Feed Resource Management, Genetic Improvement and Disease Control in Smallholder Dairy Production Systems

Improved disease free Napier grass

Improved cattle breeds at the National Genetic Resources Research Centre, Uganda
Feed Resource Management, Genetic Improvement and Disease Control in Smallholder Dairy Production Systems

NaLIRRI (National Livestock Resources Research Institute).
DEDICATION

This publication is dedicated to Dr. Emily K. Twinamasiko (R.I.P) (Director General, NARO, 2012 – 2014) who passed away on 13th January 2014. She will be remembered for her tireless efforts in improving agricultural research and development in Uganda and particularly for the efforts in the development and implementation of the Eastern Africa Agricultural Productivity Project (EAAPP) in Uganda.

May her Soul Rest in Eternal Peace
<table>
<thead>
<tr>
<th>Abbreviation</th>
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<tr>
<td>%</td>
<td>Percentage</td>
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<tr>
<td>°C</td>
<td>Degrees Centigrade</td>
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<tr>
<td>AI</td>
<td>Artificial Insemination</td>
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<tr>
<td>CAN</td>
<td>Calcium Ammonium Nitrate</td>
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<tr>
<td>CoE</td>
<td>Center of Excellence</td>
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<tr>
<td>CP</td>
<td>Crude Protein</td>
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<tr>
<td>CRCoE</td>
<td>Cassava Regional Centre of Excellence</td>
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<tr>
<td>DAPM</td>
<td>Department of Animal Production and Marketing</td>
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<tr>
<td>DM</td>
<td>Dry matter</td>
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<tr>
<td>EA</td>
<td>East Africa</td>
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<tr>
<td>EAAPP</td>
<td>Eastern Africa Agricultural Productivity Project</td>
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<tr>
<td>ECA</td>
<td>Eastern and Central Africa</td>
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<td>ECF</td>
<td>East Coast Fever</td>
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<td>Ft</td>
<td>Feet</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>Kg</td>
<td>Kilogramme</td>
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<td>KW</td>
<td>Kawanda variety</td>
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<td>M</td>
<td>Meter</td>
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<tr>
<td>MAAIF</td>
<td>Ministry of Agriculture, Animal Industry and Fisheries</td>
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<tr>
<td>MTPs</td>
<td>Multipurpose trees</td>
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<tr>
<td>NAADS</td>
<td>National Agricultural Advisory Services</td>
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<td>NAGRC &amp; DB</td>
<td>National Animal Genetic Resources Centre and Database</td>
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<td>NaLIRRI</td>
<td>National Livestock Resources Research Institute</td>
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<tr>
<td>NARL</td>
<td>National Agricultural Research Laboratories</td>
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<td>NARO</td>
<td>National Agricultural Research Organization</td>
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<tr>
<td>NEPAD</td>
<td>New Partnership for African Development</td>
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<td>RCoE</td>
<td>Regional Centers of Excellence</td>
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Smallholder dairy is an important component of agricultural production in Eastern and Central Africa (ECA) that provides the majority of milk marketed and consumed in the region. Dairy production is therefore essential in improving food and nutritional security as well as increasing household income. Several studies from ECA region have established that inadequate feeds and poor feeding systems, reproductive inefficiency, poor breeds and breeding programmes and diseases are the major challenges in limiting production and productivity of smallholder dairy systems. The consequences are often death of animals, low animal performance in terms of growth and milk yield leading to escalating levels of food and nutritional insecurity and poverty. The projected increase in demand for dairy and dairy products calls for the development of a strong and dynamic strategy for research and dissemination of technologies and innovations that will sustain dairy production.

This publication involves innovative and practical technologies for use by dairy farmers to address the challenges in production, management and utilization of feed resources (forages and crop residues), disease management and genetic improvement. The publication originates from East African Agricultural Productivity Project – Dairy component of Uganda that was implemented by the National Livestock
Resources Research Institute (feed resource utilization, breeding and disease control); National Animal Genetic Resource Centre and Data bank (genetic improvement) under Kenya Agricultural Research Institute (KARI) as the Regional Center of excellence. The book will help stakeholders to access information that would enhance their productivity and improve livelihoods.

It is my hope that this book will prove to be useful to extension staff, service providers, researchers and livestock farmers in the region.

I acknowledge financial and technical support from the World Bank, EAAPP and the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA).

Dr. Ambrose Agona
Ag. DIRECTOR GENERAL,
NATIONAL AGRICULTURAL RESEARCH ORGANIZATION (NARO)

February 2014
CHAPTER 1

EASTERN AFRICA AGRICULTURAL PRODUCTIVITY PROJECT (EAAPP)

By

George Lukwago and Jolly Kabirizi

1.1 Background

Agriculture accounts for about two-fifths of gross domestic product (GDP) in East Africa and is the primary source of income for more than two thirds of the population. Its growth must be maintained at 5-6% annually in order to achieve the structural change and poverty reduction targets that are consistent with the expectations laid out in the New Partnership for African Development (NEPAD).

Agricultural technology is fundamental to productivity growth and requires effective and efficient innovation systems in order to generate high returns in investments. According to the 2008 World Development Report, the policy environment for agriculture in much of Africa has much improved relative to earlier years. This justifies increased investment in agricultural technology development in order to negate losses in foregone returns. Among the foregone returns are gains from economies of scale that would arise from the assembly of the critical mass of researchers and facilities needed to address the complex problems of African agricultural innovation systems and commodity value chains.

Several countries in Africa, including in Eastern Africa have
similar ecological and socio-economic conditions, potentials and constraints. Hence the likelihood of relevance across large areas and successful replication of results within eco-regional blocks of countries is likely to reduce the costs of investments in research and to increase gains from economies of scale across national boundaries. In pursuit of this opportunity, the Eastern Africa Agricultural Productivity Project (EAAPP), established specialized Centers of Excellence (CoE) in the region to spearhead research in selected priority commodities of Cassava (Uganda), Dairy (Kenya), Rice (Tanzania) and Wheat (Ethiopia). To increase gains from CoEs, the resulting technology and information products flow freely throughout the technology space, finding clients able to adopt new technologies with minimal transactions costs and few administrative barriers in all countries in the region.

The objectives of EAAPP were to: (i) enhance regional specialization in agricultural research; (ii) increase regional collaboration in agricultural training and dissemination and (iii) facilitate increased sharing of agricultural information, knowledge and technology across national boundaries.

These objectives are pursued by: (i) strengthening the existing Uganda national agricultural research program in cassava to become a RCoE, (ii) supporting regional research, training and dissemination of relevant technologies and (iii) supporting increased availability of improved genetic materials (planting materials, seeds and livestock germplasm) in the selected commodities in participating countries (PAD, Uganda, 2009)
1.2 EAAPP Project Components and Sub-components
The Uganda EAAPP with the establishment of the Cassava Regional Centre of Excellence (CRCoE) as a Center is implemented over a period of five years starting in fiscal year 2010/2011. The project consists of four components:

(1) Establishing/Strengthening the Cassava Regional Centre of Excellence

The component aims at strengthening the institutional capacity that is needed to establish the CRCoE.

(2) Technology Generation, Training and Dissemination.

The component supports research activities developed within the CRCoE and the Regional Centres of Excellence (RCoEs) for the other three selected priority commodities, as well as related training and dissemination subprojects. This component has a regional focus and uses participatory strategies and mechanisms to train researchers, extensionists and farmers in the latest innovations, and to scale up application of technologies.

(3) Improved availability of planting materials, seeds and livestock germplasm

The component supports multiplication of planting materials, seeds and breeds, strengthen the enabling environment for regional exchange and trade in seeds and breeds, and improve the capacity of seed and breed producers and traders.
(4) **Project coordination and management**
This component finances management and coordination of the Project at the national and regional levels.

1.2.1 **Overview of the Regional Dairy Centre of Excellence**
The goal of the **Regional Dairy Centre of Excellence** is to improve the livelihoods of smallholder dairy farmers within the Eastern Africa region and the **Purpose** is to develop, test and disseminate technologies, knowledge and information that will assist in building a globally competitive dairy industry in the region.

**Regional objectives**
(a) Provide state-of-the-art analysis of feeds and dairy products in the region.
(b) Develop, test and disseminate improved dairy technologies in the region.
(c) Build scientific capacity to carry out quality dairy research in the region.
(d) Build the capacity of other stakeholders in the region to provide support services to the dairy sector in the region.
(e) Together with other stakeholders generate information that will assist in the development of enabling dairy policies in the region.
(f) Establish an elaborate communication strategy both nationally and regionally to ensure real-time information exchange

**Regional Priority areas of focus**
(a) **Animal genetic improvement**
Animal genetic improvement covers genetic resource
characterization, breeding, germ-plasm multiplication, upgrading of local genetic resources, gene-environment interaction/matching, related policies etc.

(b) **Feed resource utilization**

Feed resource utilization covers fodder/pasture, crop residues, fortified feeds, ration formulation, pasture/forage breeding, seed multiplication, feed conservation, feed safety, farming systems) Animal health (Covering all aspects of animal health, policy, regulatory services.

(c) **Processing and value addition**

Processing and value addition covers all aspects of dairy products value addition to increase competitiveness in the regional and world markets)

(d) **Socio-economics**

Socio-economics covers policy analyses, farmer oriented socio-economic studies, trade, management of information systems, monitoring and evaluation, impact assessment studies, feasibility studies, input/output markets, gender studies.

**Expected outcomes**

- A state of the art dairy centre of excellence with the necessary support systems that will underpin a competitive dairy sector in the region is established.
- Competitiveness, productivity and sustainability of the regional dairy industry is improved through development, validation, dissemination and up-scaling of appropriate technologies to stakeholders.
- Linkages between the regional scientific and farming community with the various Eastern Africa governments’
policy-making organs and the general integration of regional economy catalysed.

