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Preface

The world today is ever becoming a global village, with the massive exchange of genetic material of the various dairy cattle breeds and populations. Alongside this, has been the advent of a desire to compare the performance of breeding animals to rank the best, thereby maximizing the gain from them; at the same time eliminate the worst and the average performers for slaughter and other purposes. Various genetic evaluation systems exist for different countries and in some countries, more than one evaluation system is in use for similar populations.

For much of Africa, little or no genetic evaluation takes place, and most countries rely on continuous importation of genetic materials. For Uganda, a reality check arose in the late 1990 with the advent of Bovine Spongiform Encephaloparthy (BSE) outbreaks in Europe, when the Government of Uganda banned importation of genetic materials and dairy products (https://www.just-food.com/news/uganda-uganda-bans-dairy-products-to-protect-against-bse/?cf-view&cf-closed). It became prudent to start recruitment within Uganda of the breeding bulls needed at the Animal Breeding Centre for semen production. However, to achieve this there is need for harmonized protocols for genetic evaluation and certification of dairy and other livestock seed.

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Glossary

Animal genetic resources (AnGR): any genetic material of animal origin biological resource contained in genetic information having actual or potential value for humanity and its includes derivatives

Artificial Insemination Centre: a facility approved by the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) that meets the conditions required in the Terrestrial Code for the collection, processing and storage of bull semen.

Biosecurity: a set of physical and management actions designed to decrease the risk of introduction, establishment, and spread of animal diseases, infections, or infestations to, from, and within a cattle population.

Blood: When collected from live or animals shortly postmortem can be used for DNA analysis or cloning via somatic cell nuclear transfer (SCNT). The DNA from the blood of mammals can be obtained only from white blood cells (WBC) while in avian it can be obtained from both WBCs and red blood cells (RBCs). The collection of blood from mammals is usually from the jugular or caudal vein with a needle and EDTA vacutainer tube. Blood samples from a vein are usually collected from the wing web veins. DNA from blood can generally be isolated by use of commercial kits following their specifications.

Collection centre: a facility approved by the MAAIF for the collection of cattle semen, embryos, and ova and then used exclusively for artificial insemination (semen), and donor cows that meet the conditions of the Terrestrial Code (embryos/ova).

Collection of somatic cells: collection these cells from tissues other than germ cells that can be useful for gene banking; either for the production of new animals – through SCNT or for DNA isolation from the cells. These somatic cells can be tissues, blood, or gonadal tissues in the case of poultry

Competent authority: the Commissioner of Animal Health in MAAIF who is responsible and competent to ensure or supervise the implementation of animal health and welfare measures in Uganda, international veterinary certification, and other standards and recommendations in the Terrestrial Code and the OIE (World Organization for Animal Health) Animal Health Code in Uganda.

Deoxyribonucleic acid extraction (DNA): strips of skin from the body surface for example the shoulder area or peripheral border of the ear of a live animal using a sterile hole punch and then placed on pre-labeled sterile screw-top vial for transport to the processing laboratory. In case of need for freezing, the tissue samples should be wrapped in blotting paper moistened with PBS and maintained at 4^{o}C to minimize degradation of the samples. An alternative to cryopreservation consists of preserving the tissue through dehydration by storing each sample in a glass vial containing a grain of silica gel.

Derivative: a naturally occurring biochemical compound resulting from the genetic expression or metabolism of biological or genetic resources, even if it does not contain functional units of heredity.

DNA storage: storage of extracted DNA at 4^{o}C for two months provided the preparation is pure enough. For long-term storage, DNA can be maintained at –20^{o}C or lower.

Embryo: a product of fertilization between the 2-cell stage and the end of organogenesis, which varies by species

Exporting country: a country from which commodities are sent to another country.

Ex-situ conservation: the condition in which an AnGR is kept outside its natural habitat. Under the present law, any lineage that is raised within its country of origin is not considered to be in an ex-situ condition.

Importing country: a country that is the destination to which commodities are sent.

In-situ conservation: the condition in which an animal is found in its ecosystem or natural habitat. In the case of a domesticated or crossbreed animal, its condition is in situ when that animal is found in the cultural context in which its specific properties have been developed.

Liquid nitrogen: nitrogen in liquid state at an extremely low temperature. It is a colourless clear liquid with a density of 0.807 g/ml at its boiling point (−195.79°C). Liquid nitrogen is a cryogenic fluid that can cause rapid freezing on contact with living tissue.

Material transfer agreement: an agreement between a provider and a user.

Movement: includes transhumance mobility and trade of live animals, genetic materials, cultural exchanges of animal genetic resources between and within the communities, exchanges of products and by-products of animal origin, exchange within the framework of research and development, for utilization as defined in Article 2 of the Nagoya Protocol.

National competent authority: the entity authorized by the state to supervise and watch over implementing the components of the present regulation.

Oocyte: means a female gametocyte or germ cell involved in reproduction. An oocyte is produced in the ovary during female gametogenesis.

Quarantine station is an establishment under the control of the Commissioner of Animal Health where cattle are maintained in isolation with no direct or indirect contact with other animals, ensuring that there is totally no transmission of the specified pathogen(s) outside the given establishment while the cattle are undergoing observation for a specified duration and, if appropriate, testing and treatment.

Semen or Sperm: liquid emitted by ejaculation, constituted of spermatozoids and the product of secretion of glands genitals

Spermatozoids: male gametes suitable after capacitation, to fertilize an egg

Tissue: an ensemble of similar cells and their extracellular matrix from the same origin that together carry out a specific function. Tissues can be sampled from live animals or shortly postmortem for use in DNA analysis or SCNT. However, separate protocols are used for these.

Traditional or community knowledge*:* the knowledge, practices, innovations or technologies created or developed over generation by local community on the conservation and sustainable use of animal genetic resources.

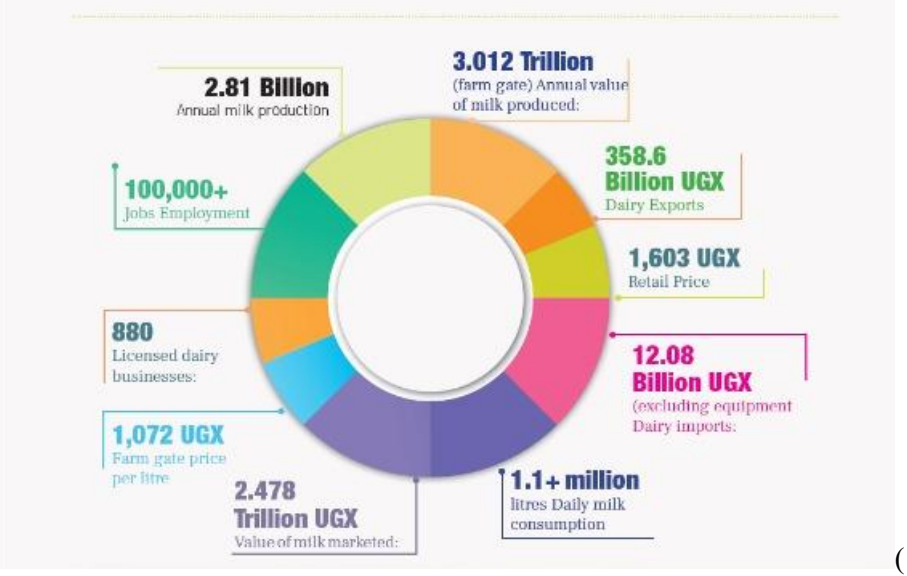
List of acronyms

ABS	Access and benefit sharing
ADGG	Africa Dairy Genetic Gains
AI	Artificial insemination
AIC	Artificial Insemination Centre
AnGR	Animal genetic resources
AU	African Union
AV	Artificial vagina
AVDG	Average daily weight gain
BCS	Body condition score
BLAD	Bovine leukocyte adhesion disease
BVD	Bovine viral diarrhoea
BQ	Black quarter
CAH	Commissioner of Animal Health
CAP	Commissioner of Animal Production
CBD	Convention on Biological Diversity
CBOs	Community-based organizations
DVS	Director of Veterinary Services
FAO	Food and Agriculture Organization of the United Nations
FMD	Foot and mouth disease
GoU	Government of Uganda
GPC	Genetics production centre
HS	Hemorrhagic septicaemia
INAPH	Information Network for Animal Productivity and Health Application
ICT	Information communication technology
JD	Johne's disease
LC	Local council
LITS	Livestock identification and traceability system
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MDAs	Ministries, Departments and Agencies
MEAL	Monitoring, Evaluation Assessment and Learning
NAGEC	National Animal Genetics Evaluation Centre
NAGRC&DB	National Animal Genetic Resource Centre and Data Bank
NCIRC	National Cattle Identification and Registration Centre
NDP	National Development Plan
NGEC	National Genetic Evaluation Centre
NS	Natural service
SCNT	Somatic cell nuclear transfer
UNHB	Uganda National Herd Book

1.0 Introduction

1.1 Overview of the livestock sector and dairy industry in Uganda

Uganda is endowed with a diverse animal resource base composed of livestock, poultry, and fish genetic resources. Most of them being indigenous, but whose productivity is still low compared to exotic genetic resources. These indigenous genetic resources are well-adapted to a variety of production environments under low input production systems, while a few exotics that were imported for increased production per unit under high input production systems are not producing at optimal levels. To overcome this discrepancy between potential and actual production, there is a need to develop tropicalized lines of the popular breeds/dairy genetics within the country to recruit replacement breeding stock from within. In 2020, Uganda produced milk valued at 3.012 trillion Uganda shillings (USD 1 = UGX 3700), from an annual production of 2.81 billion litres and over the next two decades, these values are projected to double. The dairy sector employs over 100,000 people in formal employment in 880 licensed dairy businesses. The exported dairy products were worth 358.6 billion Uganda shillings over the past half-decade, but the imports of dairy products remain a significant proportion worth 12.1 billion Uganda shillings (Figure 1).



(1US$ = 3700)

Figure 1: Economic power of the dairy sector in Uganda (DDA, 2021)

The leading actors in the dairy sector include the Dairy Development Authority (DDA) (https://dda.go.ug/); the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) (https://www.agriculture.go.ug/), and the National Animal Genetic Resource Centre and Data Bank (NAGRC&DB) (https://nagrc.go.ug/). The Dairy Development Authority is a statutory body created under the MAAIF to develop and regulate the dairy industry in Uganda and is serviced by several other government agencies including NAGRC&DB that ensures production and multiplication of high-quality dairy cattle genetics. Genetic improvement has been the focus of the Ugandan government to improve production and productivity of dairy and beef animals through use of imported semen or semen produced from imported bulls, imported heifers, and cows. However, for sustained improvement of the dairy and beef sectors in Uganda, there is need for well-designed and appropriately implemented within-country genetic improvement programs. This should be guided by use of improved genetics from ongoing and

future national cattle breeding programs need to be appropriately guided by set guidelines, protocols and standards. Without these, Uganda's continued reliance on importation of genetic materials and live breeding stock, most of which are ill-suited to local and predicted future production environments, would impact the county's dairy and beef sector's vision and goal (DDA, 2020).

Dairy production supports household incomes for over one million households in Uganda, many of which sell milk and for income that is then used to buy food crops (DDA, 2021). In this way, the dairy sector contributes strongly to food security and stable livelihoods. The dairy sector also produces replacement heifers that are sold for income in the households where they originate from. For instance, over the past two decades, Uganda has exported over 406,000 cows to Rwanda, under the "Girinka program". There is also a growing demand for high-grade cows and heifers as the markets in South Sudan and the Democratic Republic of Congo stabilize (AU-IBAR, 2002). Hence, Uganda is well placed to raise its production of good-quality dairy cattle genetics to meet this growing market demand.

1.2 Contribution to and importance of the dairy industry to Uganda's GDP

Dairy production is a priority area of the government of Uganda and is part of its agro-industrialization programme as highlighted in the National Development Plan III that covers the first half of the 2020-2030 period (https://budget.finance.go.ug/sites/default/files/NDPIII.pdf). This drive is intended to increase milk production as this is among the ten major products targeted for the economic transformation of the country. Just over 25 years ago, the government promogulated the Dairy Industry Act of Parliament in 1998 and this led to the establishment of the Dairy Development Authority (DDA).

Currently, the dairy industry is mainly based on 11.2 million indigenous and 3.3 million exotic cattle and their crosses with various indigenous types (UBOS, 2024). The industry contributes just over 3% of the total Ugandan gross domestic product (GDP). Milk production in Uganda has risen tremendously over the past decade from about 1.4 billion litres produced per year (Van Campenhout et al., 2019) to 2.81 billion litres in 2022 (DDA, 2022) with an annual growth rate of 11%. Of the total yield, 80.2% of the milk is marketed and the rest is consumed on the farm. Over 66% of the marketed milk is sold unprocessed and of that, 56% is sold at sales outlets while the rest is sold door-to-door (https://businesstimesug.com/dairy-development-authority/).

By mid-2023, the dairy sector was rated second to coffee in the agricultural sector export earning, valued then at US$3.8 billion (https://app.infotradeconnect.com/index?tab=tips&section=milk). The processed dairy products that command these returns include pasteurised milk, UHT milk, whey, powdered milk, yoghurt, cheese, butter, butter oil, cream, fat, ghee, casein, and others. These products are exported to several countries in Central and North Africa, Middle East, and Asia (https://www.researchtecglobal.com/report/dairy-industry-in-uganda-2022-2023).

1.3 Vision and goals of the dairy industry

The dairy industry in Uganda has a vision of ensuring "dairy for improved health and prosperity of Ugandans". The goal is "to enhance dairy value chain addition and quality for increased market competitiveness" (DDA, 2020). For the third decade of this century, the Government of Uganda strategizes to focus on a dairy cottage revolution for employment, increased farmers' incomes, and wealth creation.

1.4 Scope and objectives of the guidelines and protocols

These guidelines and protocols are intended to:

- Guide and inform the improvement of the genetic merit of dairy cattle in Uganda with a specific focus on the choice of which males and cows to use as artificial insemination (AI) and natural service bulls and bull dams.
- Provide a roadmap to enhance the performance of the dairy sector to improve dairy productivity and the livelihoods of Ugandans.
- For use by the National Animal Genetic Resource Centre and Data Bank (NAGRC&DB), researchers, farmers, farmer associations, breed associations, MAAIF, and civil society organizations.

1.5 Development of the guidelines and protocols - the process

The guidelines have been produced through a process that included:

(i) Desktop review of a dozen national strategic documents and ten technical documents on certification and genetic evaluation from various breed societies and national genetic evaluation centres and stations.

(ii) Consultative engagements to determine the current status of the dairy industry were made with senior staff of NAGRC&DB, MAAIF, the Dairy Development Authority (DDA), the academia, groups of dairy producers, farmers of dairy cattle, and dairy processors.

1.6 Interpretation of the guidelines and protocols

To streamline all animal breeding processes in Uganda as envisaged in the National Animal Breeding Policy of 1997, the National Animal Genetic Resource Centre and Data Bank (NAGRC&DB) was established as a semi-autonomous agency under the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) by the Animal Breeding Act of 2001.

The two-fold mandate of NAGRC&DB are:

- To provide leadership in the commercialization of animal breeding activities across Uganda and carry out development activities that enhance animal genetic improvement and productivity.
- To operate farms and ranches in all sub-regions of Uganda where they breed various animals and enable access to superior breeding stock mostly of cattle, goats, pigs, and poultry.

1.7 Recent developments that informed the process

- Since 2022, performance recording is underway for dairy cattle in parts of Uganda under the Africa Dairy Genetic Gains (ADGG) project which has in its database over 46,000 cows kept mostly by smallholder farmers.

- The dairy farms are located in 41 districts including: Buikwe, Iganga, Kabarole, Kamuli, Kiruhura, Luweero, Masaka, Mbarara, Mukono, and Wakiso (https://portal.adgg.ilri.org/).
- The data being collected is on parameters that include sire breed, dam breed, calving season, parity, milk yield, lactation length, calving rates, and others.
- There is a framework for a national database with some infrastructure for dairy cattle recording; there are also some human resources for the recording role; and a Uganda National Strategy for Animal Breeding and Action Plan is being prepared.
- NAGRC&DB is the authority of the government of Uganda that is responsible for interpreting and executing the plans described in these guidelines and protocols.

2.0 Current status and available options for bull and bull dam evaluation

2.1 Current status and options for change

- Uganda has been using semen imported from different countries and semen processed from imported bulls.
- Starting in 2022, in collaboration with the International Livestock Research Institute (ILRI), a project was initiated to establish a national digital dairy cattle performance recording platform and a genomic evaluation pipeline that would inform the national dairy breeding program. This platform enables the selection of more productive and adaptable dairy genetics, and promotion for their wider use by smallholder dairy farmers in Uganda.
- The breeding program uses information and communication technology (ICT) tools for data capture and genomic tools to identify the best bulls for propagation using AI and natural service.
- Furthermore, in the 41 ADGG project districts of Uganda (Figure 2), there is a framework for a national database with some infrastructure for dairy cattle recording. This is being upscaled to other districts by NAGRC&DB.
- The infrastructure includes the National Animal Genetic Resources Databank hosted at Entebbe, Uganda.
- However, there is no requisite infrastructure to adequately host the animal performance and genomic data being captured, nor is there a harmonized national identification, and animal traceability system.
- These should commence with a robust animal identification and traceability system. To date, NAGRC&DB and the general dairy farming community do not have a uniform identification, recording, and traceability system.
- Small- and medium-scale farmers also have digital tools that enable them to directly share records of their dairy herds with the platform and plans are underway to enable NAGRC&DB to fully host the data.
- Certification and genetic evaluation of dairy bulls and dams follow a specific flow of events as presented in Figure 3. This will have to be mainstreamed into the National Genetic Evaluation Centre (NGEC) described in Section 3.
- Additionally, the Uganda National Strategy for Animal Breeding and Action Plan is being prepared to streamline the performance data recording at farm level. To be able to undertake genetic evaluation and certification there is a need for the development of a robust digital performance data capture and analytics system that supports the National Livestock Data Bank. NAGRC&DB already possesses a batch of cattle production

records at its various station farms and ranches. These are mostly in hard copies and need to be digitized and consolidated into the digital database.

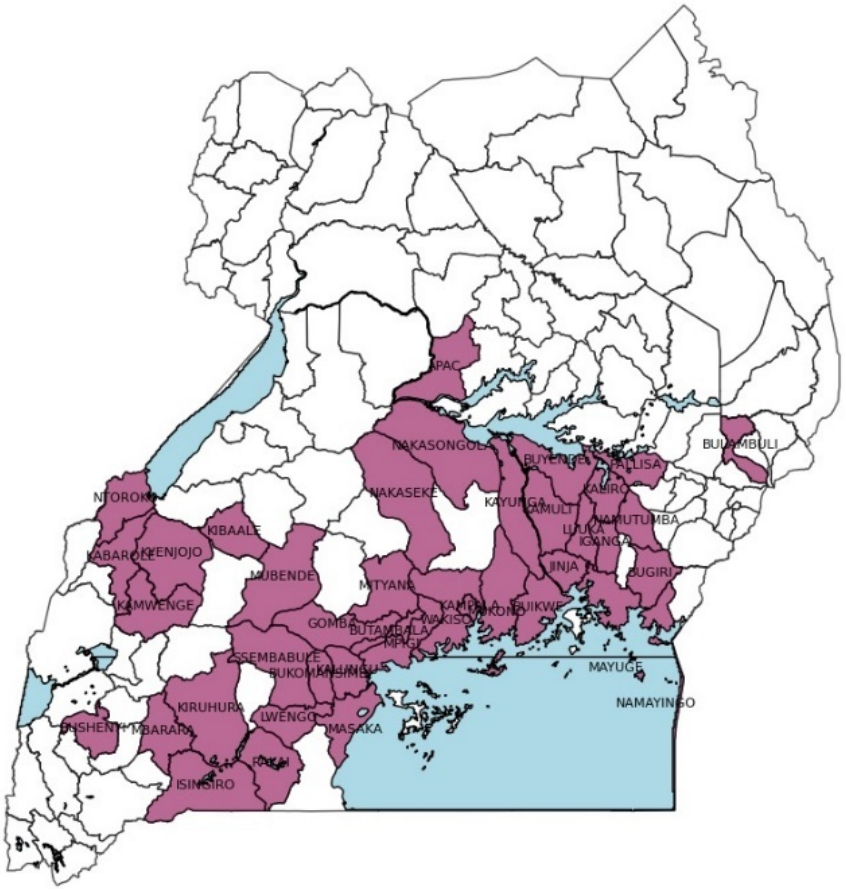


Figure 2: Map of Uganda showing the districts where cows are currently providing dairy performance data under the AADGG.