- Capacity of all dairy industry stakeholders (researchers, extension, farmers, private entrepreneurs, policy-makers, etc) improved through formal training and learning exchange visits.
- Information flow in the region reinvigorated through establishment of region-wide information exchange network. Dairy data, analytical reports, publications, extension messages and experiential knowledge can have wide circulation and therefore readership also improved.
- Overall, an improved dairy industry, will impact positively on both national and regional economy. In particular, it will directly contribute towards poverty reduction and creation of employment

1.2.2 Overview of Uganda’s EAAPP Dairy component

The EAAPP Dairy programme in Uganda has three key sub-components. The objectives of the sub-components and collaborating institutions are shown in Table 1.
Table 1.2.2: Key sub-components objectives of the Dairy component

<table>
<thead>
<tr>
<th>Sub-component</th>
<th>Key sub-component objectives</th>
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</table>
| Dairy research component                           | • Screen and promote promising Napier grass varieties tolerant to Napier stunt disease and alternative forages such as *Brachiaria* hybrid cv. Mulato I & II  
• Formulate nutritionally valuable supplemental feeds for the dairy cattle and its calf.  
• Improve milk and meat production capacity of local cattle populations through selection and crossbreeding.  
• Develop and promote technologies to improve the detection of mastitis, milk-borne zoonoses and drug residues in milk.  
• Improve ECF control by contributing towards efficient vaccine development.  
• Capacity building of stakeholders (Scientists, farmers, policy makers, extension staff).  
• Package and disseminate research results.                                                                                     |
| Improving availability of dairy breeding materials  | • Support increased access to and use of Artificial Insemination (AI) and high yielding dairy breeding stock                                                                                                         |
| Strengthening dairy breeds system                  | • Support and promote systematic dairy breeding programs that will ensure a sustained supply of high quality dairy cattle                                                                                                       |
CHAPTER 2

PRINCIPLES, CONCEPTS AND PRACTICES IN SMALLHOLDER DAIRY FARMING

By
Jolly Kabirizi, Swidiq Mugerwa, George Lukwago, John Kigongo, Agnes Namagembe, Clementine Namazzi, and George Ocen

2.1 Description of smallholder dairy farming
2.1.1 Emergence of smallholder dairy farming in ECA
The conducive environment for dairy growth in the region such as involvement of private sector, increased investment in the sector, urbanization and enabling policies, has led to the development of the dairy industry in Eastern and Central Africa (ECA) region. Factors in favour of intensifying dairy production systems in ECA region include the accessibility of production sites of fresh milk, which leads to reduction in costs associated with collection, refrigeration and transport of fresh milk from the farms to points of final sale. On the input side, urban and peri-urban producers have ready access to feed supplements, agro-industrial by-products, veterinary supplies and sometimes factory-gate prices.

2.1.2 Advantages of dairy farming
(a) Milk for food
Milk is considered as a perfect human food. Through home consumption, it contributes considerably to the health status of the people in rural areas. Consumption of milk reduces medical expenses incurred in treating diseases associated with
mal-nutrition. Milk enhances the immune system of people and in that way contributes considerably to the reduction of child mortality. Moreover, it remains available during periods when common food often is in shortage. Studies in Uganda have shown that rural people in smallholder dairy households have a better Body Mass Index (BMI) (18.5 – 24.9) compared to their counterparts in non dairy households majority of whom were under nourished with BMI below 18.5.

(b) Source of income
Milk provides the farmer with a regular income throughout the year. Income from milk is more reliable than from beef. The animals provide income through the sale of surplus heifers, and at the same time form a source of meat.

(c) Source of manure
The animals provide organic (kraal) manure, which is essential to maintain soil fertility at the farm. Cow dung and cow urine are cheap sources of fertilizers which can be used to improve crop and livestock production. On some farms, the excess slurry is sold to farmers without cows. In Ethiopia, cow dung is collected from the stalls, dried and used as a source of fuel for cooking instead of charcoal. In a simple biogas unit, cow dung and urine decompose and methane gas is produced which provides energy for lighting the house and cooking purposes. Two cows have the ability to produce enough gas for one family, whereas the remaining slurry is used to fertilize food crops, cash crops and pasture. Many farmers mix cow urine with *Phytolaca dodecandra* (oluwoko) to control banana weevils and other pests on crops. This method is much cheaper and environmentally friendly than using chemicals.
(d) Employment
Small scale farming is an agricultural based rural development enterprise, which creates employment in the rural areas. Small scale farming contributes to the formation of a commercial agro-industry and creates business opportunities in feed production, feed processing, management, value addition, transportation and retailing of milk.

2.1.3 Limitations of dairy farming in Uganda
- Dairy farming requires long hours in feeding, management, health and marketing.
- High capital investment in good breeds, feeds and farm maintenance.
- Parasites and diseases.
- Dairy animals require more feed and nutrients than beef animals.

2.1.4 Conditions that favour dairy farming in Uganda
The following conditions are required to enable a good environment for dairy farming:
- A good climate with sufficient rainfall, preferably well distributed over the year is important to ensure year-round supply of forages.
- A good water supply from rivers, streams, dams, boreholes, etc. Water is essential for the animals to drink and to maintain a good hygienic standard at farms.
- A reliable market for the milk within reach. This can be either informally directly to consumers or formally through Cooperative Societies and milk processors.
- Availability of inputs, like labour, capital, feeds and veterinary drugs.
• Access to technical information and support of a dairy extension service, animal health and breeding facilities, like Artificial Insemination (A.I.) or bull camps.
• Knowledge of good crop husbandry; like maize, fodder crops and legumes.
• A cultural background with a tradition of cattle keeping and milk consumption.
• Suitable breeding animals with potential for milk production.
• Good animal husbandry practices.
• Effective disease and parasite control.
• Favourable good government policy biased towards smallholder dairy farmers.

2.1.5 Zero grazing dairy production system
Reducing malnutrition among children and pregnant mothers is a challenge to many development workers. One of the approaches is to improve production and increase availability of milk. With the ever-increasing human population, however, land holding per household is on the decline and, therefore, conventional dairy production is becoming more difficult. This is particularly so in peri-urban settings, where families need milk not only for domestic consumption, but also income generation. This scarcity of farmland calls for highly intensive dairy farming system to increase efficiency of land utilization, thus the zero grazing system.

Zero grazing is a system of dairy production whereby the dairy cows are kept in a stall all the time, and feed and water are brought to them. Animals are not taken to the pasture for grazing; pasture is cut from the field and brought to the stall.
for the animals to eat.

From the mid-1980s, development agencies in Uganda began introducing zero-grazing systems, in which high-yielding genetically improved cows (pure or cross-bred with local cattle) are kept in stalls and fed with fodder cut and carried to them daily. These more ‘intensive’ dairy systems were promoted among Ugandan farmers along with training on managing dairy breeds and growing fodder. This gave many smallholders an incentive to buy exotic dairy cows or to upgrade their indigenous cows by cross-breeding them with exotic stock. Some of Uganda’s small farmers adopted strict zero-grazing practices while others combined grazing paddocks with stall feeding, a hybrid dairy production system that came to be known as ‘semi-intensive’.

2.1.5.1 Advantages of stall-feeding or zero grazing production systems

- Cows are confined and therefore use most of the energy from feeds for growth and milk production.
- Saves land for other enterprises by allowing the use of high yielding fodder crops like Napier grass.
- Enhances the production of clean milk
- Good calf rearing is possible
- More manure which can easily collected for the benefit of fodder and food crops and production of manure.
- The animals are better protected against diseases, especially tick-borne diseases.
- Close observation of the animals is possible, making heat detection and attendance to animals easier and faster.
- The animals are kept inside which is more secure and
protect them from attack by predators

- Employment opportunities for family members or other people as hired labour.
- A calf each year to either increase milking animals in the herd or for sale to increase household income.

2.1.5.2 Disadvantages of stall-feeding or zero grazing production systems

- Requires an animal of higher genetic potential, which is more expensive.
- More land and labour devoted to production of forage, transporting the forage to the animals and feeding in the stalls.
- Large amounts of forage and supplements for high milk production.
- Increased expenses on disease control and treatment, because high milk producing animals are more susceptible to diseases.
- Much capital is required for construction of a ‘zero-grazing unit.
- There is a possibility that animals are stressed because of too much confinement inside the zero grazing unit.
- It might not be easy to detect cows with silent heat.

2.1.5.3 Tips to a profitable zero grazing enterprise

(i) The zero-grazing unit

Cows are kept and fed inside the stall all year. The site where the unit is built determines the efficiency of operations throughout the zero grazing enterprise. It should be near to the source of forage to reduce labor costs of carrying the cut
grass to the cows and carrying manure back to the farm. Zero grazing requires an increased level of labour input, due to the need to cut grass daily. Proximity to the homestead in relation to the biogas plant is also an important consideration.

The quality and quantity of construction material should be assessed thoroughly to determine the least possible cost while maintaining quality of the house. Quality materials which are locally available can greatly reduce costs. The cow shed must be functional, cheap and long lasting. The choice of an artisan is important because a lot of expensive material can be wasted by hiring a bad artisan. Note that the most expensively built stable is not always the best and most economical one.

(ii) Improved dairy cattle breeds
In order to increase milk production there is need to invest on few good quality animals that produce more milk. Stock the units with dairy cows that have been bred specifically for their high milk yield. Important dairy breeds of cattle for high-milk yield in Uganda are Jersey, Ayrshire, Guernsey and Friesian. Maintain the dairy breeds by upgrading your stock through artificial insemination using proven dairy-bull semen. Selecting good cows and culling non performing ones coupled with good calf rearing for replacement stock should be an integral part of the system.

(iii) Adequate forage resource base
Pasture management and flexibility are key to the effectiveness of this zero grazing system. Planning ahead is critical to ensure there is always adequate forage available for the animals. Zero grazing can provide opportunities for herd expansion
by increased forage utilization or through accessing land beyond cow walking distance for grazing. It is important to think commercially in order to know the maximum forage production potential of your farm holding and the potential amount of off farm forage available to your herd in a given year. This will enable you to determine the maximum number of animals your zero grazing enterprise can support. The amount of forage, whether obtained within or outside the farm, is actually the single most resource that determines the number of cows or animals that can be sustained in the unit because.

- In feeding the cows the forage and concentrate, a ratio of 70:30 is recommended.
- Forages take time to establish as opposed to concentrates which can be purchased on demand

Elephant (Napier) grass (*Pennisetum purpureum*) grass is preferred as the main fodder crop because it produces high biomass yield; is easy to grow and re-grows rapidly after cutting. Choose the most suitable fodder to your locality.

Improve soil fertility by recycling all manure on the Napier crop every 2 to 3 days. Harvest the mature Napier grass after it has grown to 60-90cm in height. The aim should always be to produce the highest amount of dry matter (DM) per unit area of fodder grown.

Plant at least 2 acres of Napier grass per mature cow and her offspring. A daily intake of 75-100kg of fresh grass/cow can be achieved with good management to give a dry matter intake of 14-16kg/day. A fresh weight intake of 100kg/cow/day would be required for 15kg DM of grass.
Other forage grasses recommended under zero-grazing production systems include *Brachiaria* hybrid cv. Mulato (Signal grass), Guatemala, and Setaria. It is recommended to intercrop forage grasses with forage legumes to improve the nutritive quality of the grass. Some of the legumes that can be intercropped with the grasses are: *Centrosema pubescens* (Centro), *Macroptilium atropurpureum* (Siratro), *Clitoria ternatea* (Clitoria) etc.

Conserve fodder for the dry season to ensure that milk production is maintained at a steady rate throughout the year. One of the greatest problems is providing good quality feed to the herd during the dry season. Dig a silage pit to store and preserve animal feed.

The increased utilization of off farm fodder can allow for an increase of stocking rate on the farm. You can buy or rent more land for animal feed or purchase feed from neighbors. Invest in a chaff-cutter (forage chopper) to mill crop residues for feed so that you reduce waste. Cows must have adequate feeding space, and wastage must be monitored, to ensure feed intake is maximized. Wastage should be less than 5%, and refused material must be removed from the feeding area daily, as this decomposes rapidly.

### 2.1.6 Feeding Dairy Cattle

Cows fed to capacity on grasses alone have the potential to produce up to a maximum of 7 litres of milk per day. Additional milk is supported by concentrates. It should be noted that it is pointless to feed supplements when forage requirements are not met.
(a) Concentrates
Give concentrate to supplement energy and protein from forages. Most farmers prefer giving dairy meal to the cows at milking time. Supplement at a rate of 1 kg for each 1.5 litres of milk the cow produces on top of the 7 Kg of milk contributed by grass. Other concentrates like sunflower seed cake, cotton seed cake and bran can be used depending on availability.

Mixing own concentrate reduces the cost of production and ensures quality supplements. But the most important thing is to have your ration formula right. You will need the skills of a qualified professional to come up with the right mixture of the feeds available to your cows. An example composition of a 100 kg of homemade dairy ration is 16 kg cottonseed cake, 82 kg maize grain, 2 kgs of mineral powder and 10 kgs of calliandra leaf meal. Mineral salt lick should be offered to the cattle ad lib in the mineral box.

Homemade multi-nutrient mineral blocks are lick blocks containing energy, protein, vitamins, minerals and other nutrients. The feeding of the blocks is a convenient and inexpensive method of providing a range of nutrients required by both the rumen microbes and the animal, which may be deficient in the diet. Strategic ruminant supplementation with the multi-nutrient feed blocks is one of the technologies to reduce methane gas which is also responsible for global warming.
Homemade multi-nutrient feed blocks

Use of brewer’s waste as a feeding supplement increases milk production by 2-3 litres per day.

(b) Supplementing with forage legumes and fodder trees
Fodder legumes constitute an additional source of protein. Common fodder legumes are *Lablab purpureus* (Lablab), *Calliandra*, *Leucaena* and *Gliricidia sp.*

(c) Water
Water should be available throughout the day as it makes the bulk of the milk. Harvest water during the rainy season for use during the dry season. Contact the Engineering department of the National Agricultural Research Laboratories, one of the research institutes under the National Agricultural Research
Organization (NARO).

2.1.7 Considerations during construction of a zero grazing unit

- Ensure that the correct site, considering the direction of wind, is chosen for the unit. The choice of site influences the security and protection of animals from rain, sunshine and other weather effects.
- The location of the unit in relation to the house should ensure minimal smell from manure pit. It should be noted that it is more important to protect an animal from the rain than from wind or sunshine.
- Ensure that the constructor is supervised by an experienced extension staff during the construction of the unit. This is necessary because some parts (i.e. walking area, troughs) once constructed are permanent. Mistakes made during construction can be costly.
- Use of local materials for construction of the unit would reduce cost.
- Finally, one should as much as possible, carry out regular maintenance of the zero-grazing unit while in use. This is important for the walking area.
Recommended zero grazing plan
**Side elevation**

The cubicle of a dairy cow shed has three distinct areas:

- The resting and sleeping cubicle or compartment
- The cattle walking or manure places
- The cattle forage, feeding and watering place

(a) **The resting and sleeping cubicle or compartment**

Each animal has its own compartment or sleeping place. Separation between compartments is done by wooden rails or posts. The floor of the house can be constructed from ordinary soil from the farm. Soil is much cheaper and comfortable to the animal than concrete or stones. The soil can be replaced if dirty or worn out. The floor of the sleeping place is raised 25cm above the level of walking and manuring passage.

The recommended standard width is 4ft or 120cm and standard length of 7ft or 210cm. The cubicle should not be too long.
or too wide or the floor will get dirty and consequently also the animals. The cubicle is of the right size if the droppings fall on the walking and manuring and not on the floor of the resting and sleeping compartment. For heifers the length and width of the cow cubicle should be reduced by moving the neck control posts towards the manuring and walking passage and by fitting another side wall into the cubicle. Provide a roof over the resting and sleeping compartment in order to provide shade and to prevent the area from getting wet and dirty.

(b) The cattle walking or manure places
This should be constructed solidly with concrete because the area is used heavily by animals. Mix cement, sand and ballast in the ration of 1:2:3. The floor should slope towards the end of the building where manure is stored in a pit about 3-5m away from the stable.

(c) The feeding and watering place
Construct troughs for feeding and drinking water on the opposite side of the sleeping and resting compartment along the walking manuring passage. 2.5-3ft or 90cm long feed troughs per cow can be constructed using woods, stones or concrete. Construct a water trough between the cow and young stock section. Use concrete or water drum.
Estimate of materials required to construct a modern zero-grazing unit

<table>
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<th>Item description</th>
<th>Units</th>
<th>Quantity</th>
</tr>
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<tbody>
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<td>No</td>
<td>24</td>
</tr>
<tr>
<td>3” x 3” timber running rails</td>
<td>Metres</td>
<td>60</td>
</tr>
<tr>
<td>3” x 2” timber running rails</td>
<td>Metres</td>
<td>55</td>
</tr>
<tr>
<td>2” x 2” timber running rails</td>
<td>Metres</td>
<td>50</td>
</tr>
<tr>
<td>6” x 2 ½” half board</td>
<td>Metres</td>
<td>50</td>
</tr>
<tr>
<td>off cuts/timber</td>
<td>Pieces</td>
<td>40</td>
</tr>
<tr>
<td>Iron sheets 32G, 3m long</td>
<td>No</td>
<td>20</td>
</tr>
<tr>
<td>Lorry load hard core 7 tons</td>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>Lorry load ballast 7 tons</td>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>Cement</td>
<td>Bags</td>
<td>20</td>
</tr>
</tbody>
</table>

2.2 Essential Nutrients for Dairy Cattle

A part from differences in productivity arising from the quality of the animals’ genotype, the most important factor contributing to sustainable dairy production systems is “feed and nutrition”. The availability of feed resources, both in quality and quantity varies greatly throughout the year. Although feed availability depends to some extent on rainfall and the length of the growing season, in most cases the feed situation becomes critical during the dry season. During the dry season, pastures on which animals depend become poor and less nutritive. Coupled with, inefficient use of crop residues this results in inadequate feeding of stock. This has adverse implications on reproductive efficiency and milk production, especially
among crossbreed and grade cattle, as feed nutrients became inadequate to support their potential yield levels. There is therefore a need to provide these animals with balanced diets throughout the year. The cow’s diet consists of protein, energy, fibre, water, fats, oils and vitamins.

2.2.1 Sources of different nutrients and their functions
(a) Protein
Protein is the material that builds and repairs the body’s enzymes, hormones, and all the tissues (e.g. muscle, skin, organs, foetus) except fat and bone. Protein is required for the following functions:

- The body’s basic metabolic processes, growth and pregnancy.
- Protein is vital for milk production. It contains various amino acid molecules needed as building blocks in milk formation.
- Amino acids are also building blocks for, tissue growth and the development of the foetus during pregnancy.
- Hair, horn, hooves and feathers are composed of protein
- Assist in providing resistance against diseases
- Excess protein is converted to carbohydrates to provide energy to the cow body.

Proteins are found in the soft and green parts of plants particularly in the leaves. When a plant grows older, it develops a strong stem and becomes less leafy. That is why an older plant contains less protein. Most plants obtain the Nitrogen (N), which they require to form proteins, from the soil.
However, one group of plants, the legumes, are able to utilize N from the air. For that reason leguminous feeds always have relatively high protein content.

(b) **Carbohydrates**
The soluble carbohydrates consist of starch and sugars. These nutrients can be digested directly by the animals. The animals are able to utilize them well and their digestibility is high. These form the major source of energy for the animals. If more energy is provided than immediately needed, the surplus is stored as body fat. Carbohydrates encompass many types of foods, grains (wheat and maize), fruits (banana), tubers (cassava and potatoes) and sugarcane. Functions of carbohydrates include;

- A ready source of energy (necessary to maintain the body and for activities, like walking, grazing, milk production, etc.)
- Maintain a constant body temperature
- Important to maintain the level of blood sugar
- Excess of carbohydrates are stored as reserve energy in form of body fat
- Milk sugar (lactose) gives sweetness to milk and is used by bacteria to turn milk sour
- Essential for the growth and multiplication of microorganisms in the rumen
- Helps in the absorption of Calcium and Phosphorus

(c) **Fibre**
Cows need a certain amount of fibre for efficient rumen function. The fibre is required to ensure that the cow chews its cud (ruminates) enough and therefore salivates. The saliva
helps to buffer the rumen pH and prevent the degree of acidity varying too much. The length and the structure of the fibre are both important. They determine how much chewing a feed requires. Feeds which need extra chewing increase the flow of saliva. Fibre in the cow’s diet also slows down the flow of material through the rumen and thus gives the microbes more chance to digest feed. Products of fibre digestion are important for the production of milk fat.

Commonly used co-products which supply fiber and energy to the diet include soybean hulls, corn gluten feed, dried distillers grains, brewers grains, beet pulp and wheat bran. Some of these co-products, such as dried distillers’ grains, are commonly considered excellent sources of crude and escape protein as well.