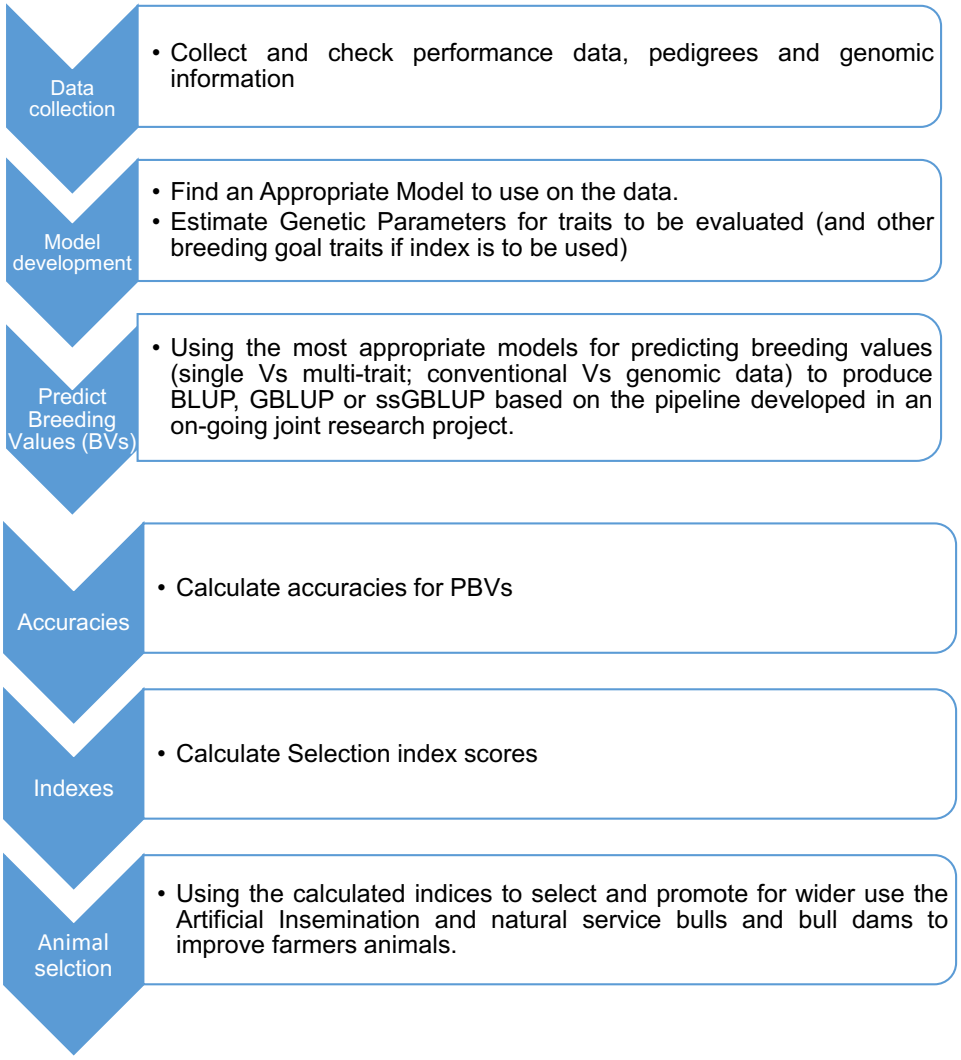


Figure 3: A flow diagram of a typical pathway to producing predicted breeding values, selection index scores and eventual selection of elite bulls and dams.

3.0 National animal genetics evaluation centre

3.1 Specifications of a National Animal Genetics Evaluation Centre (NAGEC)

a) The centre shall officially be approved and licensed by the Commissioner of Animal Production (CAP) who will be responsible for regular audits, at an interval of not more than one year. The audit will be on protocols, procedures, records, the health and welfare of the animals, hygienic production, storage, and dispatch of semen, embryos, and other genetic materials.

b) The centre shall be under the direct supervision and control of a centre veterinarian or Animal Production Officer who shall report to CAP.

c) The NAGEC facility shall have a double perimeter fence, at least 30 metres away from residential premises, public roads, or commercial premises, and at least 15 metres away from water bodies.

d) The perimeter fence of the centre shall be chain linked, at least 2.4 m high, and with a space of 5 m between the two/double fences.

e) There should be quarantine facility signage as one approaches the centre and restricted entry signage at the gate.

f) There should be a vehicle wheel bath and a human footbath should be at the entrance for vehicle and personnel disinfection as per the recommended biosecurity guidelines.

g) The entry shall be controlled with restricted movement of vehicles/people. There should be records of visitors, staff, and vehicles and clearly defined procedures for the admission of visitors.

h) There should be a sentry house with provision for cleaning and disinfection of semen storage containers and equipment, a shower, and a changing room for all people entering the facility.

i) Semen collection and processing areas shall be clearly and physically separate from the distribution/logistics areas.

3.2 Procedure for establishment of the genetics production centre (GPC)

To establish a genetics production centre in Uganda the following shall be the procedure:

a) Make an application to the Commissioner of Animal Health (CAH) for approval.

b) The Commissioner shall undertake a site inspection.

c) Preliminary designs of the production centre shall be approved by the Commissioner.

d) The construction design process shall be approved by other relevant bodies such as the city/town council where the centre is located.

e) The Commissioner of Animal Health shall undertake an audit/inspection of the centre upon completion using an audit checklist.

f) Upon meeting all the stipulated requirements, the centre shall be approved, licensed, and then issued with a unique identification code by the Commissioner of Animal Health for traceability purposes.

g) Bi-annual audits and annual licensing shall be undertaken by the Commissioner of Animal Health.

3.3 Components of the genetics production centre(s)

a) **Entrance** – Quarantine and restricted entry signage, vehicle wheel bath, human footbath, and a sentry house.

b) **Pre-quarantine area** – Offloading ramp, the inspection crush, the spray race/dip, wheel bath and footbath, lockable gate, individual pens, waste disposal pit, and sturdy perimeter fence.

c) **Sire/teaser/donor pens** – well-lit and ventilated individual pens with feeding and watering areas that are easy to clean and with a non-slip floor, an ablution block with provision for showering and changing of staff at the entrance into the animal compound

d) **Sick animal isolation pens** – Treatment crush, well-lit, and ventilated individual pens, easy to clean and non-slip floor, feeding and watering areas.

e) **Semen/embryo collection area** – Sufficient lighting and ventilation, high roof (at least 5 m high), easy to clean and non-slippery floor, half crushes, holding area, and safety rails.

f) **Laboratory –** Restricted entry signage; fully enclosed and physically separate from bull housing and semen collection areas; structured to provide hygienic handling and storage of semen, embryos, and other genetic materials; laboratory floor, countertops and other semen processing areas constructed with materials which permit easy cleaning and disinfection; ablution block for showering and changing of staff at entrance of laboratory; and facility for quarantine and storage of semen/embryos.

g) **Waste disposal** – there shall be a disposal pit and incinerator which is physically separate from bull housing, semen collection areas, and laboratory.

h) **Feed storage** – should be separate from the animal shed, be easy to clean, and be damp and rodent-proof.

i) **Semen/embryo dispatch** – Clearly separated from the collection and processing area, Provide an area for cleaning and disinfection of storage containers at the entry.

j) **Semen/embryo distribution** – Appoint licensed distribution agents in consultation with the Commissioner of Animal Health.

k) **Administration block –** this shall be physically separate with a fence from the collection area, processing laboratory, and animal accommodation facilities.

3.4 Biosecurity measures in GPCs

Biosecurity is a set of management and physical measures designed to reduce the risk of introduction, establishment, and spread of animal diseases, infections, or infestations to, from, and within an animal population (OIE, 2024). Biosecurity in livestock facilities has three main goals i.e. isolation, sanitation, and traffic control achieved through segregation, sanitation, and disinfection respectively.

An animal genetics production centre is classified as a quarantine facility and has three biosecurity zones namely low, medium, and high-risk areas with different protocols for access and exit.

a) **Low biosecurity zone:** – Visitors lounge, office building, parking lot, canteen, security outpost, stores, residential area, workshop, recreational and other socializing facilities, etc. These areas should be outside and physically demarcated from the high biosecurity zone. Entry shall be by permission only and other zones cannot be accessed from here.

b) **Medium biosecurity zone**: – Feed mixing area, silage pits, isolation shed, fodder plots, machine barn, equipment stores, etc. These areas are outside and physically demarcated from the high biosecurity zone. Protective boots are required to enter this zone. Entry is not allowed without the permission of the unit head.

c) **High biosecurity zone:** – All animal sheds, collection areas, processing laboratories and storage facilities. The area should have clear signage of the biosecurity zone. Protective

clothing (overall, caps) and proper hand sanitation are required to enter these areas. Change of protective clothing is required if entering from the medium-risk zone. No entry other than for designated personnel unless necessary, with the permission of the person in charge.

3.4.1 Regulation of quarantine facility

The national animal genetics production facility, after attainment of all required biosecurity measures will apply to the Commissioner of Animal Health (CAH) for approval as a quarantine facility. Quarantine facilities are under direct regulation of the CAH who has final authority in granting, suspending, and revoking the status of any quarantine station. The CAH will supervise compliance with all requirements critical to the maintenance of the quarantine station and ensure that all information is available to whoever requires it. A biosecurity audit will be carried out by the CAH.

3.4.2 Biosecurity policy

The animal genetics production facility has to have a written biosecurity policy in place describing the structural and operational biosecurity. There is a need to identify a biosecurity manager responsible for developing a biosecurity plan with written authority to ensure compliance with biosecurity protocols. Biosecurity policy must have provision for continuous staff training and guidelines for monitoring and evaluation. The biosecurity policy should address the principles of biosecurity which include:

a. Measures to prevent the introduction of disease.
b. Measures to prevent disease spread within the facility.
c. Measures to improve animals' immunity (disease resistance).

3.4.2.1 Measures to prevent the introduction of disease

a) Biosecurity signage at the entrance of semen collection centres

A sign board is placed indicating "biosecure area" or "quarantine area" at the main gate to inform visitors not to enter the biosecure area without the permission of an authorized person. This makes the visitors understand that the facility falls under a protected area and that entry is restricted.

A gate control system should be in place and manned 24 hours to restrict unauthorized entry or exit from the facility. As per the biosecurity policy, visitors can be categorized as follows:

- Farm to farm – Not allowed until quarantined
- Farm to office – Allowed with proper protocol
- Office to office – Allowed

b) Disinfection of vehicles and personnel

Vehicles can be a source of pathogens gaining entry into the facility, other than newly introduced animals and people. All vehicles visiting the facility should be parked outside the biosecurity perimeter fence and only essential vehicles may enter the NAGEC. At the gate there should be facilities for vehicle and personnel disinfection. A wheel bath is provided at the entry of the facility. After cleaning of the vehicle, disinfection is done using an agent that will destroy bacteria and viruses. Vehicles should pass through a wheel bath of a minimum of 5.5 m length, 3.5 m width and 6-9 inches depth. A footbath and handwashing facility should also be provided at the main gate. Ensure the right disinfectant that will destroy bacteria and viruses is used in

the footbath and handwash. The footbath should be cleaned and replenishment of disinfectants done regularly. All the staff and visitors must use footbath as well as handwash before entering the farm.

Farm vehicles carrying manure are to be cleaned thoroughly on a regular basis. Vehicle tyres and undercarriages that have direct contact with animals' discharges should be cleaned thoroughly and disinfected with appropriate disinfectants at the end of the day's operations. Other farm vehicles are to be cleaned and disinfected on a regular basis (monthly/weekly/fortnightly) based on the exposure risk. NAGEC centres should develop and follow the established SOPs for cleaning each type of vehicle.

c) Guidelines for restricted movements and visitors

A biosecurity protocol is not effective without restricted movement of visitors and vehicles into the facility. One of the major sources of pathogens gaining entry into the facility, other than newly introduced animals, is people. For this reason, the following steps should be taken:

a. Set up a vehicle parking area near the main entrance and visitors room at the main gate.
b. Entries are made in the visitors' logbook
c. Incoming liquid nitrogen containers (to take delivery of animal genetics and liquid nitrogen) are sprayed with effective disinfectant at the entrance of the facility.

Visitors should be banned from entering the genetics production centre. However, if visits become necessary, the visitors must follow guidelines such as.

a. Visits by appointment (pre-arranged).
b. Signing in and out.
c. Cleaning and disinfection of hands, footwear, and tools/ equipment (in and out)
d. Use of polyethylene boot covers.
e. Waiting period between animal contact in other farm(s) and visiting a genetics production centre (suggested minimum: 3 days).
f. SOPs to be in place and followed for visitor regulation.

d) Restrict the entry of wild/other animals

A combination of fencing and boundary walls around the farm should be in place to keep out wild and other animals. The genetics production centre should have a double chain-linked perimeter fence of at least 2.4 m high and a space of 5 m between the fences and a gate control system to restrict the entry of other animals into the facility.

e) Ring vaccination program

It is important during vaccination especially against foot and mouth disease (FMD) to include the surrounding animal population within a 5 km radius of the genetics production centre (GPC). This facilitates creating a protective shield around the farm against FMD.

f) Hygiene of workers

Before entering the facility, all workers should take a bath and wear clean clothes and gumboots as per the specified dress code. Periodic washing of protective attire for workers should be undertaken to ensure the prevention of the spread of disease.

Tuberculosis testing of workers/officers having direct contact with the animals should be carried out at regular intervals. Routine checking for personal hygiene (nails, hair, etc.) of people working with animals and laboratories is also important.

g) Quarantine of animals

New animals to the animal genetics production centre must be purchased from reliable sources with known health status after following a set protocol. The animals are kept in the pre-quarantine area upon recruitment. There should be a minimum distance of at least 500 metres between the quarantine area for the resident herd and the pre-quarantine area. A reception facility including a loading/ off-loading ramp, crush, and a holding pen should be available for inspection of animals prior to entry in the pre-quarantine area.

In the pre-quarantine area, strict protocols are to be followed before animals are admitted. A minimum quarantine period of 30 days is compulsory in the pre-quarantine. The personnel in the pre-quarantine area should not mix with personnel in the quarantine area.

Each new animal in the quarantine station should be tested against the following diseases before entry into the resident herd tuberculosis, bovine viral diarrhea (BVD), brucellosis, infectious bovine rhinotracheitis (IBR), campylobacteriosis, trichomoniasis, and any other disease as may be advised by the Director of Veterinary Services (DVS). All tests should be done by DVS diagnostic laboratories.

3.4.2.2 Measures to prevent disease spread within the facility

a) Veterinary staff

The genetics production centre should ensure that adequate veterinary staff are available at all times to monitor the health of animals. In case of an infectious/contagious disease, the Director of Veterinary Services should be informed to take appropriate measures.

b) Farm activities

Maximum efforts are made to restrict the contact of animals and workers with people involved in other farm activities that may present a risk of disease(s). Separate tractors and trolley are to be used exclusively for feed and fodder distribution to animal sheds as common facilities may compromise with biosecurity within the facility. Separate dress codes are helpful in identifying the personnel working in different areas. Access to animal sheds, semen collection arena, feed mixing and storage area, veterinary drug store, etc. should be limited to the concerned employees only.

c) Wildlife/pest/rodent/insect control programmes

Animals should be prevented from contact with free-roaming animals (e.g. dogs, cats, wildlife animals, pests, rodents, etc.). The entry of wild/other animals is controlled by a double boundary wall system–one around the perimeter and another around the animal facilities.
The following measures are helpful in preventing the spread of diseases:

- Use of bait/insecticide: bait should be kept in each animal shed for fly/insect control.
- Insecticide is changed at appropriate intervals according to manufacturers' instructions.
- Treating animals to control ectoparasites at appropriate intervals according to manufacturers' instructions.

- Closing of holes/cracks on floor and walls.
- Keep a five-meter clean area (free from herbs, shrubs and grasses) on the periphery of animal sheds.

d) Handling of feed stuff

The feeding schedule of the animals will be based on routine quality analysis of feed and fodder to ensure a balanced ration. Feed ingredients are supposed to be stored in a separate building (warehouse/ barn) away from animal sheds. Standard storage conditions should be maintained. Pest control must be ensured by using baits and insecticides in store. If feed ingredients are suspected of aflatoxins and mould, the samples should be collected and sent for testing.

For feed biosecurity the following should be followed.

i. SOPs are put in place to reduce the chances of introducing diseases when fodder is procured from other sources (contract farming).
ii. Bags of feed or feed ingredients are stored off the floor, e.g. on pallets.
iii. Areas in and around storage areas are cleaned between batches of feed.
iv. Ensure that water is not getting into storage areas.
v. Moisture problems are addressed periodically.
vi. SOP followed for storage, distribution and disposal of feed and food.

e) Water supply

Water is an important vehicle for disease transmission. All water sources should be protected from animal carcasses and manure. Water used at the facility should be free from any chemical and biological impurity. To achieve this, testing of water is done once in three years, from accredited agencies or laboratories. Water is sourced from deep bore wells and used as drinking water for animals, cleaning and washing animal buildings and agricultural purposes. The water purifier is added to drinking water. A regular cleaning schedule of water troughs and tanks must be followed. Water tanks are disinfected at least twice a year. A SOP for cleaning and disinfection of water sources should be in place.

f) Power supply

The animal genetics production centre should have a stable and reliable source of power. In addition to the connection to the main power grid, a backup power system should be in place in case of a power outage to allow normal operations.

g) Housing facility

Animal sheds should have spacious individual pens with adequate resting areas, feed and water troughs with access to drinking water at all times. The entire housing facility should be kept clean at all times. Disinfection should be carried out as per the prescribed biosecurity protocol.

h) Isolation facility

There should be an isolation area away from the other animal pens for segregating sick/suspected (for disease) animals for treatment and care. Animals once diagnosed as suffering from infectious disease(s) should be separated immediately from others.

i) Manure disposal

Removal of manure from all animal sheds is mandatory to always maintain hygienic conditions in the premises. Manure should be taken to the manure pits.

j) Disposal of carcasses
Dead animals should be removed from the pens and disposed of through incineration or burial away from the resident areas of the animals. The vehicle as well as farm equipment used for animal disposal should be cleaned and disinfected properly. The housing facility used by the dead animal should be thoroughly cleaned and disinfected as per the biosecurity protocol. y. Post-mortem examination should be performed in a post-mortem room away from the bull residential areas by qualified veterinary personnel.

k) Semen collection area
The Semen collection area and semen collection protocol should be in line with the recommended guidelines.

l) Laboratory hygiene
There should be restricted access to the laboratory to allow access to authorized personnel only. Laboratory personnel should practice personal hygiene and wear personal protective equipment (PPEs). The laboratory should have clean running water all the time.

The floor of the laboratory should be made of epoxy material and should not have sharp corners where it comes into contact with the wall (should be curved) for ease of cleaning. The laboratory and semen processing rooms should be kept germ-free. The workflow should be unidirectional, from the clean area e.g. quality control of the semen to the dirty area where packaging and dispatch are done. All the laboratory waste generated should be discarded in separate bins depending on whether they are infectious/non-infectious, hazardous/non-hazardous according to the SOP on waste management and disposal. The laboratory should be fumigated regularly using recommended reagents.
Equipment used for semen collection, glassware, bacteriological media etc. should be sterilized. A standard operating procedure should be followed for the disinfection / sterilization of all equipment in the laboratory.