**Fats and oils**
Fats are high in energy. In fact fat provides 2.5 times more energy than the same quantity of carbohydrates. In fodder fats are only found in very minor concentrations. By-products like cakes from the vegetable oil industry (i.e. sunflower, cottonseed and soya bean) have a relative high fat content. Some fat should be present in the ration as they form a source of some vitamins. Since animals derive most of their energy from starch and sugars, fats do not play a major role in the feeding of livestock. Functions of fat include;

- Source of energy
- Makes up 20% of the animal body
- Provides essential fatty acids
- Is a source of fat soluble vitamins
- Helps in absorption of carotene
• Cow milk contains about 3.5 - 5 % fat

(e) Energy
Ruminants need a daily supply of all nutrients required for maintenance and production: milk, meat, growth and pregnancy. Quantitatively any type of nutrient can limit performance levels, but the most likely to be in short supply are energy and protein, this is especially true for high and average yielding cows. Both energy and protein must be considered. For energy, the feeding system uses the Metabolisable energy (ME) in the feed as a basis to formulate rations. The ME is the energy remaining in the digested foodstuffs after the loss in faeces, urine, gases and body heat. The basic unit used to measure the energy content is the Megajoule. Examples of sources of energy are cereal and agro industrial by-products, commercial dairy meal, cotton seed cake and sunflower cake.

(f) Minerals
The major mineral requirements for dairy cows are calcium and phosphorus. The calcium phosphorus ratio is important, and an imbalance can cause infertility. There are reserves of both elements in the skeleton.

(i) Calcium (Ca): Major component of bones and teeth and essential in blood coagulation, nerve and muscle function and milk and egg production. Deficiency signs include; Retarded growth, deformed bones in young animals (rickets), osteoporosis in older animals, osteomalacia and milk fever (Parturient paresis). Calcium can be obtained from milk, oyster shells and limestone.
(ii) **Phosphorus (P):** Essential for the formation of bones, teeth, and body fluids. Required for metabolism, cell respiration and normal reproduction. Deficiency signs are similar to calcium but also includes lack of appetite, sore legs, animals would limp, show long hooves and depraved appetite (pica), poor reproduction and unthrifty appearance. Sources include; Dicalcium phosphate, bone meal, and low fluorine phosphates. Pasture is often deficient in minerals, mainly in phosphorus. In some grazing areas, particularly uplands, dairy cows are subject to a mineral deficiency (especially during lactation), thus obvious phosphorus deficiency symptoms are frequently observed (probably caused by very acid soil).

(iii) **Potassium (K):** Retention and formation of body fluids, pH concentration of body fluid and rumen digestion. Deficiency signs nonspecific and unlikely under most conditions but may have decreased feed consumption and efficiency. Sources of K include roughages and grains.

(iv) **Manganese (Mn):** Fetal development, udder development, milk production and skeleton development. Deficiency signs include abortions, reduced fertility, deformed young and poor growth. Sources include mineralized salt.
(v) **Copper (Cu):** Should be present in animal tissues for iron to be properly utilized, hemoglobin formation and synthesis of keratin for fair and wool growth. Deficiency signs are stringy wool, sway back lambs, lack of muscle coordination and anemia. Source include forages and copper salts.

(vi) **Iron (Fe):** Essential for the function of every organ and tissue of the body (Hemoglobin). Seldom occurs in older animals, nutritional anemia, labored breathing and pale eyelids, ears and nose are common symptoms of deficiency. Sources are forages and trace mineral salts.

(vii) **Cobalt (Co):** Required as a nutrient for the microorganisms in ruminants and thereby aids in rumen synthesis of Vitamin B$_{12}$. Because swine cannot manufacture B$_{12}$ from cobalt, the diets are supplemental with vitamin B$_{12}$ instead. Deficiency signs are lack of appetite, loss of weight, rough hair coat, anemia, decreased milk and wool production and death in extreme cases. Sources are legume forages and salt containing cobalt.

(viii) **Magnesium (Mg):** Similar to calcium and phosphorus. Deficiency signs are animals are irritable, their heart beat is irregular and there is severe kidney damage. Sources include Mineral supplements and ordinary feeds.
(ix) **Vitamins:** Vitamins are essential organic nutrients, required in small amounts. They cannot be synthesized by the body. They must be obtained by outside sources like diet, rumen bacteria and sun. Vitamins are required for growth, maintenance, reproduction and lactation. Most essential vitamins are Vitamin A, E, D, K, C (Ascorbic acid), B₁ (Thiamin), and B₂ (Riboflavin).

Table 2.2.1: Nutrient composition of commonly used feedstuffs in smallholder dairy systems in Uganda
<table>
<thead>
<tr>
<th>Feedstuff</th>
<th>Dry matter (%)</th>
<th>Crude protein (%)</th>
<th>Calcium (%)</th>
<th>Phosphorus (%)</th>
<th>Metabolizable energy (MJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>88</td>
<td>8</td>
<td>0.17</td>
<td>0.55</td>
<td>12.6</td>
</tr>
<tr>
<td>Maize bran</td>
<td>88</td>
<td>9.4</td>
<td>0.04</td>
<td>1.03</td>
<td>9.2</td>
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<tr>
<td>Rice bran</td>
<td>88</td>
<td>13.5</td>
<td>0.06</td>
<td>1.43</td>
<td>12.6</td>
</tr>
<tr>
<td>Cassava</td>
<td>88</td>
<td>2.8</td>
<td>0.03</td>
<td>0.05</td>
<td>12.6</td>
</tr>
<tr>
<td>Molasses</td>
<td>75</td>
<td>3</td>
<td>0.75</td>
<td>0.08</td>
<td>9.8</td>
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<tr>
<td>Millet</td>
<td>88</td>
<td>10.5</td>
<td>0.05</td>
<td>0.4</td>
<td>5.8</td>
</tr>
<tr>
<td>Sorghum</td>
<td>88</td>
<td>9</td>
<td>0.03</td>
<td>0.2</td>
<td>13.6</td>
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<tr>
<td>Fish meal</td>
<td>88</td>
<td>60</td>
<td>4.37</td>
<td>2.53</td>
<td>9.7</td>
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<tr>
<td>Blood meal</td>
<td>88</td>
<td>80</td>
<td>0.28</td>
<td>0.22</td>
<td>4.9</td>
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<tr>
<td>Cottonseed cake</td>
<td>88</td>
<td>40</td>
<td>0.2</td>
<td>1.2</td>
<td>4.1</td>
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<tr>
<td>Soya bean meal</td>
<td>88</td>
<td>43</td>
<td>0.53</td>
<td>0.64</td>
<td>11.7</td>
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<tr>
<td>Bone ash</td>
<td>89</td>
<td>-</td>
<td>32</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>Lake shell</td>
<td>98</td>
<td>-</td>
<td>36</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Homemade concentrate</td>
<td>90</td>
<td>15.8</td>
<td>0.47</td>
<td>0.24</td>
<td>11.7</td>
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<tr>
<td>Napier grass and forage legume mixtures</td>
<td>23</td>
<td>9.7</td>
<td>0.26</td>
<td>0.23</td>
<td>9.6</td>
</tr>
<tr>
<td>Residues from an intercrop of maize stover and lablab</td>
<td>89</td>
<td>6.2</td>
<td>0.37</td>
<td>0.51</td>
<td>9.2</td>
</tr>
<tr>
<td>Maize stover</td>
<td>49.5</td>
<td>4.0</td>
<td>0.33</td>
<td>0.44</td>
<td>8.5</td>
</tr>
<tr>
<td>Grasses from roadsides</td>
<td>28.1</td>
<td>5.6</td>
<td>0.31</td>
<td>0.46</td>
<td>6.2</td>
</tr>
<tr>
<td>Banana peels</td>
<td>16.1</td>
<td>7.4</td>
<td>0.58</td>
<td>0.14</td>
<td>10.7</td>
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<tr>
<td>Sweet potato vines</td>
<td>15.4</td>
<td>14.3</td>
<td>0.87</td>
<td>0.30</td>
<td>10.6</td>
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<tr>
<td>Fresh lablab fodder</td>
<td>24.9</td>
<td>22.7</td>
<td>0.16</td>
<td>0.30</td>
<td>9.9</td>
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<tr>
<td>Lablab hay</td>
<td>88.3</td>
<td>15.6</td>
<td>0.48</td>
<td>0.47</td>
<td>9.0</td>
</tr>
<tr>
<td>Fresh calliandra fodder</td>
<td>40.9</td>
<td>28.3</td>
<td>0.29</td>
<td>0.55</td>
<td>7.1</td>
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<tr>
<td>Leucaena fodder</td>
<td>41.1</td>
<td>30.4</td>
<td>0.90</td>
<td>0.20</td>
<td>7.8</td>
</tr>
<tr>
<td>Calliandra leaf hay</td>
<td>80.0</td>
<td>16.7</td>
<td>0.46</td>
<td>0.47</td>
<td>9.0</td>
</tr>
<tr>
<td>Pawpaw leaves</td>
<td>35.5</td>
<td>21.6</td>
<td>0.17</td>
<td>0.54</td>
<td>12.6</td>
</tr>
<tr>
<td>Mango leaves</td>
<td>61.1</td>
<td>10.6</td>
<td>0.38</td>
<td>0.44</td>
<td>10.4</td>
</tr>
<tr>
<td>Jack fruit leaves</td>
<td>55.4</td>
<td>18.8</td>
<td>0.19</td>
<td>0.50</td>
<td>8.4</td>
</tr>
<tr>
<td>Banana leaves</td>
<td>28.9</td>
<td>8.5</td>
<td>0.18</td>
<td>0.4</td>
<td>9.5</td>
</tr>
<tr>
<td>Banana stems</td>
<td>53.4</td>
<td>8.1</td>
<td>0.25</td>
<td>0.31</td>
<td>10.7</td>
</tr>
<tr>
<td>Banana peels</td>
<td>27.0</td>
<td>7.6</td>
<td>0.11</td>
<td>0.20</td>
<td>8.3</td>
</tr>
<tr>
<td>Banana flower</td>
<td>23.9</td>
<td>10.2</td>
<td>0.22</td>
<td>0.52</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Source: Kabirizi (2004)
2.3 Feeding Dairy Cattle and Calf

2.3.1 Introduction

The future of a dairy herd depends on the feeds offered to the animal and feeding management. With the present situation of rising feed prices and low milk price, it is tempting to cut costs where the effects may not be immediately seen – the young stock program. However, this may be a costly mistake since feed costs are the major expenses involved in rearing heifers. Poor feeding results in higher age at the first calving and increased susceptibility to disease and failure of heifers to produce to their genetic potential during the first lactation. If the heifer has not calved by 25 months, the herd owner could lose a lot of money per day until it calves down.

Research has shown that higher producing herds have heifers calving at an earlier age and increases in farm net profit as age at first calving decreased. Young stock management should therefore ensure that heifers.

- Reach breeding weight and body condition by 14-15 months of age to allow calving by 23-26 months.
- Having healthy animals.