3.4.2.3 Disease control measures
The ultimate objective of disease control measures at a facility is to keep animals disease-free. The following steps should be taken to prevent diseases in the facility.

a) Disease testing of the resident herd
Regular disease screenings of the animals play a vital role in keeping the herd free of diseases. Screening against infectious diseases such as tuberculosis, BVD, brucellosis, trichomoniasis, and campylobacteriosis is carried out as per mandate. Positive reactors for tuberculosis, BVD, and brucellosis are immediately culled from the herd without re-testing. Semen doses of positive reactors from the last negative testing are discarded to avoid the spread of infection.

b) Vaccination
Animals are vaccinated against infectious diseases such as FMD, black quarter (BQ), anthrax, lumpy skin disease, Rift Valley fever, and any other prevalent diseases. This should be done as per the specified protocol of the facility to produce the desired immunity against diseases. SOP for vaccination to be in place and be followed.

c) Endo and ecto-parasite control

SOPs for ectoparasite and endoparasite control should be put in place and shall be followed.

3.5 Sire/donor recruitment to GPC

Recruitment shall be based on clear breeding goals aimed at improving production, health, functional, and fitness traits. The selection should therefore be done:

- in consultation with experts accredited by the relevant breed societies and breeding operations,
- in consultation with the Commissioner of Animal Production (CAP) for quality and sanitary measures, and
- within standards for every breed which should be available with Uganda National Herd Book (UNHB).

Sires/donors can be recruited from contract mating farms which should be breeding true to the breed with the declaration of semen or embryo source and farm service book or AI certificate set showing the services and sires used. The contract mating farm should be:

a) Registered with Uganda National Herd Book (UNHB) and be doing the official recording of at least 70% of their herd and be a member of the respective breed society.
b) Using AI, Embryo transfer (ET) or pedigree registered sires to breed their cattle. All other males on the farm should be castrated at weaning.
c) Using an officially recognized method of identification with records available and traceable. The livestock identification and traceability system (LITS) shall be the officially recognized identification system for the country.
d) Practicing good management practices in terms of housing, feeding, offspring rearing, milking, and disease control.
e) Semen and embryo donors should originate from a farm free from any notifiable disease(s).
f) Selected sire dams should be:
    i. Either at the pedigree or appendix level of registration.
    ii. Genetically evaluated (genomic or progeny tested).
    iii. Free from breeding disease.
    iv. Have genetic values that conform to the developed standards for the particular species and breed.
g) Contract sire/selected sires should be:
    i. Registered at pedigree.
    ii. Genetically evaluated (genomic or progeny tested) with reliability of 70% and above
    iii. Free of any negative recessive traits.
    iv. Tested free of breeding diseases.
    v. Have genetic values that conform to the developed standards for the particular species and breeds.

3.6 Sire identification in animal genetics production centres

a) All sires should be registered in the National Herd Book (UNHB).
b) The centres shall adopt the unique coding system as specified in the LITS - centre code, breed prefix, and bull number.
c) Adopt the official recognized identification method.

d) The Breeders' Association for the respective cattle breeds in the country will be the clearing authority for sire names of the different breeds.

3.7 Statutory disease testing for animals in GPC

Testing against various diseases is carried out as per the World Organization for Animal Health (OIE) guidelines. Regular disease testing of the animals in the centre plays a vital role in keeping the herd free of diseases. Sires, donors, and teaser animals should only enter the GPC if they fulfill the following requirements:

3.7.1 Prior to entry

Before entering the GPC, the sires should be clinically healthy and physiologically normal and be free of the following diseases: bovine viral diarrhoea (BVD), bovine tuberculosis, infectious bovine rhinotracheitis, brucellosis, infectious pustular vulvovaginitis and blue tongue.

3.7.2 Pre-quarantine

Before entering the GPC, sires, donors, and teaser bulls should be kept in a pre-entry isolation facility for at least 28 days. The following diseases shall be monitored: bovine viral diarrhea (BVD), bovine tuberculosis, infectious bovine rhinotracheitis, brucellosis, infectious pustular vulvovaginitis and blue tongue, *Campylobacter fetus* subsp. *venerealis* and *Tritrichomonas foetus*.

3.7.3 The resident herd

All sires, donors, and teasers resident in the semen production facilities should be tested at least annually for the following diseases, with negative results. These are: Bovine Viral diarrhoea (BVD), bovine tuberculosis, infectious bovine rhinotracheitis, brucellosis, infectious pustular vulvovaginitis, *Tritrichomonas Foetus*, *Campylobacter fetus* subsp. *venerealis* and blue tongue.

3.8 Outbreak of notifiable disease(s) in the GPC

In case of an outbreak of a notifiable disease(s) in the GPC, the following should be done;

a) Notify the Commissioner of Animal Health (CAH)

b) Isolation of animals showing clinical signs c) Sample submission for testing

d) Stop semen/embryo production immediately pending confirmation

e) Semen/embryo collected one month before the detection/outbreak shall be destroyed under the supervision of the CAH

f) Thorough cleaning and disinfection

g) The CAH declares quarantine within the center and lifts quarantine when the facility is declared free of the disease.

3.9 Standard operating procedure (SOPs) for a GPC

All areas of operation must have documented standard operating procedures for the following areas.

a. Entrance

i. Cleaning/disinfection of all staff, visitors, and vehicles

ii. Wheel and footbath maintenance

iii. Admission of staff

iv. Admission of visitors- letter from CDVS from county of origin

v. Admission of vehicles

vi. Procedures for admission of animals
vii. Transport of animals into the facility

b. Pre-quarantine
i. Disease and pest control
ii. Disease testing
iii. Entry and exit of animals
iv. Isolation and treatment of sick animals
v. Cleaning and disinfection
vi. Housing
vii. Routine management practices

c. Bull, donor, and teaser bull pens
i. Disease and pest control
ii. Disease testing
iii. Housing
iv. Entry and exit of animals
v. Isolation and treatment of sick animals
vi. Cleaning and disinfection
vii. Routine management practices.

d. Semen collection
i. Preparation of bulls and teasers
ii. Preparation of semen collection equipment
iii. Collection of semen
iv. Cleaning and disinfection

e. Laboratory
i. Access of staff to the laboratory
ii. Processing of semen
iii. Semen straw/tubes identification
iv. Testing, calibration and care of equipment
v. Cleaning and disinfection of the laboratory and equipment

f. Semen quality control
i. pre- and post-thaw semen quality control
ii. differentiating, tracking, and releasing of semen
iii. training and continuing education for lab personnel

g. Storage and dispatch
i. Quarantine of semen
ii. Storage of semen
iii. Dispatch of semen

h. Feeds
i. Sourcing feeds

ii. Storage of feeds
iii. Pest and rodent control programs in feed storage

4.0 Animal identification and breed registration

The following shall be considered in determining the breed of the animal under evaluation:

- All cattle breeds that are locally and internationally recognized shall be identified by their known parameters. Assigning of an animal to a specific breed shall be justified if 75% of the animal's genes originate from that breed (or both sire and maternal grandsire are from the breed under genetic evaluation).
- In the case of crossbreeding, the breed with the highest percentage should be considered.
- Bulls and dams for dairy production should be classified under the following breed groups:
    - Brown-Swiss type
    - Charolais type
    - Tyrolean Grey type
    - Girlando type
    - Holstein-Friesian type
    - Guernsey type
    - Jersey type
    - Ayrshire type

- Bulls and dams for beef production should be classified under the following breed groups:
    - Brahman type
    - Boran type
    - Sahiwal type
    - Simmental type
    - Bonsmara type
    - Fleckvieh type
    - Black-Angus type

- Bulls and dams for dual-purpose/milk + beef production should be classified under the following breed groups:
    - Ankole type
    - Nganda type
    - Nkedi type
    - Karamojong type
    - Teso-Zebu type
    - Small-East-African-Zebu type

4.1 Animal identification

Following the proposed livestock identification and traceability system (LITS) for Uganda, the guidelines here below shall be followed:

- Each animal shall be identified with a unique electronic identity (e-ID) number.
- Each animal's ID should be unique to that animal, given to the animal at birth, never to be used again for any other animal, and shall be used throughout the life of the animal in Uganda. This identifier shall:
    - Commence with the ISO country code for Uganda (800), then
    - a three-digit ICAR Breed-ID code, followed by
    - the sex code (0, 1 for female or male) and then
    - a unique ID number of up to 8 digits.
    - A register of the visible E-ID number, breed, sex, year born, and location of the bull or bull dam shall be kept in the central database (Mugisha, 2023).
    - It is worth noting that a LITS is only limited to identification and traceability and should be integrated with the performance recording system so as to have value to the overall development of the livestock industry, as the system would inform selection decisions. In reference to ICAR guidelines, an animal's identity

should be attached to the animal by a tag, tattoo, or brand, or implanted in the body and read-off by an electronic device (ICAR, 2023).

- The cattle identification number may be supplemented with a sketch or photograph.
- All bulls and cows used in an evaluation program should always maintain their identification as provided for by the ICAR guidelines.
- If modification of the original animal ID is necessary, it should be considered a re-registration and documented by cross-referencing the original animal ID and the new animal ID.

4.2 Pedigree Information

In Uganda, very limited pedigree records are available for use in the selection of breeding bulls and bull dams and where they exist, they are largely kept in memory of the animal owner. This is not sustainable and must be replaced by a robust recording system.

- There is a need to adopt ICAR recommendations for performance and pedigree recording. The National Genetic Evaluation Centre (NGEC) as a department of NAGRC&DB should keep track of and report the percentage of cattle with missing identification and pedigree information.
- The NGEC will closely collaborate with farmer associations, producer groups, breed societies (when eventually formed), and the National Cattle Identification and Registration Centre (NCIRC), which should become fully operational.
- A minimum of three generations of pedigree should be required for evaluations to be of acceptable quality as this will be considered to have been based on sufficient pedigree information (ICAR, 2023).
- Notwithstanding, the absence of phenotype records shall not disqualify the need for pedigree information.
- However, if genomic information is available, it should be used to accurately construct pedigrees.
- To reduce the percentage of non-parent identified animals and animals with missing birth information, the proposed evaluation guidelines should include:
    a) Supervised and recorded natural mating and artificial inseminations.
    b) Avoidance of using mixed semen.
    c) Close monitoring of parturitions to match service dates and calving/birth dates
    d) Careful taking of bull ID from AI straws.
    e) Use of genetic markers such as MSTATS to ascertain parentage at birth, when parentage of the calf is in doubt and technology is affordable.

4.3 Breed registration

Currently, there are no registered breed societies and associations in Uganda. Part of the challenge has been the absence of breed registration processes by the Ministry of Agriculture Animal Industry and Fisheries (MAAIF). Current efforts are aimed at developing industry-acceptable regulations that provide for, among others, guidelines for registration of individuals and entities involved in breed development and breed multiplication and promotion in Uganda. Registration of the breed societies and associations shall go a long way to ensure that breed development efforts at the national level are achieved and are mainstreamed in government

planning processes. Promising crossbred animals and nondescript breeds will be subjected to characterization protocols and will then be stabilized for true-to-type traits and then registered.

5.0 Bull selection and evaluation

5.1 Categories of sires for evaluation

The following categories shall be used for classifying sires for genetic evaluation and distinguishing them .

- Imported bulls
- Domestically proven bulls
- Young bulls genomically tested but not yet selected for AI
- Young bulls with the first batch of daughters
- Proven bulls with a second batch of daughters
- Bulls with only parent average and genomic information
- Natural service (NS) bulls
- Artificial insemination (AI) bulls

For AI bulls, evaluation should establish and consider daughters of each bull in at least 10 herds.

5.2 Recruiting bulls and bull dams

This is based **on clear breeding goals** agreed upon by the farmers, breeders/ breeder societies, policymakers, and research scientists. These breeding goals should be well communicated to the Commissioner of Animal Production at MAAIF and coordinated by the District Veterinary Officer in the area of operation.

5.2.1 Sources of breeding bulls

- Bulls from the top 10% best performing bull dams from the community breeding scheme or the breed society and this is based on records provided by the farmers / breed society and carefully analysed by the breeders and scientists.
- Imported bulls with their pedigree information available.
- Bulls identified by breeders and there is some information to back up their performance (could be based on performance of the dam or sisters.
- Bulls recruited from the national ranches managed by NAGRC&DB after fulfilling all necessary requirements.

5.2.2 Standard for genetic merit of breeding bulls and bull dams

- Breeding bulls should be procured through government-approved Progeny testing (PT) Programmes supervised by NAGRC&DB.
- If such bulls are not available and if there are no Progeny Testing programs for certain breeds, the procurement of bulls should be based on the dam's Standard lactation yield.
- The Lactation yield can be arrived at by recording each animal's day milk yield once a month continuously for 11 times or until the animal becomes dry.
- The standard lactation yield of the milk-recorded animal should be calculated using the Test Interval Method (A4) of the International Agreement of Recording Practices published by the International Committee for Animal Recording (ICAR).

Below is the standard lactation yield per breed that shall be acceptable for Uganda. These are based on performance records of well-managed cows in the East Africa region.

	Dam's lactation yield (Kgs)		
Breed	**First**	**Best**	**Fat %**
Pure Holstein Friesian	4200	5500	3.5
Pure Jersey	3100	3850	5.0
Sahiwal	2200	3200	4.0
Zebu	1500	2000	4.5
Ankole	800	1600	3.9
Boran	2400	3000	4.5

5.2.3 Other considerations for imported breeding bulls

- For import of bulls and embryos, the standards for import of germplasm as prescribed in the "Regulations for export and import of bovine germplasm" issued by MAAIF shall be followed (the regulations are currently being drafted).
- Select animals shall be of registered pedigree, whose parentage and sister performance are top five (5%) per cent for the herd's functional and productive traits for dairy breeds.
- Beef breeds should be registered pedigree animals, having a recorded parentage performance of 20% above the national breed average in weight at birth, weight at weaning, yearling, 14^{th} to 24^{th} month weights, mature weight, and breed-specific conformation traits.

5.3 Parentage verification

- Parentage verification of both bulls and bull dams shall be done especially where records are questionable. Where there is doubt, blood samples from the dam and progeny (son/ daughter) and semen from the bull and submitted for genetic/ parentage testing using DNA markers.
- The approved bull shall be recruited in the breeding program at the age of 14 months and shall be exited after 4 years.
- Male calves from elite dams should be procured from candidate farmers as early as possible to avoid loss of germplasm. Parentage verification of the calves shall be done as well.
- Bulls whose dam's milk yield is more than the average yield specified in the standard of genetic merit of breeding bulls shall be selected.
- Pedigree/progeny tested bulls shall have at least 50 daughters' performance recorded in 20 or more herds with better than 80% accuracy of production traits. If genomic information is added to recorded performance, accuracy will increase.
- Estimated Breeding values or Predicted Transmitting Abilities for milk, fat and protein yields shall be positive in the most recent genetic evaluation. Semen from negatively ranked bulls for production traits shall not be allowed to be used.
- Bulls should not cause more dystocia than average bulls in the recent most genetic evaluation nor should their daughters prone to mastitis than the average bulls.

- Bulls shall be free from genetic disease such as bovine leukocyte adhesion disease (BLAD), complex vertebral malformation, citrullinemia, factor XI and should have normal karyotype.
- Breeding bulls and bull dams shall be free from reproductive problems, transmittable venereal diseases and shall be duly certified by the veterinarian after testing from an accredited laboratory. Health certificates from competent authority of the country of origin shall be provide during application for import permit and on arrival of the semen.
- The motility percentage of sperm in frozen semen shall not be less than 50% after thawing of the semen.
- Each semen straw (0.25/0.5 ml capacity) shall carry at least 20 million sperms for non-sexed and 2 million for sexed semen doses. With sexed semen, the accuracy of female births should be 90% or better.
- Bulls shall be registered with and traceable from the breed association or semen supplier's website.

5.4 Physical examination

- Before procuring new bull calves / bulls for a semen station, a thorough physical examination shall be conducted by an accredited official / veterinarian to ensure that the bulls are free from abnormality and do not display clinical symptom(s) of any infection or any contagious diseases.
- For every new breeding bull or calf recruited, the measurement of scrotal circumference and body weight shall be initiated immediately (Figure 10 in the Appendix).
- Prior to introduction of new bulls for semen collection, breeding soundness examination shall also be carried out (Annex 3).

5.5 Karyotyping and testing for genetically transmitted diseases

- It is compulsory that all animals recruited in the national breeding program across all participating farms and institutions be genotyped to rule out any chromosomal defects:
- Tests to be conducted for genetically transmitted diseases include:
    - ✓ Factor XI deficiency syndrome
    - ✓ Bovine leukocyte adhesion deficiency (BLAD),
    - ✓ Citrullinemia
    - ✓ Deficiency of uridine monophosphate synthase (DUMPS)

5.6 Quarantine

A quarantine period of minimum 60 days is compulsory before bringing new bulls into the NGEC and semen station. Only after favourable results from the health control point, the bulls shall be admitted to the semen station.

a) In the quarantine station, new animals shall be housed for a minimum of 60 days in a place which is effectively separated and away from (preferably at a distance of 5 km) the facilities occupied by resident bulls. Manpower deployed and all equipment used in handling, feeding, watering and cleaning the new bulls shall not be shared with the resident herd(s).

b) Each new animal in quarantine station will be tested against major contagious diseases before its entry to resident herd e.g. tuberculosis, Johne's disease (JD), brucellosis,

campylobacteriosis and trichomoniasis. All tests shall be done by an accredited agency or disease diagnostic laboratory.

c) During quarantine period, the bulls shall be vaccinated against FMD, haemorrhagic septicaemia (HS), BQ, theileriosis and anthrax. However, vaccinations against bacterial diseases shall be done only if there is an outbreak or prevalence of a particular disease. Once the quarantine period is over, all bulls shall be introduced to the NGEC.

5.7 Testing of bulls against disease

New bulls and bull dams should be tested for tuberculosis, Johne's disease, brucellosis, campylobacteriosis and trichomoniasis. As per WOAH guidelines, the breeding bulls should be free from above mentioned diseases. The bulls in the rearing station and the resident herd should go through periodical testing and vaccinations as per the schedule listed in the manual.

6. Vaccination schedule

- The bulls shall be vaccinated against FMD, HS, BQ, theileriosis and anthrax. However, vaccinations against bacterial diseases shall be done only if there is an outbreak or prevalence of a particular disease.
- Theileriosis – Exotic and crossbred bulls shall be vaccinated once in their lifetime.
- To reduce lay off time, the bulls shall be vaccinated on the rest day or the day after completing semen collection. Sexual rest may not be required unless otherwise febrile condition is noticed.
- The semen station shall arrange for carrying out ring vaccinations for all cloven-footed animals including swine against FMD within a radius of 10 km around the semen station. Vaccinations against HS and BQ shall be carried out in the areas having incidence of these diseases.
- The semen station must remove bulls (within 48 hours) which are positive for Brucellosis, TB and JD. Bulls found positive for campylobacteriosis and trichomoniasis shall be isolated and treated.
- The semen station shall cull those bulls which have completed eight years of productive period or 300,000 semen doses, whichever is achieved earlier. In addition, the bulls with poor libido, poor semen quality, incurable lameness, etc. shall also be culled.

7. Housing of bulls

Bull sheds shall have spacious individual pens with adequate loafing area, manger and water trough with access to drinking water all time. Adequate shade around the bull shed shall be provided. The roof shall be made of insulating materials.

During the dry season, cooling system with sprinklers and fans may be required particularly for exotic dairy bulls.

Disinfectants like formalin or phenyl-based compounds shall not be used in the bull sheds. Alternatively, compounds containing Formaldehyde shall be used. Weekly spraying of sodium carbonate (4%) solution shall also be practiced. The floor shall be sterilized at least once a year by a blowlamp or by burning straws. At one corner of every bull stud farm, there shall be an isolation shed for separating ailing / sick bull(s) that are undergoing treatment.

Once any bull is diagnosed to be suffering from an infectious disease, it shall be removed immediately from the semen station for the safety of other bulls.
There shall be separate staff and separate biosecurity arrangements for semen station/bull stud and female herd, if there is one on the breeding farm.