The delivery and consumption of balanced rations that will foster a uniform rate of gain is dependent on development of facilities that will provide for a relatively even distribution of daily feed intake; minimize problems associated with completion for feed, and minimize labour associated with feeding. Nutrient needs of a dairy cow vary from birth through the time that heifers enter milking herd. The young stock program begins with feeding and the care of the dry cow.
2.3.2 Dry cow management

Dry cow management prepares the cow for next calving and will affect:

- Ease of calving,
- Health of the born calf
- Milk production in the next lactation
- Udder health

The dry cow should be in good body condition (carrying slightly excess amounts of flesh) when dried off and maintained in this condition until calving. The nutrient requirements of the dry cow differ greatly from those of the lactating cow. It is apparent that dry cows must be separated from the lactating herd. Those with poor body condition should fed with at least 2 kg/day of concentrate (steaming up). Even if concentrates are not fed to dry cows, intake of low quality forages will not meet dry cow nutrient requirements and predispose cows to metabolic disease like: milk fever and dystocia.

A good mixture of grasses and legumes pasture is the most desirable for dry cows rations. The major grass used for feeding dairy cow is elephant grass (*Pennisetum purpureum*). Because dry cows require extra source of protein, supplementation with forage legumes like: Siratro (*Macroptilium atropurpureum*); Centro (*Centosema pubescens*); Lablab (*Lablab purpureus*) or Multipurpose fodder trees (MPTs) like Sesbania (*Sesbania Sesban*); Calliandra (*Calliandra calothyrsus*); Leucaena (*Leucaena leucocephola*).

Supplementation with mineral lick is beneficial in reducing incidence of white muscle disease in calves especially where
selenium is deficient in some soils. The goal of feeding a dry cow should be to maintain body condition and allow plenty of exercise to minimize problems associated with dystocia and encourage birth of healthy calves.

2.3.3 The Newborn Calf
The calf does not receive any immunity from the dam in utero. The new-born calf is also sterile. What happens during the first hour of life is critical to the health of the calf and therefore the calving environment must be conducive. Research has shown that the bacterial exposure a calf receives at birth influences the amount of colostrums it will absorb. Early exposure of the intestine to large quantities of bacteria probably interferes with colostrums absorption. A clean, well-drained grass paddock is preferred. If maternity stalls are used, they should be clean, dry and bedded well with dry grass.

2.3.4 Feeding the Calf from Birth to Weaning
This is the most critical period in a calf’s life. Goals may be simply stated as “Keep them alive, healthy and growing” during this period of feeding. Nutrition time is geared towards feeding high quality liquid and dry feeds to enable weaning at an early age. Adequate performance may be obtained by feeding colostrums, milk replacer (available in the shops) or whole milk.
(a) Feeding Colostrum
Colostrum, the first milk of the cow, is rich in antibodies which confer immunity to disease. The intestine of the calf absorbs antibodies quite well during the first few hours of life. However, the ability decreases rapidly with age and increasing bacterial colonization of the intestine. It is recommended that the calf receive 2 litres of colostrum as soon as possible after birth, preferably within one hour. There is evidence that it improves intestinal health and thus it is necessary to feed colostrums for the first three days.

In case the mother cow dies at calving, artificial colostrums can be constituted formulated with: 0.5 litre fresh milk + 1 fresh egg + 0.25 litre fresh water + 1 teaspoon cod liver oil + 1 teaspoon castor oil (Laxative)

On day 3 or 4 start feeding whole milk at a rate 1 kg/day for every 10 kg live weight of calf. The ration is again split into 2 feedings. Do not alter feedings. Do not alter feeding times and quantity utensils. Bottle-feeding can be used up to the third day. Bucket feeding starts by inserting your 2 fingers in the bucket with milk and lowering the heard of the calf’s mouth into the bucket.

(b) Roughage and Concentrate feeding
Gradually introduce good quality forage initially, from about 2 weeks of age. This stimulates rumen development and reduces problems of scours. Introduce concentrate (calf started/pencils) at about the same time pasture is introduced. Feeding is gradually increased so that by 12 weeks of age the calf is receiving 1-1.5 kg per day. Any change over of feed
type should allow a gradual adaptation to new feed at least over a period of 7 days.

(c) Feeding whole milk
Whole milk is an excellent, but expensive feed for dairy calves. It should be fed at a rate of 8-10% of body weight per day. The type of feeding utensils used in liquid feeding or the time calves are fed per day does not appear to affect performance, provided rigid sanitation of utensils is accomplished. Pails are easiest to keep clean and reduce spread of disease. Twice daily feeding permits more frequent observation of calves and increase the chances of early detection of digestive upsets. It has been observed that feeding fixed amounts of liquids encourages dry grain intake and promotes early weaning. High quality dry feeds are critical to successful early weaning. Economics dictate that the calf should be fed and managed to transform it to a ruminant at the earliest possible age.

(d) Water
Provide at least 10 it per day of clean drinking water at all times, especially when the calf begins eating solid feed.

2.3.5 Weaning
Prolonged whole milk feeding reduces profits for the dairy farmer especially when the calf is able to obtain the required nutrients from solid feeds. The time to wean however varies from farmer to farmer and depends on:

(i) Age of the calf
The most common weaning age in intensive systems is 8 weeks but it may go up to 13 weeks.
• Physical body condition of the calf
• Body weight
• Feed consumption

(ii) When should calves be weaned?
Calves should be weaned gradually when they are eating one or two kg of calf starter per day. Usually, calves can be weaned by four to eight weeks of age. This practice not only reduces costs associated with the high price of liquid feeds, but reduces the likelihood of calf scours. Weaning may be delayed when weather is cold or calves are weakened by previous or existing illnesses. Small breed calves need 9-10 more days of liquid feeding.

(iii) Feeding the weaned calf
Calves should be housed individually until they are 9-10 weeks of age. High quality pasture may be offered in limited quantities after weaning. Forage legumes like *lablab purpureus* have the highest nutrient content, but legume hay or a mixture of lablab-grass pasture cut at early maturity may be more palatable. Continue to feed calf starter and limited quantities of pasture until starter intake reaches about 2 kg/day. At this time calves may be switched to a less expensive concentrate that will adequately supplement the forage fed.

(iv) Feeding the heifer from four months to calving
Once the heifer has switched from a calf starter to a less expensive concentrate, forage quality is still important, as dry matter intake is relatively low and energy requirements are high. Breeding age heifers should be fed and managed as a separate group. Optimum conception is observed in heifer possessing adequate size (300-400 kg for Friesians, 250-350 kg for cross-bred animals. If heifers do not conceive on the
first service, ad libitum intake of forage fed to the lactating herd may lead to over-conditioning.

(v) **Feeding a lactating cow**
While feeding herd is like an old hat to some farmers, the challenge on how to feel high producing cows properly in early lactation still remains to many farmers. As production increases, feeding strategies and diagnosing nutritional problems become critical for profitability, optimum reproductive performance and minimum heat stress. To design an economic and efficient feeding strategies for a milking cow requires knowledge of dry matter (DM) intake, milk yield and body weight changes. The farmer should consult an extension worker for advice.

(vi) **Early lactation (0-60 days)**
- Milk production is high with peak yield occurring 7-9 weeks after calving.
- Nutritional demands are very high. Dry matter (DM) intake is therefore high. Cows may consume 18% less dry matter than they require.
- There is a high response to concentrate feeding. Each additional kg of DM a cow consumes may support up to 2.0-2.4 it more milk.
- Body weight loss may go up to 45 kg due to faster increase in milk production relative to feed intake.

(vii) **Feeding management should aim at:**
- Maximizing dry matter intake (DM) intake;
- Avoid excessive body weight loss;
- Developing the milk production potential of the cow for a; along-term effect. Poorly fed cows have a lower peak yield and; a shorter lactation.
(viii) Mid-lactation (60-140 days)
After peak period, milk yield declines gradually at about 2.5% per week. Yield of high producing cow drops faster than that of heifers. Concentrate feeding should be adjusted to milk yield and body condition and roughage increased in the ration. The plane of nutrition is very important at this stage if cows are to conceive.

(ix) Late lactation (140-304 days)
Milk yield and nutritional demands fall steadily. Body fat accumulation increased. The animal should be in mid-pregnancy during this phase. Lactating cows use feed energy more efficiently than dry cows. Feeding should be geared towards building the cow’s body reserves in readiness for the next lactation. Feeding of concentrates should be minimal unless the quality roughage is poor. Provision of supplementary mineral salts is important during this period.

2.4 Clean Milk Production

2.4.1 Introduction
Milk is an important dairy product that can easily perish if handled in an unhygienic manner. A dairy milking environment and poor milking techniques may also cause infection if the mammary gland (mastitis). Mastitis causes poor milk quality and reduces milk yield. It may also cause systemic illness and death of the cow. This will cause grante economic loss to the farmer. Production of clean milk is therefore a package of activities for the farm.
2.4.2 Preparing for the milk

(i) The milk shed
The milking shed should be provided with a feeding trough for concentrates. It is important that the milk shed is kept tidy if clean, wholesome milk of the highest standard is to be provided.

(ii) Preparing the cow
During milking, the cow should be handled in a quiet manner and should not be beaten, disturbed or denied access to concentrate feed. Stress on an animal in any way, such as beating it, banging utensils can be dangerous to the milker.

Young animals should be milked first, then older cows later. This will minimise the risk of transferring infection from the older cows to the young ones. The following procedures should be observed when preparing the cow for milking:

- The cow should always be led into the milking shed quietly.
- Maintain regular time of milking
- Once led into the milking shed, the animal should be restrained.
- Once restrained, the cow’s udder should be washed preferably with a clean cloth and warm water. If udder wash is available, it should be added to the water.
- An appropriate amount of dairy meal should be put into the feeding trough during milking time.
(iii) **Preparation of the milker**
The milker should be healthy, clean and free from any infectious diseases. The farmer should be familiar with good milking techniques and must handle the animal gently. The milker must wash his/her hands and arms with soap and water. Use of insecticidal spray during milking should be avoided.

(iv) **Proper milking technique**
(a) **Provide a clean, stress-free environment for cows**
A clean environment is essential to preventing environmentally caused mastitis. For maximum production, cows should have minimum stress. Stress reduces the milk let-down process. Handle cows calmly.

(b) **Sit or squat in a position that will allow you to move away quickly if the cow becomes uncooperative**
Sitting cross-legged on the ground, for example, is not safe. A common milk stool is fabricated using two 2x4’s cut and nailed to form a “T” - cut to fit your behind and make sure it is low enough to afford comfortable access to the underside of the cow.
(c) Apply a lubricant such as **Vaseline** to your hands to keep friction to a minimum
(d) Check foremilk and udder for mastitis
Examine the udder for swelling, heat or pain, and, using a strip
cup or plate, examine the foremilk from each quarter prior to
every milking. Get samples of milk from each test. This is
important in ensuring that milk from udder with mastitis is
not mixed with milk from other uninfected udder.

(e) Wash teats with an udder wash sanitizing solution
Washing each teat aids milk let-down and removes mud, dirt,
manure and other foreign objects on the skin.

(f) Dry teats completely with individual paper towels
Apply milking cream (salve), on teats sparingly for lubrication
and to avoid damaging the teats. Do not use milk, water or
saliva for this purpose.

Milking machines are designed to stay securely attached to a
dry teat. Drying the teat also prevents possible contamination
of the milk and teat by bacteria in the water running off
the cow’s udder and teats. This water, if present, acts as a
freeway for bacteria to enter the milking system. Remember,
the goal of every mastitis-control program is to prevent the
introduction of bacteria into a normal and healthy mammary
gland.

(g) Full-Hand Technique
The proper technique for the majority of your milking time
is using your full hand. Grasp the top of the teat by wrapping
your thumb and forefinger around it, then compress the teat
and wrap your other fingers around it as you squeeze. This
forces milk already in the teat out in a stream without sliding
your hand up and down the teat. Release the compression without fully letting go of the teat. This allows more milk to drop from the udder into the teat so you can compress your fingers from top to bottom and squeeze out the milk. Because your hand isn’t sliding on the teat, it reduces the chance of irritation to the cow.
(h) Which Side of the Cow
A cow which is not used to being milked won’t care which side you work from; there’s no set rule you must use to choose a side. However, it’s important to always work from the side the cow is comfortable with. When you choose a side, or if someone has milked the cow previously, use the same side every time you milk. This helps the cow relax. In the United States, most people approach the cow from the right side to milk, although people in other countries, such as India, often milk from the left.

2.5 Environmental Protection in Smallholder Dairy Production Systems

2.5.1 Introduction
The increase in human population has led to an increase in farming activities, deforestation and swamp reclamation in order to increase food availability. Crop and livestock farming in areas that would have been left as swamps, highlands,
river banks and other places that keep water in the soil is still going on. The environment that has changed or totally been damaged includes soil eroded by running water or wind, deforestation, and farming in swamps. All these have led to changes in climate and other aspects of environmental degradation. Thus, it is important that every crop and livestock farmer should try to protect the environment. This will result in increased sustainability of crop and livestock production and improved household welfare.

2.5.2 Environmental considerations in zero-grazing production systems

(a) Water sources and waste management

With increasing population density, the development of the dairy sector and human drinking water supplies are key aspects in areas where surface water is a constraint. The development of water points based on limited and in some cases seasonal sources of water and local ground water sites results in a concentration of livestock in such areas. The most obvious impact is often on vegetation, with the localised overgrazing resulting in degraded “sacrifice zones” around water points. However, the impact on water is through the direct contamination of water sources, which due to their restricted availability are often shared between livestock and humans.

In zero-grazing systems, the direct contamination of water with the dung, urine and mud which is washed down into the water sources by rain increases human and livestock health risks considerably. Water quality in wells is reduced as a result of the contamination of ropes and buckets used for
drawing water. The resulting contamination is less obvious than ground water sources, as the water may appear clean and therefore suitable for human consumption. It is therefore essential that animal wastes are disposed off in a way that limits contamination of water resources and water resources should be protected from contamination.

Water harvesting from the roof (top) and from the surface run-off (bottom) that are protected from contamination by covering and water cover plants which utilize nutrients from water.
(b) Choosing the site for a zero-grazing unit
Before you start constructing a zero-grazing unit, you should seek advice from the extension staff on where to construct the unit, plant pastures and other food and cash crops.
- Construct a zero-grazing unit on land which is not fertile or waterlogged. Leave fertile land for crop production.
- It should not be very far from the fodder garden.
- The shelter for the animals should not be very far from the residential house but not too near the residential house as to avoid house flies and stinking from cow dung.
- It should be located in such a way that the wind does not blow through into the residential house.

2.5.3 Contributing to environmental sustainability in smallholder dairy farming
(a) Planting multi-purpose trees – (Agroforestry)
Planting trees on hilly fields or on contours helps to prevent soil erosion. Trees such as *Leucaena, Calliandra, Gliricidia* and *Sesbania* provide additional high quality fodder for the animals that can be used to supplement proteins from grass. Trees such as *Ficus* Spp provide live fencing on farms as well as fodder.
(b) **Biogas production in zero-grazing production systems**

Biogas is obtained from cow dung and urine collected in a pit. The pit should be completely covered. The biogas is then collected and passed through tubes to where it is going to be used as a source of fuel or for lighting the house. Biogas has a number of advantages and disadvantages:

- Provides energy and reduces the cutting down of trees (deforestation)
- Provides slurry that is used as fertilizers and feed for pigs and fish.
- The production of biogas helps to protect the environment clean since the urine and dung are kept in a covered pit. This means that no smelly gas can pollute the environment and insects like flies that transmit diseases are prevented
CHAPTER 3

FEED PRODUCTION, MANAGEMENT AND UTILIZATION

By
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3.1 Pasture Establishment and Management

3.1.1 Introduction
The most important constraints to improve livestock production, in particular dairy production, are related to animal nutrition. When improved dairy cows are kept on small-scale farms, planting improved pastures and fodder crops is essential. To obtain increased milk yields the animals should be provided with supplementary feeds next to the grazing of natural grasses. Improved pastures, especially when legumes are included, can produce large quantities of high quality feed for the dairy animals at a low cost. Several possibilities are available to farmers to improve the ration of their animals. These include:

- Planting of improved pastures for grazing
- Planting of fodder crops for supplementary feeding during the dry season
- Cutting natural grass in the veldt or improved pasture for making hay
- Inter-cropping legumes in maize and/or grass to improve the nutritional quality and the utilization of the fodder
3.1.2 Importance of improved pastures in smallholder dairy farming systems

A pasture is a grass or other vegetation eaten as food by grazing animals. A forage is plant material (mainly plant leaves and stems) eaten by grazing livestock. Historically, the term forage has meant only plants eaten by the animals directly as pasture, crop residue, or immature cereal crops, but it is also used more loosely to include similar plants cut for fodder and carried to the animals, especially as hay or silage. While the term forage has a broad definition, the term forage crop is used to define crops, annual or biennial, which are grown to be utilized by grazing or harvesting as a whole crop.

(a) Cheapest source of feed
Pasture is the cheapest form of animal feed available and inexpensive concentrates are only required at very high levels of management. For good animal production, pasture species are required which give a high yield of palatable and digestible herbage, containing adequate nutrients for the animal. Grasses (elephant grass, Guinea grass, Rhodes etc) and forage legumes (Lablab, Green leaf desmodium etc) vary considerably in their nutritive value and productivity, it is therefore important to select those species which have been found suitable for the area in which the pasture is to be shown. As improved breeds of stock become more readily available provision of better nutrition and management will be even more important.

(b) Soil fertility improvement

- Utilization of selected crop residues such as maize, sorghum stovers etc.
Forage legumes have an important ability to extract nitrogen from the air and incorporate it into their tissue proteins. Proteins and hence nitrogen, are one of the fundamental constituents of living matter, and adequate supplies of nitrogen are thus essential for the normal growth of all plants and animals. Whereas other plants rely on nitrogen supplies in the soil for their requirements, legumes are independent of soil nitrogen and can thrive on nitrogen –deficient soils, provided that other nutrients are in ample supply. All grass covers are able to build up soil fertility. The organic matter content of the soil is increased by decaying plant material, and the minerals through deeply penetrating roots from lower levels in the soil. Under grazing there is in addition, a circulation of nutrients through the animal and back into soil via the dung.

(c) Soil erosion control
Soil erosion occurs when the soil surface is exposed to the sun, wind and rain by removal of the natural vegetation cover e.g. in cultivation or by burning, or through over grazing. As the physical structure of the soil deteriorates, which it does especially after periods of cultivation, the risk of erosion is greatly increased. Grass and legume covers are one of the best safeguards against erosion, since their finely branched roots systems help to consolidate and hold the soil, while the rapidly-growing tufted or creeping shoot system produces an efficient above ground protection, rebuild the physical structure of the soil.
(d) Source of income
Fodder (fresh and conserved) is a source of income particularly for urban and peri-urban farmers with inadequate land. Pasture seed production is another source of income due to the high demand and unavailability of good pasture seed.

3.1.3 Establishment of a pasture
Pasture establishment is vital to ensure high levels of production pastures. A good stand is necessary since any bare patches of soil will be filled with unproductive weeds. Rapid and vigorous early growth helps to suppress weeds. Before establishing new pastures or renovating existing pastures, the farmer must evaluate the farm’s forage needs. It is important to consider how the forage will be used (grazing vs. hay), what species might be more adapted to the area, and what resources (equipment, money, and time) are available. Renovating a pasture should be based on existing percentages of the desirable species present in the pasture. The following criteria could be used in such a decision:

(a) Selecting the right pasture species
The pasture species selected must be adapted to the climate and soil where they are to be sown, and also be suitable for their intended use. Having selected appropriate species, it is also important to plant locally preferred cultivars of these species. Major types of pastures include: forage legumes, grasses and fodder trees.

(i) Forage legumes
Forage legumes belong to the legume or bean family (Fabaceae or Leguminosae). Members of this large family (more
than 16,000 unique species) are characterized by having seeds born in pods, compound leaves with multiple leaflets, and root associations with bacteria that allow for symbiotic nitrogen fixation. Legumes produce seeds and foliage that are usually rich in protein with a desirable amino acid composition.

Forage legumes continue to be valuable crops throughout the world and especially in ECA region. They are integral components of sustainable agricultural systems, providing high quality livestock feed, nectar, seed, green manure, and soil cover. Properly managed forage legumes are nitrogen self-sufficient. These plants can achieve vigorous growth without the nitrogen fertilizers that are required for grasses. This self-sufficiency is achieved through the process of biological nitrogen fixation. Common pasture legume species include *Lablab purpureus* (Lablab), *Macroptilium atropurpureum* (Siratro), *Centrosema pubecens* (Centro) and others.
- **Macroptilium atropurpureum** (sirato)
- **Desmodium intortum** (Green leaf desmodium)
- **Desmodium uncinatum** (Silver leaf desmodium)
- **Centrosema pubescens** (Centro)
- **Clitoria ternatea**
- **Stylosanthes guyanensis** (Stylo)
(ii) Pasture Grasses

Pasture grasses are herbaceous plants used as feed for livestock in the form of hay, green feed, silage and haylage. Forage grasses are grown both in field and fodder crop rotations and apart from crop rotation, and many forage grasses grow on natural grasslands.