8. Management of bulls

The objective of daily care of bulls is to ensure a satisfactory state of cleanliness in the bull stud facility. For proper management of the bulls, the following aspects shall be considered:

a) The bulls shall be always kept under hygienic conditions.
b) The hair coat of the bulls shall be kept clean and generally short. The hooves shall be regularly trimmed.
c) The length of the tuft of hairs at the preputial orifice, which is invariably soiled, shall be cut to about 2 cm. The hair shall not be removed altogether, because of its protective role. If cut too short, this might cause irritation of the preputial mucosa.
d) Bulls shall be brushed and groomed regularly, and where necessary, special attention shall be given to the underside of the abdomen, a day prior to semen collection.
e) Cleaning of the prepuce with sterile normal saline solution may be done every 10 days if the microbial load is close to the prescribed limits. Cleaning prior to the day of collection can be practiced if the microbial load in frozen semen is beyond the prescribed limit.
f) In the event of obvious soiling, careful cleaning of the preputial orifice and the adjoining areas with soap or a detergent is recommended; followed by thorough rinsing and drying.
g) Scientific feeding schedule shall be followed for the bulls. The semen station shall carry out routine quality analysis of feed and fodder for arriving at a balanced ration for the bulls.

6.0 Implementing a bull production program for natural service

6.1 Objectives of the bull for natural service program

The main objectives of the programme are:

a. Genetic upgrading of the "general cattle population" in the country through natural service.
b. Production of disease-free bulls with high genetic merit for natural service.
c. Active participation of the community in genetic upgradation programmes.

6.2 Standard operating procedure and minimum standard protocol to produce bulls for natural service

Animal recording for bull production has two components: (i) identification and recording of elite bull dams/mothers, (ii) rearing of the male calves up to breeding age.

NAGRC&DB shall implement a programme of field performance recording to produce bull calves of breeds (particularly those not actively in use at the bull stud / GPC; and may follow the following guidelines.

6.2.1 Identification and recording:

The Following procedures shall be undertaken:

(i) Identification and recording of subject bulls and cows to be included in the breeding program. Identify the breed/type of animals for which recording system is proposed to be established for production of bull calves.

(ii) Identify one or two pockets of about 50 local council areas having a large number of cattle of a pure breed. The areas/villages shall preferably be in a compact area for operational and monitoring ease. The actual number of villages would depend on concentration of quality cows and bulls.

(iii) Conduct door to door surveys in the picked 50 local councils/villages to create a critical database on the breed/animals present to understand the herd structure.

(iv) Establish the benchmark for milk production based on records provided by the District Veterinary Officer. Benchmark with the highest ever recorded yields. Aim to select cows with the highest milk yield compared to the average in the area. Other information such date of service, date of calving, sex of calf, birth weights among others should also be captured depending on the breeding objectives.

(v) Based on the survey information, select as many villages as required to have about 1000 cows of the breed that meet the standards of milk production, set by the local authorities (Based on the District Production Office [DPO] and District Veterinary Office [DVO]).

(vi) Call a meeting of the farmers in each village to explain the purpose, objectives, and advantages of the field performance recording (FPR); discuss the prices to be paid for the male calves (that is if there are calves that will be bought from them), and the cooperation expected from them.

(vii) Select an educated person (preferably high school/A-level) from each village to work as a milk recorder and or private bovine AI technician.

(viii) Appoint one supervisor for a set of 20 villages and community resource persons. Train the supervisors and the village resource persons in recording milk production growth, breeding (AI/NS) pregnancy diagnosis, and calving.

(ix) Register and ear tag (based on the LITS system), for all the cows whose average production is above the minimum standards. The cow or bull is to be selected based on the information provided by the farmer and on at least three consecutive milking.
All the cows and bulls should be tested for TB, JD, and brucellosis. If the cow has a calf at its feet, ear tag the calf and register it under the program.

(x) Always, start milk recording from the beginning of the lactation and not in the middle. The first recording shall be done within 15 days, best at 5 days post-calving. Each recording shall be done at one-month intervals till the animal dries off or crosses 305 days of lactation, whichever is less. Each day record morning and evening milk production.

(xi) At least 30% of the records of each data recorder should be checked by the supervisor by visiting and personally recording the production on the prescribed date, at any time without informing the farmer and recorder.

(xii) A copy of the dams' milk record format shall always be available with the farmer and shall be regularly filled and signed by the field data recorder to facilitate proper monitoring by the field supervisors.

(xiii) The milk recorder shall record the reasons if there is a large variation between two records.

(xiv) Check all the udder quarters are functional. Any loss of the quarter initially or during the recording shall be noted.

6.2.2 Some key assumptions

(i) NAGRC&DB shall include up to 50 villages under the recording in the breeding tract or milk pocket.

(ii) At least 20 cows will meet the minimum standards of recording in each selected village.

(iii) Each identified animal will be milk recorded once a month morning and evening for complete lactation.

(iv) All registered animals will be recorded in their subsequent lactation up to third lactation (based on Inter-bull recommendations).

(v) About 20% of the animals included in the recording will be replaced every year by new animals.

(vi) Each such project shall supply at least 100 bulls suitable for breeding.

6.2.3 Rearing of male calves

NAGRC&DB shall adopt the following SOPs for rearing male calves:

(i) Encourage farmers to rear male calves born to registered animals by offering them an attractive price.

(ii) Test all the male calves for TB, JD, and brucellosis.

(iii) Transfer disease-free male calves to calf rearing stations (National Genetic Evaluation Centre) and rear them scientifically up to breeding age (two years).

(iv) Growth of the male calves shall be checked regularly and examined for breeding soundness.

6.2.4 Recruiting of male calves

Bull calves between 4 to 6 months of age shall be recruited and reared till maturity at calf-rearing centres operated by the National Genetic Evaluation Centres.

6.2.5 Bull maintenance by the bull custodian centres or farms

The custodian shall adopt the following SOPs for maintaining bull for natural service

(i) Select a farmer/ bull stud technician as a custodian of the elite breeding bull to be supplied for natural service in case AI facilities are not available in the village.

(ii) Train the custodian and enter into an agreement with him for maintenance of the bull, service charges, rotation of the bull, etc.

(iii) Organize milk yield competitions, calf exhibitions, and open days to reward the farmers for maintaining high-yielding animals in their area. A minimum of two milk yield competitions and two calf exhibitions/shows will be organized by NAGRC&DB in one financial year.

(iv) The custodian shall be allowed to charge the other farmers for natural breeding services.

(v) The cost of the breeding services is to be decided by the Director NAGRC&DB based on feeding and maintenance costs. The cost decided will be reviewed annually.

6.2.6 Records of the National Genetic Evaluation Centre (NGEC)

The following records shall be maintained by NAGRC&DB

(i) NGEC shall maintain records of all the bulls identified and registered in a given region/ district or areas of operation using a unique identification number.

(ii) A record of the bulls regularly tested against TB, JD, and brucellosis as per protocols provided.

(iii) A record of the bull rotation in the areas of operation after every three years to avoid inbreeding. The record shall clearly state that the bulls have been tested properly against STDs.

(iv) A record of the dams identified under the program tested against TB, JD, and brucellosis as per protocol.

(v) A record of the male calves identified under the program tested against TB, JD, and brucellosis.

6.3 Registration of breeding cows, bulls and breeds/dairy genetics for genetic evaluation

- Currently, there is neither registration of breeding animals nor of breeder farms in Uganda, lack of the latter which leads to the absence of breed associations and societies as exists elsewhere. Data captured from unregistered animals and herds whereas useful for project-based analysis and use, its long-term benefit to broader genetic evaluation efforts is minimal.
- There are recent efforts to initiate processes of animal and breed registration, along with that of service providers in the assisted reproduction technology space. One such a system is the proposed LITS (Mugisha, 2023).
- All the proposed levels of registration will require government approval of such regulation, as part of the operationalization of the Animal Breeding Act, 2001.

Such registration should eventually, as part of the recommended outcomes of these breeding guidelines be ascertained from

(a) Evidence of payment of the prescribed fees to the Government of Uganda.

(b) Pedigree records of the bull of up to two generations back; for a start this will not be possible as there are almost no records on-farm, but eventually, data should build up.

(c) Blood typing laboratory results of the bull – the health status and DNA genotyping. Health status analyses could be done at the National Animal Disease Diagnostics and Epidemiology

Centre (NADDEC) under the Ministry of Agriculture; and/or at the Central Diagnostic Laboratory, Makerere University. The NAGRC&DB has an operational molecular laboratory that should handle the DNA genotyping and with staffing together with their capacity building should eventually achieve this. A robust ICT infrastructure that is needed for data handling and utilization should be set up as part of the NAGRC&DB. Performance data of the bull should be handled in accordance with the Animal Breeding Act (2001) and its provisions.

(d) Recent health reports from a Veterinary Officer for the animals.

The registration of all animals born into the national herd should ease the process of screening for diseases especially the hereditary conditions. When a robust digital platform is set up followed by a unique identification system covering the national herd, genomic information shall be very useful in enabling rapid assessments of the animals. As the backbone of an ICT-enhanced platform for data capture, storage and utilization is being set up, physical inspection of the animals on the farms may have to work at the moment. This requires that the seller farm location is declared and the fitness of the animals for breeding is determined by a team of inspectors that shall include a registered breed inspector, a professional animal breeder and a Veterinarian.

The tripartite animal inspection team shall assess:

(a) the type of records being captured on each farm and the mode of recording in use.
(b) the presence of hereditary effects and diseases (those of a physical nature);
(c) the nature and number of biological samples to be collected from the animals for further analyses.
(d) the parameters desirable for bull or cow certification.
(e) the state of the quarantine and isolation areas of the farm premises.

For the registration of cattle breeds/dairy genetics, the procedure required for those that were developed elsewhere and then introduced into Uganda, is similar for those breeds/dairy genetics that were recently developed in Uganda.

The breed registration form shall be filled and submitted along with:

(a) a description of the procedure and processes used to develop the breed (but with considered protection of the innovators intellectual property that is registered with the Uganda Registration Services Bureau (URSB).
(b) evidence of compliance with internationally acceptable breed development standards.
(c) evidence of payment of appropriate fees to the Government of Uganda.
(d) a breed evaluation report written by a team of **bio-informatician breed inspectors** nominated by MAAIF in consultation with NAGRC&DB, who shall among others determine: the genetic potential or goodness of the new breed to the national herd; the performance data of a sizable number of animals of the breed; community perceptions of the breed and its fitness for registration and addition to the list of accepted breeds/dairy genetics for Uganda.
(e) Thereafter, there should be the creation of the National Registry and National Stud Book for the new breed; followed by the issuance of a three-year renewable breed registration certificate.

6.4 Guidelines for bull selection (based on traits of economic importance)

I. Establish a national breeding program: to select adaptable high yielding seed stock, there must be a national breeding program with a national database to store data captured from farms, establish a harmonized standardized animal identification system, register animals, farms and farmers in the data base and a data capture system to collect real time data and associated geographic locations and run the analysis to estimate breeding value. In advanced breeding programs, animals with phenotype data are genotyped and the genomic information is used together with the phenotypic data to run genomic evaluation through which animals are ranked, and best top are selected to be used as AI bulls or bull dams. Selection of bulls shall be based on clear breeding goals aimed at increasing milk production, resilience, efficiency and improved overall productivity.

II. Dairy production is one of the most important components of livestock production in which bulls with high genetic potential play a critical role to gain maximum production in the next generation.

The evidence shows that the sire and the dam contribute equally to the inheritance of the offspring, the sire has many more offspring than the dam and therefore his influence on the herd is more than that of a cow. So, a superior bull can be responsible for the improvement of the herd.

But unfortunately, in Uganda, farmers do not pay any attention to bull-to-female ratio, housing, feeding, disease control and overall management of breeding bulls. Therefore, farmers should consider the following manage-mental point of view regarding bulls which are going to be used for natural breeding.

III. Selection of the dairy bull is by far the most important decision a dairy farmer must make.

IV. The main considerations in selecting dairy bulls are their ancestor history and the production records of the progenies of a cohort of bulls. The pedigree of the dairy bull is important as it contains information on production records of the sire and the dam. This information is valuable in selecting the bull for its efficiency. The pedigree should be complete with all vital information.

V. Dairy bulls are also selected based on superior performance differences compared to others. This is the most reliable method of selecting a bull for dairy purposes. With genomic tools, it should now be possible to compare the potential of several bulls using genomic information and then screen for superiority.

VI. A proven bull is the best insurance that a breeder can have, but there are several objections to the use of a proven bull. Proven bulls are more costly, it is scarce and frequently impossible to get it and takes a long time to make a proven bull and by that time he becomes old.

VII. When selecting a stock bull first consideration must be given to the female lines from which he has descended. After locating a bull that has descended from a long time of desirable female's attention should then be given to the individuality of the bull himself. There is little question that a bull of good type that has descended from the right kind of females is more likely to be a herd improver than another bull descending from an equally good line of females but himself being defective in conformation. The important aspects of dairy bull type are described here

VIII. A breeding bull should be a worker who is never 'off duty.' He should be able to walk long distances, see, smell, and have the urge and ability to detect females in heat.

The selection of bulls and cows presents an important opportunity to ensure that the profitability of the dairy industry. Bull selection is a key decision for both farmers and

semen-producing companies. The greatest opportunity for genetic change results from sire selection. Most farmers raise their own replacement heifers instead of introducing from outside. As a result, the contribution of female selection to genetic change is significantly reduced. The common practice of retaining most of the heifers at weaning ensures that further selection at breeding time is possible. Even in cases where the best half of the heifers are retained, some average heifers are still present in the selected group and for commercial herds, there would be limited information. Data on females such as heifers' dams and in-herd ratios do not reflect genetic differences as Expected Progeny Differences that are used for the selection of bulls. Use of AI enables the use of some of the genetically top-ranked bulls at a reasonable cost, enabling significant and progressive genetic gains at both individual herd and national levels, so long as such bulls are appropriately evaluated and ranked.

In addition, genetic change that results from selection decision is both incremental and permanent, and among the many breeding management decisions, genetic selection needs to be informed by current and predicted future production environment. Selecting for growth, milk yield or calving performance, once established in a herd, are automatically passed on to the next generation.

6.5 Performance data

These include adjusted performance data and performance ratios and contemporary groups. Most of the individual trait measurements are adjusted for age of the animals and of its dam. This allows for a fairer comparison of cattle. Examples of adjusted performance data include actual birth weight, weaning weight adjusted to 205 days of age, yearling measurements (including weight, hip-height, scrotal circumference) done at 365 days of age. The individual performance ratios rank bulls within their contemporary groups.

A contemporary group consists of bulls born in the same birth management group (same management system, calf age group and dam age group), managed together and performance data collected on the same dates. The average performance ratio of a contemporary group is 100. The difference between a ratio and 100 indicates the percent an animal is higher or lower than the average of the group for that trait measured. When reporting performance data for a contemporary group, it's important to include all animals in the group including the low performers. Many bulls should be included in the contemporary group for a more accurate indication of the cattle performance. A group of 30 bulls gives a better indication of the cattle performance.

6.5.1 Generation of Expected Breeding Values (EBVs and gEBVs) for candidate bulls

These are useful genetic selection tools available for a wide variety of beef and dairy cattle traits. These predict the expected performance for specific traits of calves sired by a particular bull or dam, compared to the expected performance of calves sired by another bull or dam, or group of bulls or dams. These values are based on the performance records of a reference population, its relatives, and its progeny. The values are used to compare animal within a breed (Parish et al., 2011).

6.5.2 Bull physical examination

Thorough physical examination should be conducted by a designated/accredited official/ veterinarian to ensure that the bulls do not display clinical symptom(s) of any infection or any contagious diseases and are structurally correct. Structural anomalies such as cyptorchidism, penile frenulum, and leg defects such as hocked-in or testicular shapes such as asymmetrical testis are unacceptable even when pedigrees are popular. Testicular sizes may vary with the age of the male yet, very narrow scrotal circumference is neither economical nor desirable. Breed associations (e.g. https://usacattlegenetics.com/breed-information/) may also fix certain minimums for weight, height, or other attributes for breeding males so that semen collection facilities can adhere to these parameters. Gait defects may be temporary or permanent and breeding soundness examination should help avoid undesirable males.

6.5.3 Breeding soundness examination (BS)/ selecting bulls for fertility

The objective of the BS exam is to identify infertile and sub fertile males and promote fertile bulls. There are many components to a bull breeding soundness examination that can be simplified as follows: -

6.5.3.1 Health status: This involves reviewing the health status of the herd of origin and reviewing the results of previous health records, collecting samples, and commissioning more laboratory tests, reviewing vaccination and other treatment history and reviewing previous breeding performance.

The diseases to be considered during examination include:

- Leptospirosis
- Clostridial diseases
- Vibriosis
- Trichomoniasis
- Brucellosis

6.5.3.2 Physical condition: This involves assessing the body size relative to age, body condition, conformation, and locomotion.

A more detailed examination may then be required particularly to assess:

- Eyes, teeth, legs and feet
- Prepuce should be examined for evidence of constriction or discharge.
- Penis should be palpated to ensure that it is freely moveable within the prepuce and that there is no evidence of any abnormal swellings or growths.
- Scrotal circumference should be measured and,
- Testicle palpation to ensure uniform size and consistency.
- Testis should be freely moveable within the scrotum.
- Other defects to look out for: Orchitis, Excessive fat around testes, Hernia, Cryptorchidism, Hypoplasia.
- Trans-scrotal ultrasonography and testicular fine needle aspiration cytology may also be used to diagnose sub-fertile males.
- An internal examination should be carried out to palpate the accessory reproductive apparatus and ensure normality.

6.6 Semen examination: Assessment shall be made on:

- Ejaculate volume (≥4-8mL),
- Density (200-2000 million cells per mL),
- Sperm motility (≥70%) and,
- Number of abnormal or damaged sperm (<20%).

6.7 Sexual behaviour assessment: Keenness to serve (libido) and ability to serve are important for any breeding male. It is particularly important during this part of the examination to watch carefully for any penile deviations which may prevent intromission (the penis entering the vagina) and for evidence of an ejaculatory thrust.

6.8 Genetic Evaluation

(a) Collect complete and accurate pedigrees, avoiding any human error as much as possible.

(b) Generate genomic data for each population and use these to validate and correct pedigree records. This approach is also helpful for situations where pedigree data is not available or difficult to collect.

(c) The task of collation and checking of performance and pedigree records may be assigned to a recording agency, which could be a company that charges a service fee per farmer or breed association (e.g. https://usacattlegenetics.com/breed-information/).

(d) Prediction of breeding values for bulls will be carried out at national level and this will provide genetic merit for all (or at least some) breeding animals in the country.

(e) The national competent authority (NAGRC&DB) will be responsible for the genetic evaluation and the data will be transferred from the recording agency to the evaluation centre. An example of a national dairy evaluation centre is the Canadian Dairy Network (https://www.cdn.ca/home.php). For Uganda, the Dairy Farmers Network (DAFAN) is taking shape and could take on this task in future.

(f) Evaluation shall be done separately for each breed, although with the advent of availability of performance information on crossbred animals, across-breed evaluations are becoming in vogue.

6.9 Procedures for bull evaluations at evaluation centres

6.9.1 The bull testing and evaluation centre

- The National Animal Genetic Evaluation and Testing Centre exists as part of the National Animal Genetic Resources Centre & Data Bank (NAGRC&DB) and is located in Entebbe.
- It consists of infrastructure that houses laboratories for both the Regional Gene Bank and the National Gene Bank.
- It has well-equipped hi-tech laboratories that have up-to-date testing equipment that are maintained and serviced periodically to ensure continued and proper functionality and well-trained competent and motivated personnel who run the specific activities that involve collecting, handling transporting, processing, evaluating, testing, and storage of both indigenous and imported animal genetics. It also has a well-constructed crush house used for restraining animals during the collection of germplasm embryos. It also has a

data management, security and biosecurity/ biosafety, and quality assurance system in place.

- The process of predicting breeding values of potential breeding bulls for a breeding program is referred to as genetic evaluation. NAGRC&DB operates 15 genetic resource centres spread across the country (Figure 4). At these centres, there has got to be rigorous evaluation of the different breeds/dairy genetics for the wide array of species reared in Uganda. These centres shall continue to be the main genetic evaluation centres for not only dairy cattle but beef cattle and other species and breeds/dairy genetics of interest using the proposed National breeding program guidelines.
- Performance data is a basic requirement for all genetic evaluation endeavours. This data shall be either directly measured for the respective traits of interest in a given selection program, or be correlated, or proxies, that is traits which can be used as a selection criterion.
- These data shall be recorded on the bulls and dams in the breeding program and their relatives, as well as appropriate details that shall later be used to build the most appropriate model for analysis.
- Performance records shall be accurate as possible since any inaccuracies in data will increase in phenotypic variation of the trait.
- Develop a proper database for the storage of this pedigree information and ensure their validation at the point of collection.

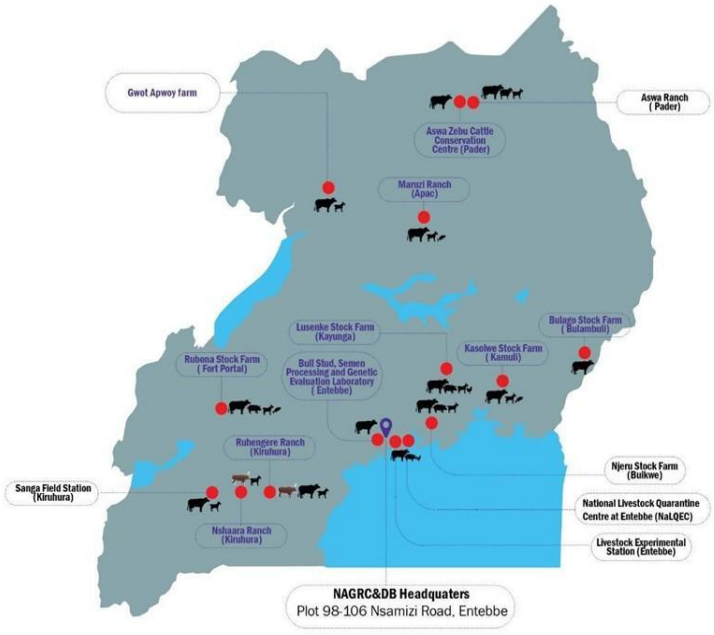


Figure 4: Animal Genetic Resources Centres – AnGRCs of NAGRC&DB

7.0 Bull dam selection and evaluation

7.1 Dairy cattle trait performance data for evaluation

Currently, NAGRC&DB in collaboration with the ILRI-ADGG program is recording information. This program should be mainstreamed to sustainably enable the collation, storage, and management of data and information generated.

Data collected for the database should include:

- Insemination dates,
- Pedigree information,
- Calving dates,
- Feeding information,
- Hoof health,
- Body injuries,
- Test-day milk yield (One day in a month),
- Pregnancy diagnosis,
- Parasitic infection management,
- Estrus synchronization,
- Vaccination dates,
- Birth weight
- Monthly weight for growing animals, mature cows and bulls

This data recording program is being piloted with 2800 farmers in 40 districts for 24,000 animals but needs to be upscaled to national level and mainstreamed into government processes. Additionally, the recording scheme should also capture other traits of importance including: Body frame (rump angle, hip-height, shoulder conformation, stature); dairy character (rib cage conformation, wither height, neck length, nature of the skin, thigh); Body capacity (barrel width, chest volume, Body Condition Scores), Feet and leg conformation (hoof angle, nature of the legs), scrotal circumference, udder traits (udder depth, teat placements, fore udder attachments), milk traits (milk yield, protein content, butter fat content, Solids not fat content), and Semen quality traits (volume, density, motility, abnormal and damaged sperm cells). Undesirable traits/ Genetic defects also must be monitored and selected against. Such traits include skeletal and tissue disorders, central nervous system abnormalities, skin tissue abnormalities, and gonadal abnormalities. Standard procedures for functional traits measurement is indicated in Annex 2.

7.2 Procedures for evaluations of bull dams (at evaluation centres, data collection and management)

7.2.1 Protocols for certification of bull dams - Progeny testing

Objectives of the progeny testing programme/ centre:

- To produce high genetic merit bulls for semen stations through progeny testing
- To achieve a steady genetic progress in the cattle population for milk, fat and protein yield and type traits.

7.2.2 Requirements for a progeny testing/ evaluation centre

- Should have an area having a sizeable breed-able female cattle population of the proposed breed in a compact area.
- Should have a big network of registered AI technicians, to carry out test AI in the area
- Have a dedicated team with necessary skills and competences to implement and supervise the project.

- There should be a bull stud and semen collection station for putting in place the required number of bulls under test and obtaining the required number of test doses and semen doses for long term storage from the bulls put under test.
- Qualified manpower to run and manage the project.
- Long Financial commitment/ funding.

7.2.3 Standard operating procedures (SOP), minimum standards (MS) and evaluation procedure for implementing a pedigree selection (PS) programme for cattle

The main objectives are:

a. Developing indigenous breeds in their native breeding tracts
b. Improving the genetic potential of indigenous breeds for milk production in their native tracts.
c. Producing genetically superior quality bulls for semen production stations of the country.
d. Ensuring active participation of the communities in breed development programmes.

A schematic representation of various activities that should be taken up in a pedigree selection programme is given in Figure 3 above.

7.2.4 Standard operating procedure, minimum standards and evaluation procedure

A. Standard operating procedure (SOP)

a) Bulls and semen used in AI programme

i. Semen produced from a semen station graded "A" or "B" by NAGRC&DB shall only be used.
ii. The very best bulls that meet the "Standards of Genetic Merit of Breeding Bulls" as specified in the Minimum Standards for Production of Bovine Frozen Semen prescribed by NAGRC&DB and MAAIF shall only be used for AI

b) When an animal is brought for the first time for insemination, it should be ear- tagged and registered as a dam under the programme and then inseminated. Subsequently, the animals will be examined for pregnancy after 90 days of AI and then followed for calving.

c) Guidelines for animal identification

All animals (calves, bull and bull dams) inseminated under the breeding programme either from Artificial Insemination, animals under milk recording and all daughters that are born under the AI or natural service programme and all male calves born out of nominated mating shall be identified by applying ear tags as per guidelines in Annex 1.

d) Registration of calves

Upon receiving the information about the birth of daughter or male calf born from nominated mating, the AI technician along with the concerned supervisor and the Milk recorder / local resource person shall visit the calf and physically verify the animal and the number of the dam and the insemination particulars of the dam for verifying the sire number as well as ear tag the calf within 45 days of birth.

e) Parentage verification

i. Records of all daughters or male calves born of nominated mating where the gestation period is found to be less than 265 days and greater than 290 days would be re-checked for correct parentage. In all doubtful cases, a blood sample would be taken from both mother and progeny (daughter/ son) and semen sample from the sire, for parentage confirmation using DNA markers.
ii. A blood sample of all male calves born out of nominated mating would be collected for parentage confirmation.
iii. Parentage verification database would be created to give feed back to the concerned AI technicians and supervisors.
iv. Calf rallies: Calf rallies shall be conducted in the area to create awareness about the programme and to provide platform to the farmers to exhibit their improved animals.

f) Milk recording

The key points to be considered for milk recording include:

i. The milk recording work should be assigned to exclusive milk recorders. In case an AI technician is covering only one village, he could be entrusted with the responsibility of milk recording.
ii. Area assigned to one milk recorder would depend on the number of animals under milk recording and the spread of animals. A milk recorder shall not do milk recording of more than 5 animals per day.
iii. First recording would be carried out on or after 5 days of calving and not later than 25 days of calving.
iv. Milk recording for an animal would be done once a month, morning and evening, and in the afternoon if three-time milking is practiced, preferably on a fixed day of the month (plus minus 5 days) at the place of milking.
v. A monthly milk recording schedule shall be prepared, detailing the animal to be recorded, the order of recording, the address of the farmer, the name of the village, and the date and time of recording.
vi. Milk recording would be carried out using a transparent calibrated plastic jar with a sensitivity of 100 cc or using an accurately calibrated weighing machine (Figure 5).
vii. On each day of milk recording a milk sample would be taken in a sample bottle (during morning recording), properly labelled, recorded, and sent to the laboratory for milk component analysis for fat.
viii. Every animal would be recorded both for milk volume and milk components monthly continuously for 11 times or until the animal becomes dry or is permanently lost from the system whichever is earlier.
ix. If the animal becomes dry, the dry date should be recorded invariably.
x. If weaning is not practiced by the farmer or if the farmer could not be motivated to practice weaning, at least on the day of milk recording the calf would not be allowed to suckle its mother. Milk collected from all four quarters would be measured and the farmer would be advised to feed the calf separately.
xi. Milk would not be recorded on the day when milk has dropped suddenly by 50% of the previous recording or when the animal is suffering from some form of illness. In such cases, the reason for the sudden drop would be recorded and the milk recording would be reattempted after at least five days.
xii. If the animal gives milk only one time, then only that would be recorded, and the other timing would be left blank.

xiii. The milk recorder shall also record the details of the recorded yield in a milk recording card that is kept with the animal owner.

xiv. Standard lactation yield of the milk-recorded animal should be calculated using the test interval method (A4) described in Section 2.1.5.1 of the International Agreement of Recording Practices published by the International Committee for Animal Recording (ICAR).

g) Procedures for supervision

The main points to be considered for putting in place an appropriate supervision system include:

i. One supervisor would exclusively be made responsible for supervising all the activities including milk recording. The number of supervisors would depend on the number of villages a supervisor can supervise in a month, the workload, and the distance between the villages.

ii. Each supervisor would every month check all the events happening in that month such as: 100% of daughters born and 100% of male calves reported born to nominated mating, randomly check at least 30% of milk recordings and pregnancy diagnosis results in his assigned villages. He would submit a tour diary every month.

iii. For checking the milk recordings, the supervisor would conduct a surprise check by visiting the site of milking, at the time of the scheduled milk recording and checking the procedure of recording, the records, and the functionality of the equipment used. Alternately, the supervisor would, on the day of a visit to a particular village, visit a randomly selected animal, which is currently under-recording, at the time of milking measure the quantity of milk produced, and record the data. This would be used to compare with the preceding milk recording data of the same animal.

iv. In addition to supervisors, project activities would also be supervised and monitored by the district coordinator, and project coordinator through regular and surprise field visits, bimonthly review meetings, AI technicians review meetings etc.

h) Nominated mating

i. It should be ensured that only semen from top high genetic merit bulls of the respective breed shall be used for nominated mating of the top females declared elite under the project to produce superior male calves.

ii. It shall be ensured that the standard lactation milk yield that has been arrived at of elite females, based on a milk recording for a complete lactation, is more than the yield specified in the "standards of genetic merit of breeding bulls" in the minimum standards for production of bovine frozen semen prescribed by NAGRC&DB and MAAIF.

iii. Semen from bulls whose dams milk yield is more than the yield specified in the "standards of genetic merit of breeding bulls" in the minimum standards for production of frozen semen prescribed by NAGRC should be used for nominated mating.

i) Male calf procurement

The points to be kept in mind in the procurement of male calves include:

i. The male calves produced out of nominated mating would be procured by the project at the earliest possible to avoid loss of this superior germplasm

ii. A price decided by the organization shall be paid to the owner for a healthy male calf.

iii. It shall be ensured that all the procured bull calves have a confirmed parentage that has been confirmed using DNA markers and it would be ensured that the bull calves are free from any physical and congenital abnormalities.
iv. It should also be ensured that the bull calves and their mothers are free from TB, JD, and brucellosis. TB and JD are to be tested by Single Intradermal Test (SIT) and brucellosis by ELISA.
v. Bull calves sufficient to meet the requirement of semen stations shall only be procured and reared. Bulls for natural service shall be reared only if there is a firm demand from any of the agencies implementing such programs.

j) Rearing of male calves

Procured male calves would be tested for TB, JD, and brucellosis regularly till their disposal/ sale.

k) Information system

All data such as Animal registration details, AI details, results of pregnancy diagnosis, calving details, milk recording, milk component testing, animal re-registration details, Animal movement details, animal ear tag change/ renumbering details, etc shall be captured through the National Livestock Database Application.

l) Extension programmes

The project shall develop appropriate extension materials related to the breed improvement, breeding, AI awareness, improved animal husbandry practices, calf rearing, milk recording to produce bull calves, etc., and conducting periodical extension programs in the villages. The project/ NAGRC&DB/ NGEC shall organize regular infertility camps to address the infertility problems of the cows in the project areas.

m) Wherever possible, the project shall coordinate with other agencies that are involved in animal productivity enhancement programs in the project area.

n) Farmers' interest groups/village committees

i. The project may organize village committees or farmers‟ interest groups/breed societies/ associations in each of the project areas. The Project Management Committee shall determine the composition and functioning of these committees. It should be ensured that the group meets periodically, and the minutes of the meeting are recorded.
ii. The area project groups (farmers/ breed societies/ associations) shall render all possible assistance for the entire range of activities planned at the village level. The groups also shall aid in monitoring the progress of the programs in their respective village along with the project staff and offer suggestions and help for program improvement.

o) Animal health protocols for personnel in project areas

i. All personnel working in close contact with the animals namely: AI technicians, milk recorders & supervisors have an important role to play as primary reporters of any adverse health event(s) occurring in their area of operation.

ii. Disease reporting:

The milk recorder or the AI technician who observes any abnormal health event like high mortality, high rate of abortions/ retention of placenta, mastitis, symptoms of diseases like

FMD etc. in his/her area of operation would report the same to an identified/ government appointed Animal Health Officer of the area through his superior.

iii. Biosecurity protocols for personnel: All AI technicians would need to follow certain hygienic practices that would minimize the spread of infection. The SOPs for the same would be developed.

B. Minimum standards to be achieved

The program shall ensure that the following minimum standards are achieved:

i. It would be ensured that semen from at least 5 bulls of high genetic merit bulls shall be used in the AI program annually.
ii. Semen produced from a semen station graded "A" or "B" by MAAIF/ NAGRC/ NGEC shall only be used.
iii. AI bulls should be changed/rotated among the multiplier villages at least once every 3 years to keep inbreeding under control.
iv. All data related to the pedigree selection program shall be captured through the Information Network for Animal Productivity and Health (INAPH) application.
v. At least 80% of the calves that are tested for DNA-based parentage tests shall have the correct parentage as recorded.
vi. Bulls whose dam's milk yield is more than the yield specified in the "standards of genetic merit of breeding bulls" in the minimum standards for production of bovine frozen semen prescribed by NAGRC/ NGEC shall only be used for AI.
vii. Cows selected for nominated mating shall have milk yield recorded for a complete lactation and have milk yield more than the yield specified in the "Standards of Genetic Merit of Breeding bulls" in the minimum standards for production of bovine frozen semen prescribed by NAGRC&DB.
viii. All bull calves selected through nominated mating shall have confirmed parentage through DNA testing.
ix. Both bull calves that are procured and their dams shall be free from TB, JD, Brucellosis, and any physical deformities.
x. Achieve 80 % of all physical targets and qualify in annual evaluation by an independent expert panel appointed by NAGRC&DB.

Standard operating procedures (SOP), minimum standards (MS) and evaluation procedure for implementing a progeny testing (PT) program for cattle

One of the key factors affecting productivity is the genetic ability of an animal for milk production, which is an inherited character, while others provide an enabling environment. The breeding bull contributes significantly in enhancing the genetic potential of its progenies for economically important traits like milk production, fat and protein production, fertility, body conformation etc. Therefore, building an infrastructure for the evaluation and production of breeding bulls with high genetic potential for milk production and other important traits and an infrastructure to transmit their genetic potential to maximum number of progenies is very important in any animal breeding programme.

Progeny Testing is a method for accurately evaluating and selecting top bulls and using them to produce future bulls. This document describes the standard operating procedures (sop) and minimum standards for implementing a progeny testing programme both for cattle in the field for evaluation and selection of high-quality bulls and for production of young bulls by inseminating best performing elite females using semen of top ranked progeny tested bulls.

The main objectives of the progeny testing programme are:

- To produce the required high genetic merit bulls for semen stations through progeny testing.
- To achieve a steady genetic progress in the cattle population for milk, fat and protein yield and type characters in the villages where the progeny testing programme is implemented.

A schematic representation of various activities that should be taken up under a progeny testing programme is given in Figure 1.

Standard operating procedures (SOP), minimum standards and evaluation procedure

A. Standard operating procedures (SOP)

Test bulls

The best bulls that meet the "standards of genetic merit of breeding bulls" as specified by NAGRC&DB and MAAIF should be put under test. Preference should be given to young bulls, less than 4 years in cattle. A test bull should be inducted for test mating preferably after producing a minimum of 5000 doses – 2000 for test mating and 3000 for long-term storage. The test doses should be produced at a semen station graded 'A" or 'B" MAAIF. The number of bulls put under test shall be raised from a minimum of 20 to start with and increased to a minimum of 40 within five years.

If a sufficient number of test bulls are not available with the semen station, semen doses (minimum 2000 doses for test AIs and 3000 doses for long-term storage) from quality bulls meeting "standards of genetic merit of breeding bulls" as specified in the "minimum standards for production of bovine frozen semen" prescribed by NAGRC&DB and MAAIF, shall be procured from other grade "A" or "B" semen stations.

Animal identification

All female animals that are inseminated with test doses, all daughters that are born under the project and all male calves that are born out of nominated mating shall be identified by applying ear tags following the prescribed guidelines in **Annex 1.**

Test inseminations

Minimum 2000 doses of each test bull shall be distributed amongst the project villages spread over a test insemination period to carry out at least 2000 test inseminations.
Test insemination period for a bull should be between 12-18 months. If different PT programmes for a breed in different locations are sharing their bulls, test doses and long-term storage doses of each bull should be equally shared (a minimum of 200 doses per bull) among all the programmes so that daughters of each bull are produced in all the locations

The AI Service Provider shall arrange for regular supply of test doses and LN and other consumables to all their AI technicians.

A bull wise, centre wise and month-wise semen distribution schedule for all the AI centres covered under the programme shall be prepared and the timely procurement of test doses from semen stations and their timely distribution to all AI centres as per the distribution schedule shall be ensured by the AI service provider.

The AI technician would inseminate animals with the test doses supplied to him for that month. When an animal is inseminated for the first time, the animal would be ear-tagged and registered as a dam under the programme and then inseminated. Subsequently, the animals will be examined for pregnancy after 90 days of AI and then followed for calving.

Daughters' registration

Upon receiving the information about the birth of daughter, the AI technician along with the concerned supervisor and the Milk recorder should visit the animal and physically verify the animal and the ear tag number of the dam within 45 days of birth. He should also verify the insemination particulars of the dam for verifying the sire number. The daughter then shall be ear-tagged. Once the daughter is identified, AI technician shall also record the body measurements to estimate initial body weight.

Parentage verification

Records of all daughters or male calves born of nominated mating, where the gestation period is found to be less than 265 days and greater than 290 days, should be re-checked for the correct parentage. In all doubtful cases, a blood sample should be taken from both mother and progeny (daughter/ son) and semen sample from the sire, for parentage confirmation using DNA markers. A blood sample of randomly selected 10% of the daughters born under each AI centre and all male calves born out of nominated mating should be collected for parentage confirmation. A parentage verification database should be created to give feed back to the concerned AI technicians and supervisors.

Follow up of daughters

All daughters born under the programme shall be followed up after birth for growth, AI, pregnancy, calving, and lactation. The milk recorder shall visit all daughters of test bulls at an interval of at least 6 months. A monthly schedule for such visits shall be prepared. During such visits the milk recorder should check for the loss of ear tags, take body measurements and de-worm the daughters. Follow-up of daughter for growth shall be carried out at least at 6 monthly intervals, de-worming every six months, and vaccination of all female calves between 4-8 months of age in the project villages for brucellosis. The follow-up of the daughters shall continue till the daughter calves, dies or is sold, whichever is earlier. In case of loss of ear tags, the milk recorder should apply a new ear tag, record the particulars of new tag and report immediately. It is also proposed to conduct calf rallies in the project area.