Good plant nutrition is essential for tropical perennial grass pastures to achieve optimum growth and quality for animal production. Tropical grasses are responsive to increasing nutrition and can produce an additional 100 kg of herbage in the growing season for every kg of nitrogen applied.

*Panicum maximum* (Guinea grass)  
*Chloris gayana* (Rhodes grass)  
*Setaria* spp (Setaria)  
*Brachiaria* spp (Signal grass)
(iii) **Fodder trees/Multi-purpose trees**

**Multipurpose trees** are trees that are deliberately grown and managed for more than one output. They may supply food in the form of fruit, nuts, or leaves that can be used as a vegetable; while at the same time supplying firewood, add nitrogen to the soil, or supply some other combination of multiple outputs. “Multipurpose tree” is a term common to agroforestry, particularly when speaking of tropical agroforestry where the tree owner is a subsistence farmer.

Fodder trees and fodder shrubs also known as multipurpose trees have always played a significant role in feeding domestic animals. In fact, trees and shrubs are increasingly recognized as important components of animal feeding, particularly as suppliers of protein and especially in harsh environmental conditions. In such situations, the available grazing is not generally sufficient to meet the maintenance requirements of animals, at least for part of the year. Thus, in extensive, animal production systems in the dry areas of Africa, it is generally estimated that ligneous materials such as pasture grasses
and crop residues contribute 40–50% of the total available feed. Such figures illustrate the existing and urgent need not only for better knowledge but also for better use of such potential, particularly in the present context of environmental degradation which is affecting our planet. Other uses of fodder trees include: fodder, fuel wood, employment, regulate the climate, wind breaks, timber, environmental protection, shade, soil fertility improvement, source of income and others.

*Sesbania sesban* (Sesbania)  
*Calliandra calothyrsus* (Calliandra)  
*Gliricidia sepium* (Gliricidia)
(b) **Soil fertility**
It is possible, if required, to adjust soil fertility prior to seeding. With today’s high fertilizer prices, a farmer cannot afford to guess how much fertilizer to apply. The first step is to obtain an accurate soil sample, and apply the recommended amounts of lime and fertilizer prior to seeding. The county extension agent in your area can be contacted for assistance on how to take a proper soil sample.

(c) **Seed quality**
Seed of most pasture legumes have hard seed that restrict entry of water. These seeds cannot germinate readily without pre-sowing treatment or until natural weathering has occurred in the field. To archive rapid establishment of pasture legumes with high degree of hard seeds e.g. *Centrosema pubescens* and *Macroptilium atropurpureum* (Siratro), it is important to “break” the seed coats before sowing.

**A simple viability test**
A farmer can carry out a simple viability test using a wet bloating paper.
- Randomly take 100 seeds from the seed you intend to use.
- Put water on a bloating paper and put the seed on the wetted paper.
- Make sure the seeds get enough light and water.
- After seven days, count the number of seeds that have germinated.
Percent (%) germination = \( \frac{\text{Number of seeds that have germinated}}{\text{100}} \)

Good pasture seed should have a germination percentage of over 30% for grasses and over 70% for legumes.

(d) Seed treatment
The seed of most forage legume species contains a high proportion of ‘hard seeds’. The seed coat of such seeds will not allow the seed to take up moisture and thus to germinate unless it is treated in some way. In the longer term, hard seed will germinate because of the influence of changes in soil temperature and moisture content on the seed coat but with some species this may take several years. For a rapid germination and establishment of seed of less than 9 months of age, seed should be treated either by mechanical scarification or by immersion in hot water – both techniques readily suited to commercial practice. There are often techniques, such as heat treatment or acid scarification but which are more difficult to undertake, especially for large quantities of seed and the lack of appropriate facilities for on farm treatments.

(i) Hot water treatment
This involves soaking seed in warm water for about 3 minutes. The seed is then soaked in cold water over night and dried in the shade in the morning before planting. Seed treated this way can be stored and dried in the shade in the morning before planting.

(ii) Mechanical scarification
Mechanical scarification can be carried out by abrasing seed
with sandpaper in a rotating drum lined with medium grain sandpaper and fitted with a spinning disc that throws seed against the walls of the container. Small quantities of seed can be treated by rubbing the seed between sandpaper. Rubbing seed on a rough cement floor is also effective. The alternative is to heat seed in water at 80°C for four minutes and allowing it to dry out. This is the specific recommendation for leucaena seed if less than 12 months old.

(iii) Rhizobial requirements of legumes
Most legumes require inoculation with rhizobia that will enable the plants to fix nitrogen from the air. In many cases a specific strain of rhizobium is required e.g. for centro seed, but in others the soil may contain the appropriate rhizobium and inoculation may not be required. However, even if the soil contains the required rhizobium strain the rate of nodulation and nitrogen fixation will be increased through applying the inoculant in contact with the seed.

The rhizobium is commercially available mixed in a peat culture, which ensures the survival of the rhizobia until seed germination. Improved survival is obtained by using an adhesive or sticker to attach the inoculum to the seed. The most readily available form of sticker is a 10% sugar solution (i.e. 10 gm sugar in 100 ml water). Seed is wetted with the solution and the peat culture mixed with the seed and allowed to dry in the shade - direct sunlight will kill the rhizobium.

The main points to be observed when inoculating seed are:

- Make sure that the seed has not been treated with chemical and that containers used do not contain toxic substances such as oil, petrol, chemical pesticides;
- do not mix inoculated seed with acid fertilisers such as
superphosphate;
- Ensure that the peat culture used is within the expiry period;
- Store inoculum in a refrigerator - up to 2 months maximum.
- Sow into moist soil.
- Spraying a peat/inoculum mix onto established legumes during cloudy weather can partially or completely overcome nodulation failure.

(iv) Dormancy
Dormancy of freshly harvested pasture grass is important. Storage of grass seed for 3-6 months in a cool dry place overcomes this.

(v) Use of fungicides and insecticides
Seeds may also be treated with fungicides and insecticides like *acetyllic* (for instance to reduce ant theft in surface sowing), or lime coated where soil acidity is marginally too high for species. The farmer is advised to get all the necessary instructions concerning the seed he buys.

(e) Seeding rate
Seeding rates depend upon the species, method of seeding and potential site productivity. Seeding rates of many grass species are based on kilograms of pure live seed (PLS) per acre. PLS is the percentage of the bulk seed material that is live seed. This is determined by multiplying percentage germination by percentage purity of the lot of seed. When hard seeds are involved, PLS = (percent germination + percent hard seed) x percent purity. A higher seeding rate will help in competing
against weed pressure and decrease the time of achieving a complete stand of grass.

Small seeded species like *Desmodium and Stylo spp* are sown at a lower rate of 2 kg/ha than the larger species like *Lablab and Centro* which are sown at a rate of 7-10 and 3kg/ha respectively.

(f) **Planting Depth**
Optimum seeding depth is dependent on seed size. The maximum depth a seed should be planted is 5 times its diameter. Since smaller seeds have a smaller quantity of stored energy, do not seed them as deeply as larger seed. As a rule, grass seed should be planted in a firm seedbed at 1/4 inches deep. When using a mixture of small and large seed, always plant at the depth of the small seeded variety in the mixture. Planting grass seed too deep is the single most reason for crop failure.

(g) **Methods of pasture establishment**
The common methods of seeding perennial warm season grasses are drill planting (row) and broadcast applications. Regardless of the planting method be sure the clods are worked down to a minimum. Drilling is the superior method because the seed is placed in the soil at a controlled planting depth, thus improving the probability of stand establishment. When using this planting method, the seedbed must be clean-tilled, free of rocks, stumps and other litter.

(ii) **Broadcasting**
Broadcast applications refer to spreading the seed over the soil
Broadcast applications can be accomplished through scattering the seed by hand, rotary spreader, with air stream applicator with fertilizer or E-Z Flow type fertilizer/seeder spreaders. Broadcast seeding is seldom effective without some soil disturbance before the seeding operation. Small, slick seed lend themselves to broadcast seeding much better than fluffy seed. Regardless of the method, the seed must have seed-to-soil contact in a very firm seedbed. Broadcast seeding has a higher probability of success if the soil is rolled before and after seeding.

(iii) **Row planting**
Row planting involves growing seeds in straight line. The recommended spacing for row-planted seed is 30 cm between rows. Planted seed must be covered lightly with soil. Uncovered seed can be eaten by birds or washed away by the rain. A garden with row planting is more visually appealing.

(iii) **Undersowing/intercopping**
Pasture is established under companion crops such as maize wheat, oat or barley. The aim is to reduce the number of operations to be undertaken. For example, the pastures are sown when for example maize is knee high and after second weeding. It is important to make sure there is no competition from weeds. If this is done at the appropriate time it will have little effect on the yield of the cereal crop and the fodder bank can be used immediately after harvest. It will also reduce on the cost of preparing land.

(iv) **Vegetative propagation**
Some grasses do not produce viable seeds therefore
establishment through vegetative means i.e. vegetative cuttings or root cuttings. Examples of such grasses are Napier grass, Kikuyu grass and Star grass. This is because seed is often not available. A wide range of methods is available ranging from complete hand planting of “runners, splits or cuttings” with a hoe to fully mechanized methods. The best planting material to use is the older stolons of stems containing new root growth. It is essential to plant into a moist seedbed and at least some part of the “runner” covered with soil. Complete burial or no coverage of the runner is both likely to fail.

Always include at least 2 nodes with viable auxiliary buds and root primordial. Root cuttings or sett should have 3 – 5 “stems”. Vegetative and root cuttings are sensitive to dry weather conditions therefore should not be planted in dry periods and only in rainy periods. Strip off excess leaves because they dehydrate the vegetative parts rapidly.

(h) Management of pastures
The reason for establishing improved pastures is to provide more feed of good quality for livestock. There will still be a seasonal growth pattern in the new pasture similar to that in the old. There will be periods of lush, high protein feed which is more that the stock can eat and there will be other periods when the total feed available is too little or its nature value is low. Pasture management is as important as selecting the right species and applying the correct fertilizers.