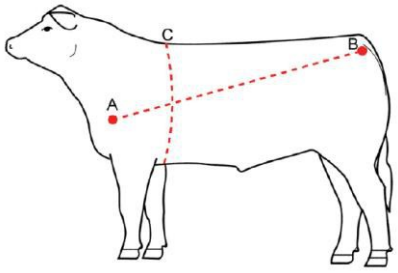
Recording for body measurements of daughters

The first body measurements of heart girth and length of female calves born should be taken within 45 days of birth at the time of registration and shall be repeated at least at 6 monthly intervals. The first measurement should be taken up by the AI technician and the subsequent measurements by the milk recorder.

Body weight calculated based on heart girth and body length using the prescribed formula shall be compared with the standard body weight at that age to find out whether a calf is growing satisfactorily and accordingly feedback should be given to the farmer. Body length of calf means measurement in inches between point of shoulder and pin bone. Heart girth means circumference of thorax at the point of elbow. Body weight is calculated using the following formula:

Body weight (kgs) = (hearth girth (inches))^2 * body length (inches)/660

Figure A: Measurement of body dimensions



Milk recording

The key points to be considered for milk recording include:

a) The milk recording work should be assigned to exclusive milk recorders. In case an AI technician is covering only one village, he could be entrusted with the responsibility of milk recording.

b) An area assigned to one milk recorder would depend on the number of animals under milk recording and the spread of animals. A milk recorder shall not do milk recording of more than 5 animals per day.

c) First recording should be carried out on or after 5 days of calving and not later than 25 days of calving.

d) Milk recording for an animal should be done once a month, morning and evening and also in the afternoon if three-time milking is practiced, preferably on a fixed day of the month (plus or minus 5 days) at the place of milking.

e) A monthly milk recording schedule shall be prepared, detailing the animal to be recorded, order of recording, address of the farmer, name of the village, date and time of recording.

f) Milk recording should be carried out using a transparent calibrated plastic jar with a sensitivity of 100 cc or using an accurate calibrated weighing machine

g) On each day of milk recording a milk sample should be taken in a sample bottle (during morning recording), properly labelled, recorded and sent to a laboratory for milk component analysis for fat, protein, lactose etc.

h) Every animal should be recorded both for milk volume and milk components monthly continuously for 11 times or until the animal becomes dry or is permanently lost from the system whichever is earlier.

i) If the animal becomes dry, the dry date should be recorded invariably.

j) If weaning is not practiced by the farmer or if the farmer could not be motivated to practice weaning, at least on the day of milk recording, the calf should not be allowed to suckle its mother. Milk collected from all four quarters should be measured and the farmer should be advised to feed the calf separately.

k) Milk yield should not be recorded on the day when it has dropped by 50% of the previous recording or when the animal is suffering from some form of illness. In such cases the reason for drop should be recorded and the milk recording should be reattempted after a period of at least five days.

l) If the animal gives milk only one time, then only that should be recorded and the other timing should be left blank.

m) The milk recorder shall also record the details of the recorded yield in a milk recording card that is kept with the animal owner.

Body typing of daughters

All the daughters born to the test bulls and that are entering the milk recording phase should be subject to body typing. This should be done by the supervisors who are trained in body typing of animals. The trained supervisors should type and score the daughters during the peak phase of first lactation. The type traits that may be measured are stature, chest width, body depth, angularity, rump angle, rump width, rear legs set, rear legs rear view, foot angle, fore udder attachment, rear udder height, central ligament, udder depth, teat placement rear view, teat length, and rear udder attachment. A methodology for body conformation trait measurement for our breeds and breed combinations is being standardized.

8.0 Certification of germplasm

8.1 Protocols for bull certification / steps in certification of breeding seedstock

- Identification of potential farmers/ farms/breeder farmers and organizations to be involved in the progeny testing exercise.
- Training of data recording technicians at every participating farm. This data can be electronically uploaded to a central data processing system daily.
- Recruitment of potential animals to be used in the exercise and assigning the animals unique identification codes.
- Data collection from farms/ seedstock and live animals included in the evaluation exercise. The data can include production data like milk, milk fat, and milk protein but also the physical characteristics like birth weights, weaning weights, and height at withers among others as guided by the National Technical Breeding Committee.
- Processing and analysis of data from the various recording stations/ farms. The frequency of the analysis can be monthly or every two (2) months. This data is to be reviewed by the National Technical Breeding Committee. The technical committee will agree on the databases and analyses to be carried out under the auspices of NAGRC&DB.
- There will be a continuous feedback mechanism to the farmers to know how their individual animals are progressing in relation to the animals in the exercise. This helps them keep involved in the system also from the feedback selection and culling decisions can be more judicious. Monthly lactation summary reports ranking farmers for average production of their cows and periodic rewarding of those who excel should help farmers pay attention to recording and improving their management. Culling decisions may· also be helped by the experts.
- Selection and raising of bull calves born to the elite cows may be monitored carefully based on the breed characters and physical conditions of the calf.
- Selection of candidate bulls can be made from bulls that mature to breeding age. From these their data and semen can be collected and preserved for later use in the registered herds. Selection may be made from among the calves brought to the evaluation centres on basis of breed characteristics, libido and semen quality.
- Genetic evaluation of the candidate bulls is carried out for milk yield and other traits of importance and estimated breeding values obtained. Genetic evaluation software can be used in the genetic evaluation and minimum criteria set for the bulls to be used in the next breeding/ improvement cycles. Bulls selected at this stage should be bred to elite cows.
- Bulls/ semen with negative or below a set minimum breeding values for traits like milk yield should be dropped/ culled and their semen discarded.
- The topmost bulls with the highest breeding values need to be mated with the elite cows to get bull calves again which go through another round of evaluation
- The national technical breeding committee will then forward the selected animals to NAGRC to be awarded a breed certificate.

9.0 Establishing community-based breeding schemes for cattle

9.1 Protocol for breeding value estimation and nominated mating

a. Breeding value of bulls and milk recorded cows should be estimated using all recorded data obtained through NGEC. Procedures for estimation of breeding values will be decided by an independent six members expert team constituted by NAGRC&DB representing GoU, ICAR, SIAs/SLBs, Cooperatives, breed societies, NGOs and universities.
b. Actual computation of breeding values shall be done using NDDB‟s computing facilities every four months using all recorded data obtained through INAPH. Breeding values would be published by the above-mentioned Independent Expert Team.
c. If more than one PT programme is being implemented for a breed in different locations, it shall be ensured that some minimum number of daughters of each bull is produced under each of those programmes. In this case, test doses and long term
b. storage doses of each bull shall be shared among all the programmes so that daughters of each bull are produced in all the locations. Not more than Top 10% of the bulls within each breed (minimum five different bulls every year) should be used for nominated mating to produce young bulls to be put under test in next cycle for all the PT programmes meant for that breed.
c. It should be ensured that only the semen from not more than top 10% (minimum five different bulls every year) of proven bulls should be used for nominated mating.
d. During the initial few years of the projects, when proven bulls from the project are not available, semen of proven bulls available with other agencies or imported semen of progeny tested bulls could be used. If semen of proven bulls is not at all available, then bulls whose dam's milk yield is 20% more than the yield specified in the "Standards of Genetic Merit of Breeding bulls" in the "Minimum Standards for Production of Bovine Frozen Semen" prescribed by NAGRC&DB AND MAAIF should be used for nominated mating.
e. Top 10% females declared elite based on breeding values shall be used for nominated mating. In absence of BV, females qualifying "Standards of Genetic Merit of Breeding bulls" as specified in the Minimum Standards for Production of Bovine Frozen Semen prescribed by NAGRC&DB AND MAAIF shall be selected for nominated mating, to produce superior male calves.
f. The elite cow/buffalo list shall be generated, updated and circulated every four months.

9.2 Male calf procurement

The points to be kept in mind in procurement of male calves include:
a. The male calves produced out of nominated mating should be procured at the earliest possible to avoid loss of this superior germplasm
b. A price decided by the organization should be paid to the owner for a healthy male calf.
c. It should be ensured that all the procured bull calves have a confirmed parentage that has been confirmed using DNA markers and it should be ensured that the bull calves conform to the breed characteristics and are free from any physical and congenital abnormalities.
d. It should also be ensured that the bull calves and their mothers are free from TB, JD and brucellosis. TB and JD to be tested by Single Intradermal Test (SIT) and brucellosis by ELISA.

Rearing of male calves

The following points to be considered while rearing of male calves

a. The calves produced in the community breeding scheme should be procured and quarantined at a quarantine station.

b. All male calves procured before the age of 3 months should be brought to a pre-quarantine station and kept there at least up to their attainment of 3 months of age. The male calves should be tested for diseases and only the ones tested free for TB, JD and brucellosis should be transferred to the quarantine station.

c. Male calves procured after the age of 3 months should be brought to the quarantine station. It shall also be ensured that the bull calves have a confirmed parentage that has been confirmed using DNA markers and the calves and their mothers are free from TB, JD and brucellosis. TB and JD to be tested by Single Intradermal Test (SIT) and brucellosis by ELISA.

d. Male calves would be tested for TB, JD and brucellosis during quarantine and only after successful completion of quarantine, the calves could be either distributed to various semen stations or reared in a separate calf rearing station and then distributed to various semen stations.

Information system

All data related to progeny testing programme such as animal registration details, AI details, results of pregnancy diagnosis, calving details, milk recording, milk component testing, animal re-registration details, animal movement details, animal ear tag change/renumbering details etc shall be captured through INAPH (Information Network for Animal Productivity and Health Application.

B. Minimum standards to be achieved

The project shall ensure that the following minimum standards are achieved:

a. It would be ensured that annually minimum 20 bulls would be put to test for each breed/ genetic group. However, efforts would be made to put as many bulls as possible under test. This number would be raised to at least 40 over a period of five (5) years.

b. All the Test bulls should meet the "Standards of Genetic Merit of Breeding bulls" as specified in the "Minimum Standards for Production of Bovine Frozen Semen" prescribed by NAGRC&DB and MAAIF.

c. The test doses should have been produced only at a Semen Station graded "A" or "B' by the Central Monitoring Unit (CMU), NAGRC&DB and MAAIF.

d. All data related to progeny testing programme shall be captured through the National Livestock Database application.

e. All efforts would be made to get complete first lactation records of about 70 daughters per bull spread over a minimum of 5 villages; however, breeding values of bulls put to test will not be published unless complete first lactation records of minimum 30 daughters per bull spread over a minimum of 5 villages are available.

f. If more than one PT programme is being implemented for a breed in different locations, it shall be ensured that complete first lactation records of about 70 daughters per bull is produced together by all these programmes.

g. At least 80% of the daughters that are tested for parentage using DNA markers shall have correct parentage as recorded.

h. For the proven bulls that are used for the nominated mating programme for production of bulls, the reliability of their breeding values shall not be less than 75%.

i. It would be ensured that only the semen from not more than top 10% (minimum five) of proven bulls would be used for nominated mating. However, during the initial few years of the projects, during which proven bulls from the project are not available, semen of proven bulls available with other agencies or imported semen of progeny tested bulls could be used. If semen of proven bulls is not at all available, then bulls whose dam's milk yield is more than 20% of the yield specified in the "Standards of Genetic Merit of Breeding bulls" in the Minimum Standards for Production of Bovine Frozen Semen, prescribed by NAGRC&DB and MAAIF should be used for nominated mating.

j. It would be ensured that not more than Top 10% females declared elite based on breeding values and conforming to breed characters shall be used for nominated mating. In absence of BV, females qualifying "Standards of Genetic Merit of Breeding bulls" as specified in the "Minimum Standards for Production of Bovine Frozen Semen" prescribed by NAGRC&DB AND MAAIF shall be selected for nominated mating, to produce superior male calves.

k. All bull calves selected through nominated mating shall have confirmed parentage through DNA testing.

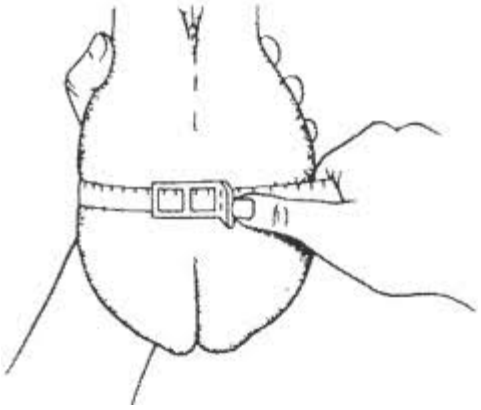
l. Both bull calves that are procured and their dams shall be free from TB, JD, brucellosis, and any physical deformities.

SCROTAL CONFORMATIONS

How to measure scrotal circumference in bulls

- Safely restrain the bull in a squeeze chute/ crush and place a bar securely behind the bull so that he can't back up in the chute Position yourself in a safe location and then slap his belly and quickly remove your hand.
- With the help an assistant grasps the bull's tail approximately 8 to 10 inches from the tail head and push the tail straight up.
- Access the bulls' testicles from behind or the sides (whichever is safe and convenient).
- For you to accurately measure scrotal circumference, push the testicles gently all the way into the bottom of the scrotum.
- Hold the testicles in this position by placing your thumb and fingers on both sides of the scrotum above the testicles. Do not place fingers between the testicles as this will inadvertently result in a larger and inaccurate scrotal circumference measurement.
- Slip the loop formed by the scrotal circumference tape over the scrotum around the widest point.
- Pull tape snugly until there is a slight indent in the skin tape that or until adequate pressure is indicated by the scrotal tape itself.
- Take the circumference reading (in centimetres) at the index formed by the small stainless-steel crossbar on the scrotal circumference tape thumb piece.
- Repeat measurement procedure to confirm results.

NB: (This exercise should be done by at least three people for safety, speed and convenience)



Source:
https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://breedplan.une.edu.au/media/iy1ept5c/recording-scrotal-circumference-measurements.pdf&ved=2ahUKEwjY5fGIhtGIAxXn87sIHd1OHgwQh-wKegQIPxAC&usg=AOvVaw2AifoXzVS5kBwdvhdX1aaX.

Minimum recommended scrotal circumference

Age	Circumference (CM)	
Younger than 15 months	30 cm	
15-18 months	31 cm	
18-21 months	32 cm	
21-24 months	33 cm	
Older than 24 months	34 cm	

Sourced from: The bull breeding soundness evaluation form, Society of Theriogenology

Annexes

Annex 1. Guidelines for animal identification

I. All animals (calves, bull and bull dams) inseminated under the breeding programme either from artificial insemination, animals under milk recording and all daughters that are born under the AI or natural service programme and all male calves born out of nominated mating shall be identified by applying ear tags.

ii. Only polyurethane laser printed ear tags having a unique 12-digit number and a bar code shall be used. The national numbering system shall be used.

iii. No two animals shall be tagged with the same number. Only numbers supplied by an agency identified by NAGRC&DB and MAAIF shall be used for unique identification of animals.

iv. The specifications for the ear tag shall be: The male tag preferably as a button shall be with a minimum diameter of 27 mm with a metal point and the flag shaped female tag with a closed head shall be with a minimum size of 55 x 65 mm. Twelve (12) digits to be printed in two rows of six digits each; second/lower six digits should be relatively much larger than first/upper six digit.

v. The ear tag should be applied inside the ear of animals, in the centre of the ear lobe with the female part of the tag, inside the ear.

vi. If the ear tag falls off, a new ear tag shall be applied within 10 days and the information shall be immediately updated in the national registry.

vii. Calves shall be tagged within 60 days from births but not earlier than 30 days from birth. Their information should be uploaded into the national database immediately after tagging.

Annex 2. A guide for functional traits measurements

1 Stature

Reference points: Measured from top of the spine in between hips to the ground. Stature is clearly a trait with an intermediate optimum. Very small cows have a lower lifetime production due to lower production per lactation. On the other side of the scale tall cows have a much lower survivability - possibly because of health issues related to their size. Select for average size 4-6 range.

2 Heart girth

Reference area: Circumference of thorax at the point of elbow. Select for average chest width 4-6.

3 Body length

Reference points: Measured between point of shoulder and pin bone.

4 Body depth

Reference points: To be measured as distance between top of spine and bottom of barrel at last rib independent of stature. This would be full body girth at the deepest point of barrel i.e. at last rib (Figure 5 & 6).

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Figure 5. Measuring the body depth in bull dams.

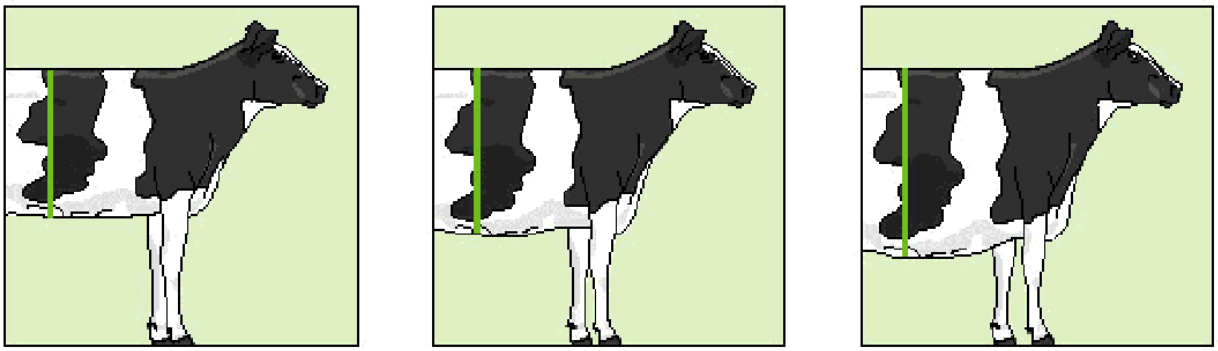

Figure6. Evaluation scale for body depth (ICAR 2023)

6 Angularity

Reference points: The angle formed by two imaginary lines – one perpendicular to the floor and the other through the last rib, select from 5 and above (Figure 7).

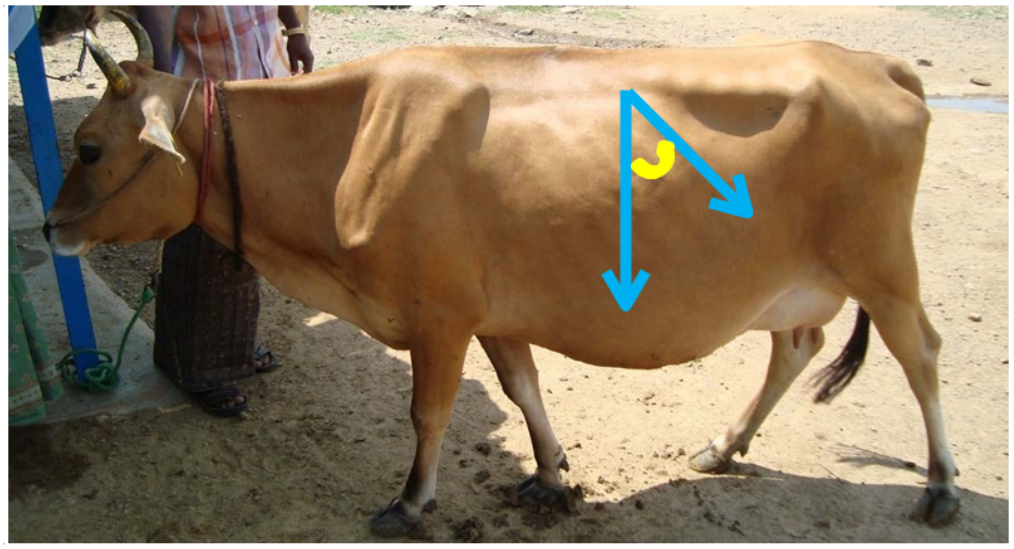
Figure 7. Determining angularity in bull dams.

7 Rump angle

Reference points: Measured as angle of the rump from hips to pins.
Two straight imaginary lines (yellow lines) may be assumed each from point of hip and uppermost point of pin (blue dots), and distance between them could be considered (red line). If pin bone is below hip bone, measure is positive; if vice versa, it is negative (Figure 8 &9).

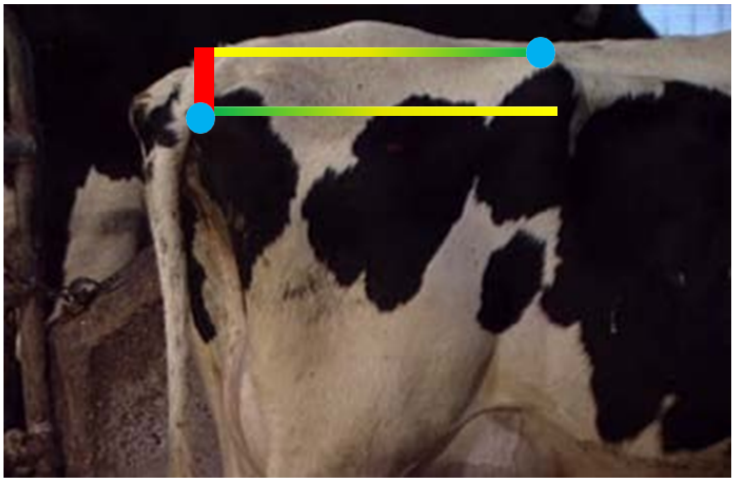

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Figure 8. Measuring the rump angle in bull dams.

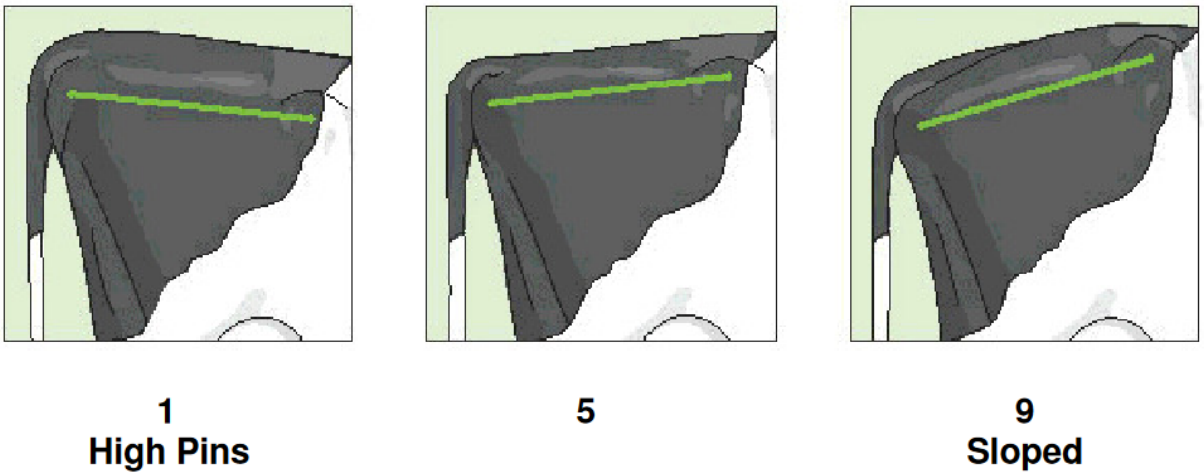


Figure 9. Evaluation scores for rump angle (ICAR 2023).

8 Rump width

The distance between the most posterior point of pin bones (distance between pin bones). Select for average 4 to 6 (Figure 10).

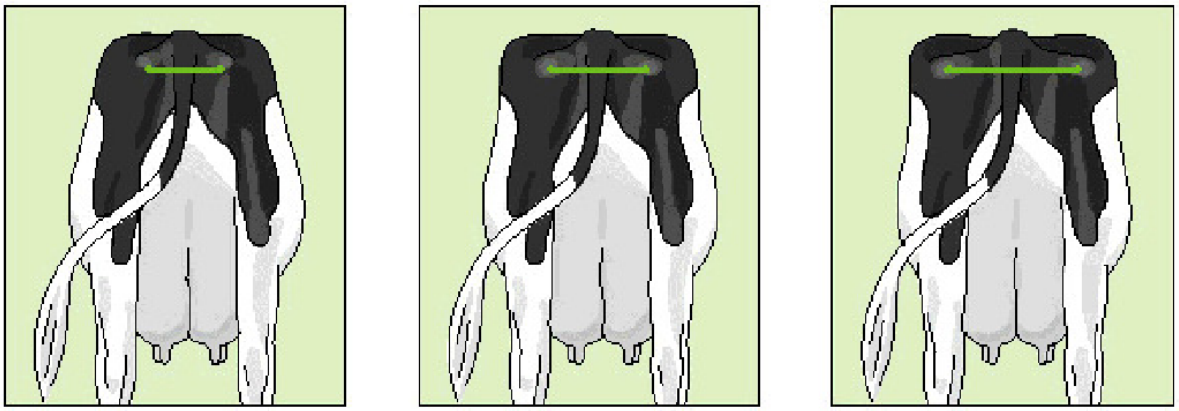


Figure 10. Evaluating the different rump width for bull dams (ICAR 2023)

12 Rear legs rear view (prefer straight legs)
Reference points: Direction of the rear feet when viewed from the rear. Hocked in animals are prone to claw disorders. Select for average and above. Look out for more straight legs

13 Rear legs set
Reference points: Angle measured at the front of the hock. An easy way would be subjective evaluation by assuming an imaginary line passing foot through hock. Avoid extreme straight and sickle legs, select for average 4-6.

14 Foot angle
Cows with low foot angle are much more susceptible to claw disorders than those with steeper foot angle. Steep foot angle is only a problem when it is extreme, survival and lifetime production are lower as well for cows with low foot angle. Foot angle is highly correlated with hoof height. Above average hoof height (more angle) will allow the weight of the cow to be more evenly distributed on the hoof and can lead to less claw disorders. Cows with higher hoofs are more stable in different conditions (slatted floor, pasture). The thickness of the heel prevents some injuries.

15 Fore udder attachment
Reference points: The strength of attachment of the fore udder to the abdominal wall. Extreme loose Fore udder attachment is associated with increase in somatic cell count Select for scores 5 and above (Figure 11 &12).

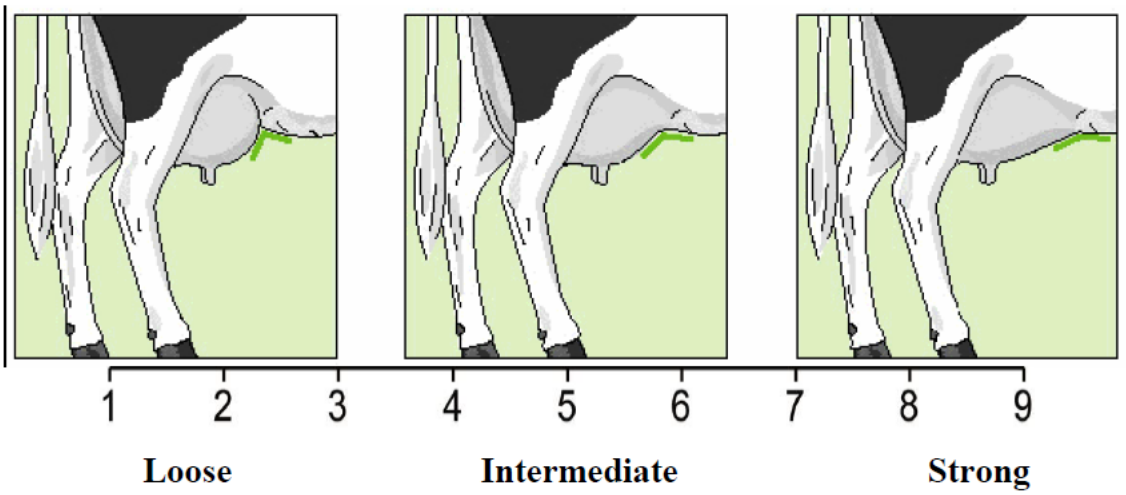


Figure 11. Ranking scales for fore udder attachment in cows (ICAR 2023).

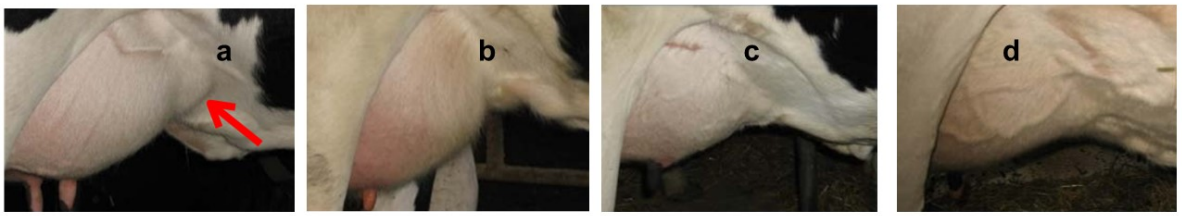


Figure 12. Point of fore udder attachment to the body wall (a), Weak attachment (b), intermediate attachment (C), Strong attachment (d) (Dairy & Board, 2019).

16 Front teat placements

Reference points: The position of the front teat from centre of quarter as viewed from the rear. Select for average scores (4 to 6). Avoid extreme cases that hinder milkability and are associated with higher cell count and lower survival (Figure 13).

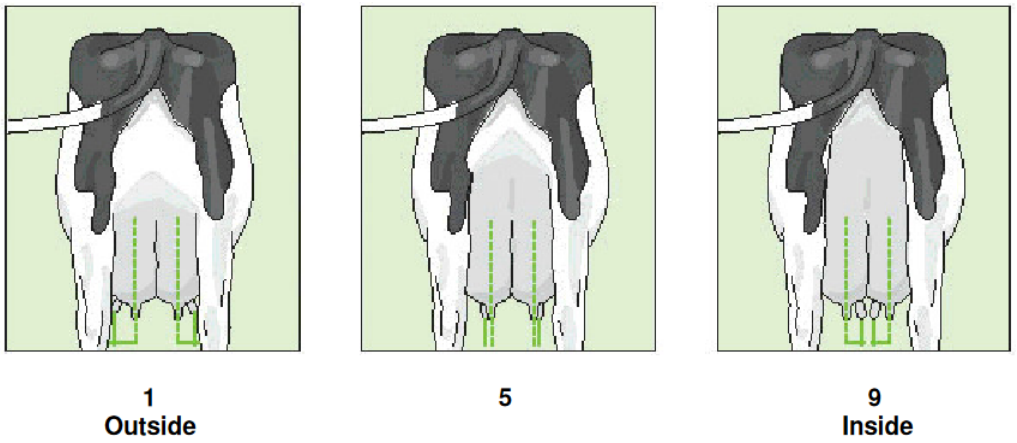


Figure 13. Evaluating the front teat placements (ICAR 2023).

17 Teat length

Reference points: The length of the left front teat for cattle. Short and long teats are associated with shorter productive life associated with being more prone to injuries and infections. Select for average scores 4 to 6 (Figure 14).

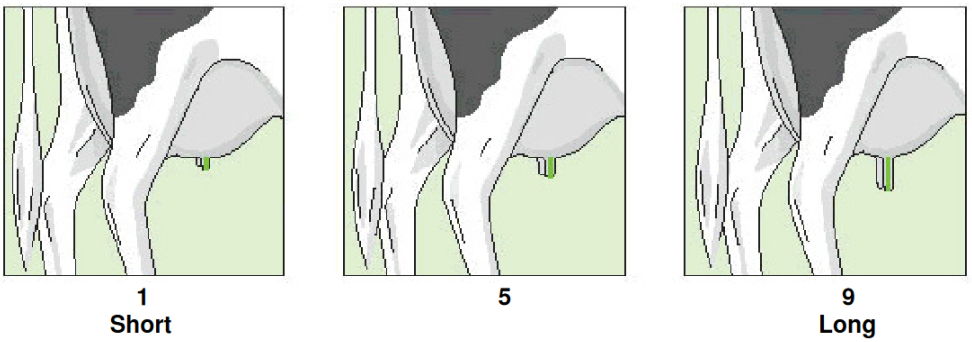


Figure 14. Evaluation of the teat length for bull dams (ICAR 2023).

18 Udder depth (as viewed from the sides)

The distance from the lowest part of the udder floor to an imaginary line through the hock. A lower udder floor (deep udder) is associated with to a poor survival and lifetime production while high floor (shallow udder) live longer but have lower lifetime production (poor producers). Select for average score 5 to 6 (Figure 15).

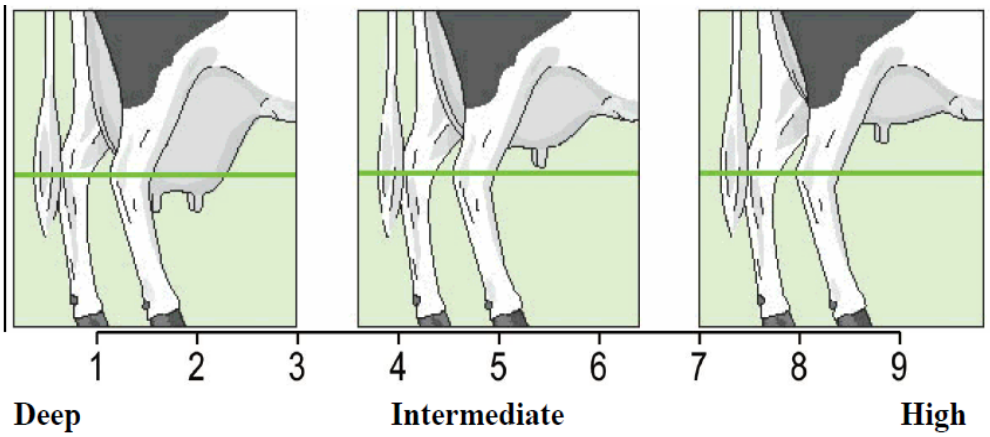


Figure 15: Ranking the udder depth of the cows (ICAR, 2023)

19 Rear udder height

The distance between the bottom of the vulva and rear point of attachment of mammary gland. There is a positive relationship between lifetime production and rear udder height. Higher rear udder makes it possible to have larger udders without lowering udder depth. Select for scores 5 and above (Figure 16 & 17).

.

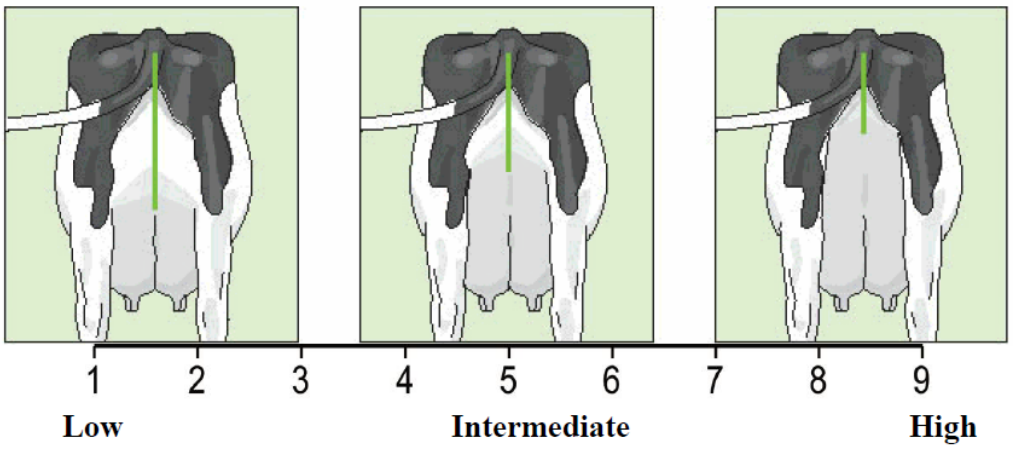


Figure 16. Ranking the rear udder heights of cows (ICAR 2023).


Figure 17. Low rear udder height (left). Intermediate udder height (right) (ICAR 2023).

20 Rear udder width

Reference points: Width at the position where mammary gland is attached to the body at the rear. Rear udder width just like rear udder height, has a positive and nearly linear relationship with lifetime production. The reason is that more room is available for milk production, without deepening the udder. Select for scores 5 and above (Figure 18 & 19).

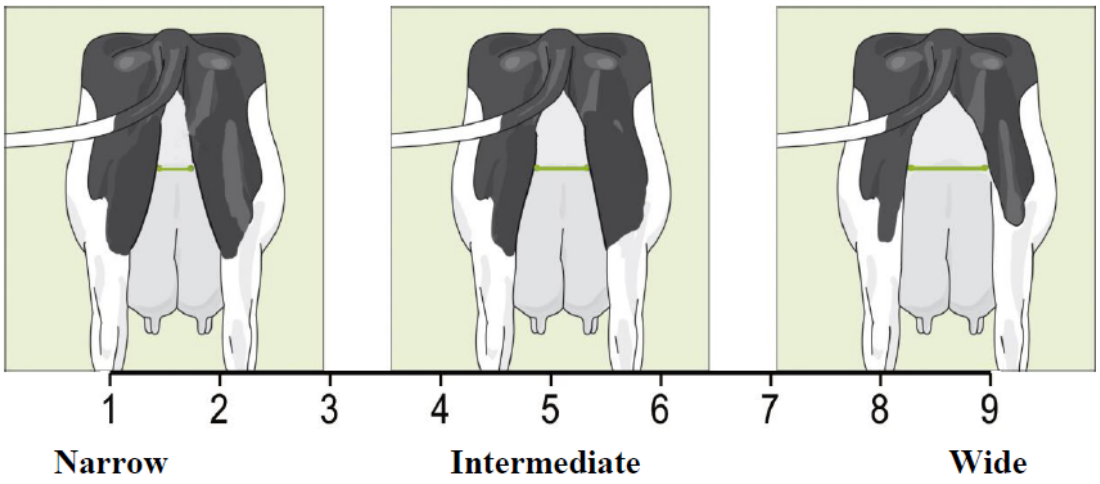


Figure 18. Evaluating the rear udder width (ICAR 2023).

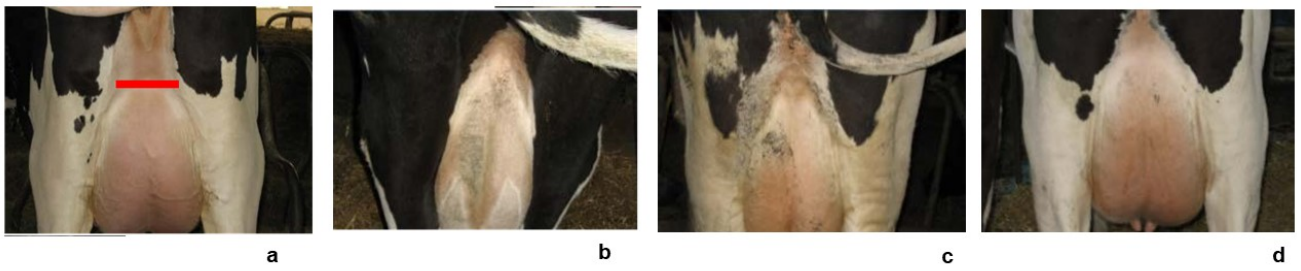


Figure 19. Evaluating the rear udder width (a), Narrow width (b), Intermediate width (c), Wide width (d) (ICAR 2023).

21 Teat thickness (Figure 20)

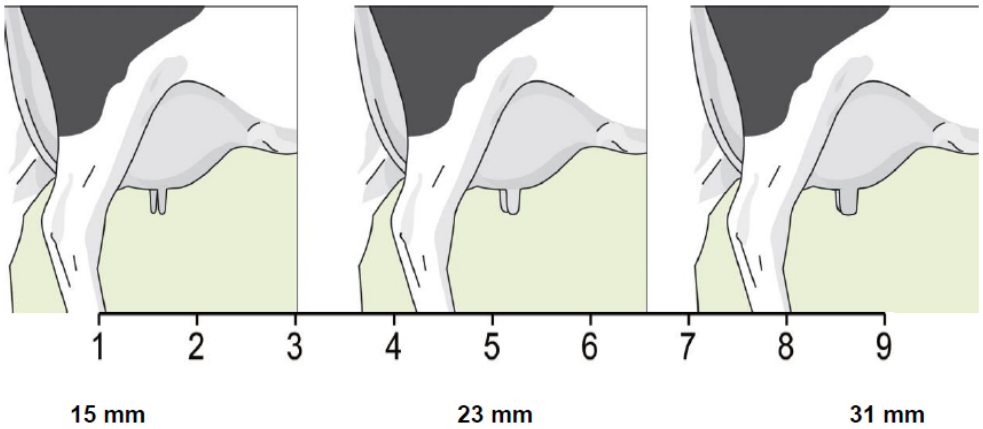


Figure 20. Evaluation of the teat thickness for bull dams (ICAR 2023).

22 Rear teat placement

Reference points: The position of the rear teat from centre of quarter. Extremes should be avoided. Wider rear teat placement is associated with a weak central ligament. Select for average scores 4 to 6 (Figure 21).

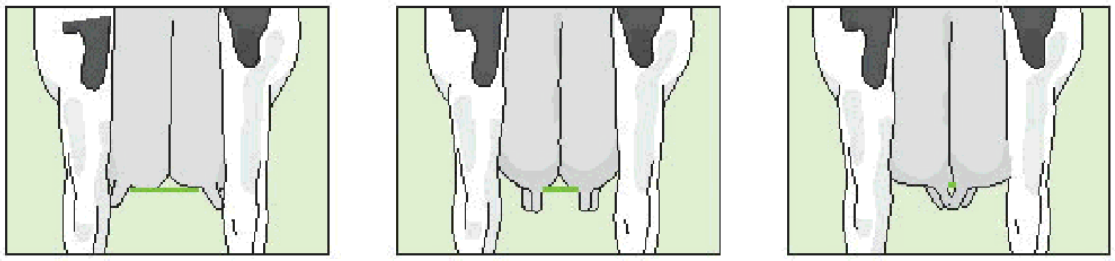


Figure 21. Evaluating the rear teat placement in bull dams (ICAR 2023).

23 Central ligament attachment

Reference points: The depth of cleft, measured at the base of the rear udder. A strong central ligament is necessary to ensure that the udder is able to produce milk over a long time without becoming too deep/ weak after a several lactations. Select for scores 5 and above (Figure 22).

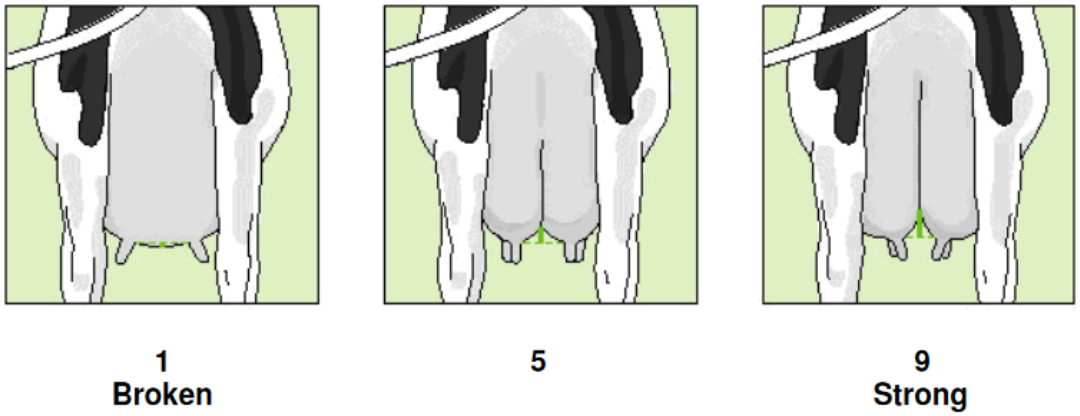


Figure 22. Evaluating the udder cleft in bull dams (ICAR 2023).

24 Body condition score (BCS)

Body condition scoring is concerned with two specific areas for assessment of fat covers. One is the loin area (between hip bone and last rib) which consists spinous and transverse processes of lumbar vertebrae and the other area is tail head and pin bones. Cows with extreme low score for BCS appears to have more claw disorders and higher. Select for Average scores 5 to 6.

25 Locomotion

There is a strong positive relationship between locomotion with survival and lifetime production. Select for scores above 5.

25 Bone structure

Low scores for bone structure are related with lower survival rates. Selected animals with higher scores 5 and above.

26 Muscularity

Muscularity, a standard trait for dual purpose cattle, shows an intermediate optimum for survival and lifetime production. The use of muscularity in linear description is also an indicator of functional traits. As with milk production, its optimum should be defined in relation to the breeding goal for meat production on one hand, and survival on the other hand. Select for animals with average scores 5 to 6.

27 Fore udder length

Fore Udder Length, a second trait that is specific for dual purpose cattle, has an intermediate optimum for survival, and for lifetime production. Shorter fore udders are found in cows with low production. Very long fore udders usually produce more milk, what leads to a higher lifetime production. Select animals with scores 5 and above.

Annex II: Type evaluation format

Village Name		**Farmer Name**	
Animal Tag No.		**Date of Birth**	
Lactation No.		**Date of calving**	
Classification Date		**Classified by**	

Section	Trait	Score										Measure (cm)
Strength	Stature	Short	1	2	3	4	5	6	7	8	9	Tall	
	Heart Girth	Narrow	1	2	3	4	5	6	7	8	9	Wide	
	Body Length	Short	1	2	3	4	5	6	7	8	9	Long	
	Body Depth	Shallow	1	2	3	4	5	6	7	8	9	Deep	
	Angularity	Non-angular	1	2	3	4	5	6	7	8	9	Angular	
Rump	Rump Angle	High	1	2	3	4	5	6	7	8	9	Low	
	Rump Width	Narrow	1	2	3	4	5	6	7	8	9	Wide	
Feet and Leg	Rear Legs Set	Straight	1	2	3	4	5	6	7	8	9	Curved	
	Rear Legs Rear View	Hocked-in	1	2	3	4	5	6	7	8	9	Straight	
	Foot Angle	Low	1	2	3	4	5	6	7	8	9	Steep	
Udder	Fore Udder Attachment	Weak	1	2	3	4	5	6	7	8	9	Strong	
	Rear Udder Height	Low	1	2	3	4	5	6	7	8	9	High	
	Central Ligament	Weak	1	2	3	4	5	6	7	8	9	Strong	
	Udder Depth	Deep	1	2	3	4	5	6	7	8	9	Shallow	
	Front Teat Placement	Wide	1	2	3	4	5	6	7	8	9	Close	
	Teat Length	Short	1	2	3	4	5	6	7	8	9	Long	
	Rear Teat Placement	Wide	1	2	3	4	5	6	7	8	9	Close	
	Rear udder width	Narrow	1	2	3	4	5	6	7	8	9	Wide	
	Teat thickness	Thin	1	2	3	4	5	6	7	8	9	Thick	
General	Body condition score	Thin	1	2	3	4	5	6	7	8	9	Fatty	

Annex 3. Guidelines to selecting bull

Selecting a breeding bull is not as simple as selecting a bull that possesses correct type. Selection of the dairy bull is by far the most important decision a dairy farmer has to make.

1. External appearance is a valuable consideration in selecting a dairy bull. It is seldom used as the only method of dairy bull selection. The main considerations in selecting dairy bulls are their ancestor history and the production records of the progeny. The pedigree of dairy bull is important as it contains information on production records of the sire and the dam. This information is valuable in selecting the bull for its efficiency. The pedigree should be complete with all vital information.
2. Dairy bulls are also selected based on progeny/ daughters' performance. This is the most reliable method of selecting a bull for dairy purpose. It is generally recognized that if a bull has sired progeny of the desired characters in one herd, he will do so in another provided the dams (cows) are of good quality. Such type of bulls are also known as "proven bull". A proven bull is a sire having daughters with production records for dams.
3. A proven bull is the best insurance that a breeder can have, but there are several objections to the use of a proven bull. Proven bulls are more costly, it is scarce and frequently impossible to get it and takes a long time to make a bull proven and by that time he becomes old.
4. When selecting a stock bull first consideration must be given to the female lines from which he has descended. After locating a bull that has descended from a long time of desirable female's attention should then be given to the individuality of the bull himself. There is little question that a bull of good type that has descended from the right kind of females is more likely to be a herd improver than another bull descending from an equally good line of females but himself being defective in conformation. The important aspects of dairy bull type are described here.

Phenotypic characteristics of breeding bulls

A good breeding bull should be attractive, revealing vigour, masculinity with harmonious blending, and correlation of parts. It should also have an impressive style and attractive carriage with an active, well-balanced walk.

Animation, angularity, general openness and freedom from excess tissues. Neck masculine and long, with moderate crest and blending smoothly into shoulders. Clean cutthroat, brisket and dewlap. Withers well defined and wedge shaped prominent according to the breed. Ribs well arched wide apart, rib bone flat, wide and long. Ranks arched and refined. Thighs when viewed from side flat, when viewed from the rear should be wide apart. Testicles and scrotum are normal. Skin of medium thickness, loose and pliable with fine hair. Rudimentary teats are wide apart.

Body capacity

Relatively large in proportion to the size of the animal, and deep at flank. Barrel deep, strongly supported, ribs wide apart, and well sprung. Heart girth large, resulting from long well sprung fore ribs, wide chest floor between the forelegs.

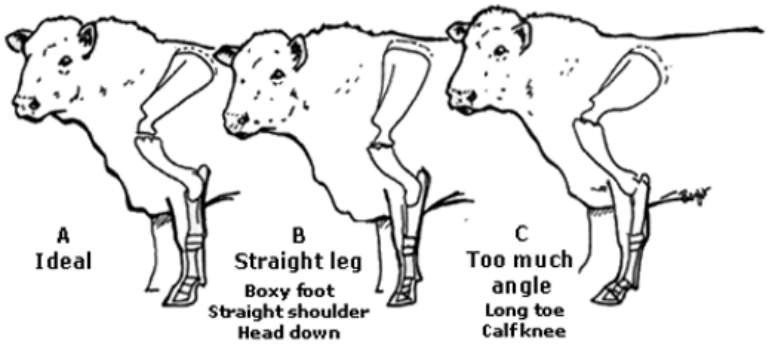
The head
The head should show reasonable length and width yet not be too large in proportion to the body. A head that is too big could potentially increase calving problems.

The neck
The neck should be of good length and held high. A bull which holds his head and neck low may in fact be straight in the shoulder. This affects the bull's gait and mobility. A straight-shouldered bull is also likely to be straight in the hind legs, a very serious fault, leading to early breakdown.

The brisket
The brisket is one area in which fat will be deposited. The bull should be trim in the brisket, as he should be throughout his body. Overfat bulls may in fact be light in their muscle, producing progeny with lower yielding carcasses.

The shoulders
The shoulders should be naturally sloping. A slope of 45–60 degrees is considered acceptable. A beast whose shoulder blade is tipped forward (straight-shouldered) has less angle at the shoulder joint and elbow joint and this reduces the shock-absorbing ability of these front joints.

Front leg and shoulder structure of the bull



The straight-shouldered bull tends to walk with a short choppy gait. He will carry his head low and may have difficulty raising his head much above his backline. Quite often the tip of the shoulder blade is prominent above his backline. A bull that is straight in the shoulder will often also be straight in the hind leg. These bulls are particularly prone to early breakdown through the wearing of the leg joints, and the onset of arthritis.

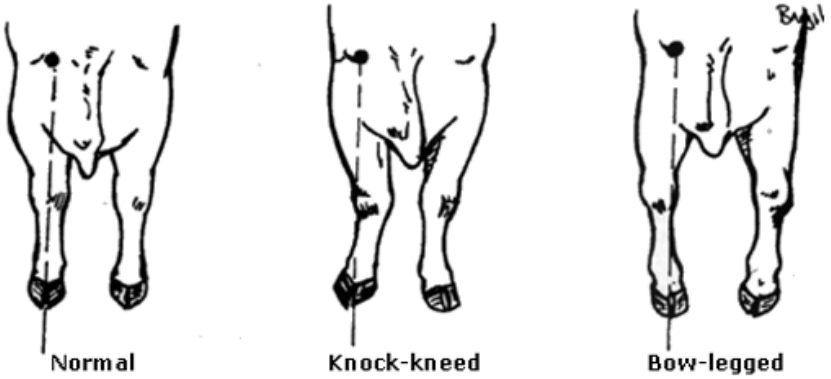
The shoulder should be smooth against the rib cage. Bulls whose shoulders are wide at the point of the shoulder (the base of the neck) or wide between the shoulder blades (when observed from above) may throw heavily shouldered calves, increasing the chance of calving problems (see figure below).

Smooth shoulders

Prominent shoulders

Front legs and feet

The front legs of the bull should be straight when viewed from in front. On a structurally sound animal, a vertical line may be drawn from the point of the shoulder to the middle of the claw. This line should intersect the knee as the knee joints carry more than half the bull's body weight, deviations from this line may cause excessive wearing of these joints. Avoid knock-kneed and bow-legged front legs.



Normal

Knock-kneed

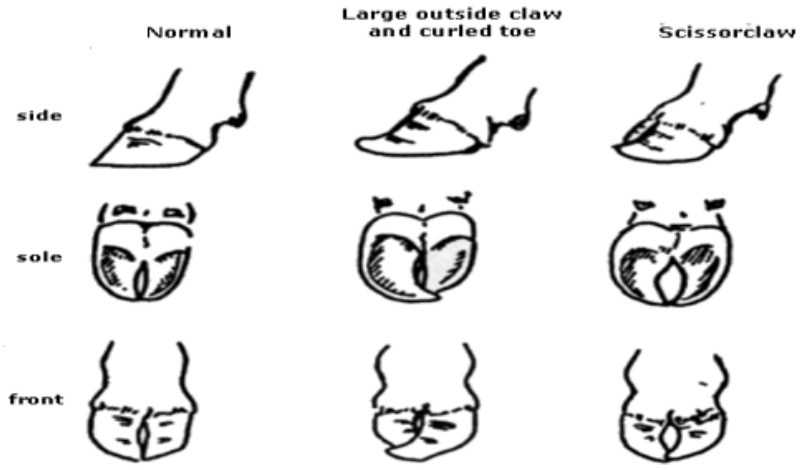
Bow-legged

From the side, the forearm and cannon bones should be in a straight line. Avoid Long or excessively short even claws, these may indicate too much or not enough pastern angle, causing both claws of the hoof to grow or wear excessively. The correct angle of the pastern joint is shown below.

If the claws curl across each other without growing long, a serious genetic fault ("scissor claw") may be apparent. These cattle wear the back of the hoof, causing lameness and reducing mobility.

Feet

Avoid overgrown, scissor or curved claws . Overgrown, uneven claws are usually indications of poor limb structure or early signs of hip arthritis. Avoid extremely short feet, which are often associated with over straight legs.



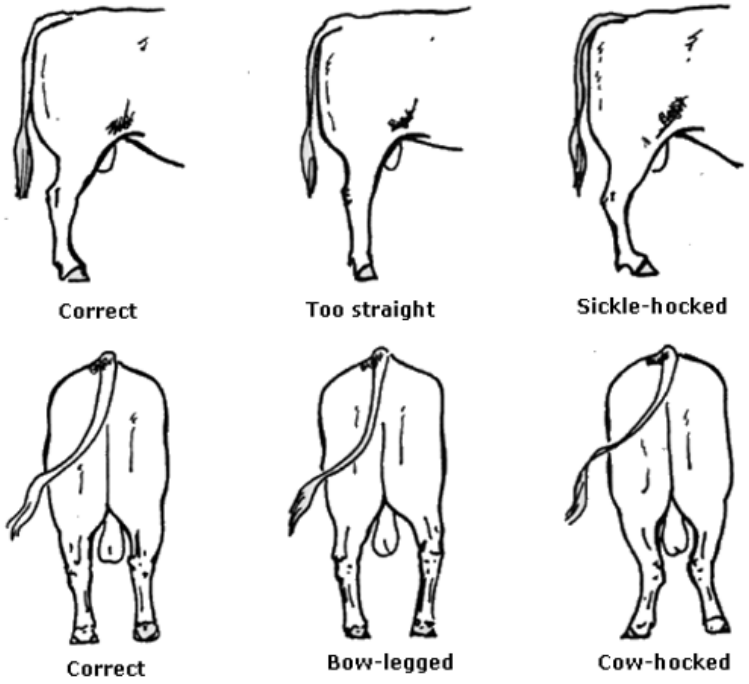
Walk

Select for a free-moving gait, with the hind feet stepping into the footprints of the front feet. Overstepping or under stepping are indications of structural problems, as are uneven footprints from the claws.

Hind legs and feet

The structure of the hind legs is like that of the front legs. There are well-defined angles in the joints at the hip, stifle, hock and pastern joints. The angles are critical, particularly during serving when large amounts of stress are placed on these joints. Deviations from the correct angles will cause excessive wear and tear on the joints, leading to early breakdown. Straightness in the hind leg can be seen in the hock and pastern joints, and this indicates straightness in the stifle and hip.

A structurally correct bull, when walking, will place his hind foot in exactly the mark left by his front foot. When viewed from behind, the tibia and metatarsus (hock joint) should be in a straight line. Avoid too straight, sickle hocked, Bow legged and cow hocked legs.



BREEDING SOUNDNESS OF A BULL:

FORM

Date of examination ……

Owner:

Address:

(A) Identification name - (Ear tattoo, Ear tag, Brand No.)

Breed ---------- Age----------

(B) Record

i) Pedigree covering information up to grand maternal and paternal sides

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ii) Progeny: No. of herds/No. of daughters - PD - Progeny Testing based on BLUP

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iii) Proven /Test:

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iv) A. I. /Natural:

(C) General Clinical Examination

i) Weight: .....

Body Condition Score: .....

ii) General Health: …….

iii) Teeth and Jaws: …… Eyes: …… …. Thorax: ……Abdomen:……

iv) Feet: ……...Legs:……Joints ……...Gait:…….

(D) Physical examination of the reproductive organs

i) Scrotum: ……. Testes: …… Scrotal Circumference……. (cm)

ii) Normalcy/

Consistency.....

iii) Epididymides.....

Spermatic Chord: .....

iv) Accessory organs:

Accessory organs	Observations	Remarks
Seminal vesicles		
Ampullae		
Prostate		
Bulbourethral:		
Penis		
Prepuce		

(E) Semen examination

	Observation/ results	Remarks	
Collection Method			
Volume (ml):			

Density (0-6)			
Wave Motion (0-6			
Motility (%)			
Examination of Serving Behavior			

Serving ability

PARAMETER	Observation/ result	Remarks	
Libido			
Erection Stiffness			
Erection Protrusion			
Erection Deviation			
Seeking			
Ejaculatory Thrust			
Protrusion on thrusting			
Body Position			
Serving Capacity			
Acceptance to vagina			
Mating & semen ejaculation			

F) Vaccination Record

Disease	Vaccination status	Remarks	
Foot and mouth disease			
Black quarter			
Haemorrhagic septicaemia			
Brucellosis			
Campylobacteriosis			
Trichomoniasis			
Anthrax			

(G) Tests for Infectious Disease

DISEASE	Test results	Remarks	
Brucellosis:			
Leptospirosis:			
Trichomoniasis			
Vibriosis:			
Tuberculosis			
Infectious bovine rhinotracheitis			
Bovine viral diarrhea			

(H) Semen Results Sheet

PARAMETERS	Test results	Remarks	
Concentration (million per ml):			
% spermatozoa alive (Nigrosin eosin):			
% abnormal sperm heads:			
% spermatozoa with: Proximal cytoplasmic droplets			
Distal cytoplasmic droplets			
Tailless heads			
Bent tails			
Coiled tails			
Acrosome defects			
Structural abnormalities			
Cells other than spermatozoa			

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