(i) Early grazing
Grazing of any kind should be different until the legumes and grasses have developed a strong root system and are well
established. Because the ground may still be soft following seedbed preparation, pasture plants may be pulled out of the soil or the soil is more likely to be compacted by livestock.

It is probably best to defer first grazing for a period of eight to twelve weeks after germination of the seed. Normally the pasture plants will be 0.9 to 1.2 m high at the time of the first grazing. This should be lenient to reduce the pasture to an average height of 0.3 m. The principle of an “on and off” or rotational grazing holds good for most legume pastures, but there are exceptions. Stylo, white clover and *Lotonisis* are low growing legumes, which are intolerant of shade by taller growing legumes. Pasture containing these species should be grazed earlier and heavier to reduce the shading effect of grasses.

(ii) Sward vigour and balance of species
In all legumes-based pastures, the legume component is the most important component. Not only are these plants the nitrogen factories on which the grass legume depends, but they also have the highest protein value themselves. If the legumes become weak or depressed, the whole pasture becomes nitrogen deficient and so decreases in food value, and a lower carrying capacity.

Because legumes have a higher protein content than grasses there is the danger that the legumes may be selectively grazed. This in turn leads to an increase in competition for light by the grasses. The intolerance to sharing of the low growing legumes especially stylo and clover, has already been mentioned and it suggested that grazing pressure can be increased with
these species. However, for stylo and other annual forage legumes, every opportunity should be given to the plants to flower and set seed as much as possible. Not only do the pods containing the seed provide a protein-rich feed for stock but many pass through livestock to be deposited in dung to germinate the following season.

(iii) Weeding
The definition of a weed is a plant in the wrong place. Clearly some species of plant are highly undesirable, particularly if they begin to dominate areas of pasture. The best way to stop weeds dominating is to manage pastures well to ensure that over grazing and poaching is kept to a minimum. Topping of areas during the wet season will reduce the vigour of some species and limit their spread. If the weed problem is extensive then spot spraying with an appropriate herbicide is often used as a method of control. If herbicides are used animals will need to be excluded for a period of at least one month. When using herbicides it is extremely important that the directions on the label are followed. If you are unsure of the correct method of use it is advisable to consult extension worker.

(iv) Paddocking
As pasture plants grow older the amount of herbage increases but its quality decreases. Rotational grazing ensures production, and helps to maintain or improve the condition of the pasture. An interval of one to two weeks grazing followed by four to eight weeks rest normally results in optimum production and breaks the life-cycle of most internal parasites. The size of the paddocks depends on the number of the animals on the farm and the total area of the pastures but paddocks of about
1-2 ha are usually satisfactory.

Night grazing, particularly at times of pasture shortage, is necessary to achieve optimum animal production and paddocks for night grazing are therefore strongly recommended.

Each paddock is grazed for 2 weeks, followed by 4 weeks rest. Any paddock can be used for night grazing, but factors, which would influence the choice, are security and the age and condition of the pasture. Where it is essential to confine animals at night it is very important to release them early in the morning to make maximum use of day light grazing, or provide some cut fodder.

(v) Fencing
Controlled grazing necessitates fencing. Fodder banks must be protected from intruding animals to ensure that the producer reaps the benefits of his investment and efforts. Fencing also enables herd owners to manage their fodder banks properly, limiting their use to specific times and specific animals.

The high price of posts and barbed wire makes fencing the greatest single cost in the establishment of pasture and economics should be made wherever possible. Proprietary fencing systems with metal posts and ring-lock type fencing are the easiest to erect and are very durable. They are however, the most expensive and difficult to acquire. Treated poles are durable but also expensive and difficult to transport.

Bush poles are cheaper but very prone to termite attack and need to be replaced almost every year. However, bush poles
can be treated with used engine iol to reduce termite attack and minimize the rate of damage. Where suitable tree species such as *Ficus spp* exist, they can be used as live fence posts, which take root and do not need to be replaced frequently.

(vi) **Kraaling or night paddocking**
If animals are kept in the kraal overnight for 2 to 5 days at the beginning of the rainy season they will reduce natural grass cover and disturb the soil sufficiently to enable good germination and establishment. Seed is then broadcasted and the cattle moved to an adjacent area. The yield in the first year, especially from the later sown areas, likely to be low but will increase in subsequent years.

(vii) **Fertilizer application**
Pasture legume establishment can be encouraged by maintenance dressings of superphosphates and/or nitrogen fertilizers which should be applied just prior to the main growing season.

(viii) **Burning**
Burning old pastures has been practiced especially when growth is rank and dry. Although burning feed is wasteful, it may be useful in giving more accessible green feed, reduce completion by taller growing and perhaps less palatable species and control scrub regrowth. It is also an effective method of preparing seedbeds for legumes provided there is adequate cover of herbage. The ash left may provide the seeds with a good cover and improve contact with moisture. This method is, however, not suitable for area with hard pans or slopes because the seeds will be washed away. Burning breaks
dormancy period for some grass species. There is a need to control burning to avoid fire spreading to the neighbourhood or harm animals and people and destroy property.

(ix) **Slashing**
Mechanical slashing can extend the grazing season and reduce any accumulation of unpalatable stemmy material. This is recommended at least once a year.

(x) **Over sowing**
Where vegetation has been grazed and the soil is forage legumes can be established by broadcasting seeds without further land preparation.

(j) **General management of pasture**
Some large trees to provide shade to the animals should be left in the paddocks. Shade alleviates heat stress. Water troughs should be made available in the paddocks.

Good management techniques can only be acquired by practical experience. A good manager must be able to assess both the needs of his livestock and the needs of the plants, especially legumes, in the pasture. It may be necessary at certain times to sacrifice temporary the needs of one or the other, but in the long term a balancing of the needs of both will give best results.
3.2 Pasture Based Beef Cattle Fattening

3.2.1 Introduction
The traditional systems of selling cattle in Uganda recognize that meat is a by-product. Cattle are kept mainly for milk. Bull calves are usually killed on many of zero-grazed farms due to the high cost of raising them. Meat yields are low, the beef is of poor quality and farmer’s returns are often inadequate to buy a replacement stock. There is obvious scope to improve this traditional and inefficient system through strategic feeding of good quality forage to fatten the bull calves and the culled cows before they are sold; or to buy and fatten animals sold by others.

3.2.2 Importance of forages in beef production
- Cheapest source of animal feed and thus high economic benefits can be realized with good pastures.
- It is technically quite simple and within the capacity of peasant farmers
- Where agro-industrial by-products are available it is possible, to use these to fatten animals
- To use these to fatten animals
- Forage-based fattening is ideally suited to “cut-and-carry” feeding. The cut-and-carry system is the most efficient way of using forage
- It increases livestock performance through higher forage production and higher rates of utilizatio
3.2.3 Feeding Management
The following recommendations apply to forage-based fattening of livestock.

- Don’t start the fattening programme until feed supplies are assured
- Animals should be fed as much as they can eat for 24 hours per day. Underfeeding is the main cause of failure in fattening programmes.
- Feed for 90-120 days. Experience from Ethiopia shows that with intensive feeding, cattle or calves can be sold off over this period
- Make sure the animals have clean water available at all times.

3.3 Fodder Crop Establishment

3.3.1 Introduction
Fodder crops are crops planted specifically to provide feed for a “cut and carry” grazing system. They are cultivated and managed in the same way as arable crops. Common useful fodder crops include: Elephant grass (*Pennisetum purpureum*), Guatemala grass (*Tripscum laxum*), Lablab (*Lablab purpureus*), Sorghum and *Brachiaria* spp.

Emphasis will be put on elephant grass and lablab since these are the most commonly used pastures in smallholder dairy farming systems.
3.3.2 Establishment and management of Napier grass (*Pennisetum purpureum*) fodder bank

Napier grass, commonly known as Elephant grass is a tall, perennial grass indigenous to tropical Africa that performs well from sea level to an altitude of 2000m. It is the dominant grass in zero-grazing systems, even in areas above 2250 m, which may be too cold for optimal performance of this grass. Napier grass can out-yield many other grasses such as guinea grass (*Panicum maximum*) and Rhodes grass (*Chloris gayana*). It has the advantage of withstanding repeated cutting, and four to six cuts in a year can produce 50-150 tonnes fresh herbage per ha. During the dry season, Napier grass is the main feed for dairy cows, supplemented by crop residues such as maize stover, bean haulms, banana leaves and pseudo-stems and indigenous fodder trees.

3.3.3 Role of Napier grass in smallholder farming systems

Napier grass commonly known as Elephant grass is an important fodder in East and Central Africa and has been increasingly associated with intensive (stall-feeding) and semi-intensive dairy cattle and goat production systems to meet the increasing demand for milk and meat. The grass produces high dry matter herbage yield (8-30 tons/ha/yr). Napier grass is widely used for soil and water conservation in hilly slope areas. In Uganda and Kenya, for example, vigorous campaigns are being undertaken to sensitise and encourage farmers to take on elephant grass cultivation for fodder and as a measure to control stem borers and soil erosion. Napier grass has been identified as an important tool in the integrated management of stem borers of maize and sorghum due to its importance.
as a trap crop for these pests. Napier grass fodder and milk are a source of income. The grass also serves as mulch in banana farming regions of Uganda, Kenya and Tanzania. Other uses of Napier grass are: wind and fire break. On farm intended matured grass turned into reeds can use for cheap farm construction.

3.3.4 Establishment, management and utilization of Napier grass
Napier grass is a fast growing, deeply rooted, perennial grass growing up to 4 metres tall that can spread by underground stems to form thick ground cover. Napier is easy to establish and persistent; drought tolerant; suitable for cutting and very good for silage making.

(a) Climate and soils
Napier grass can be grown at altitudes ranging from sea level to 2,000m above sea level. When grown at altitudes above 2000 m, growth and regeneration after cutting is slow and it may die due to frost. It does best in high rainfall areas, over 1500 mm per year. Napier grass can grow in almost any soils; but does best in deep, fertile, well-draining soils. It is however very drought resistant and can be used as dry season reserve in dry areas.

(b) Establishment
Establishment is by vegetative means using canes with 3-4 inter-nodes. These are inserted in the soil leaving one inter-node uncovered. Cane planting materials should be obtained from plants about to flower where the stems are still green.
Splits can be used instead of canes. A fine seedbed is not necessary, but is advisable to remove perennial weeds.

(c) Varieties
A number of Napier grass leafy varieties e.g. Kawanda variety 4 (KW₄) and Pennisetum 99 (a hybrid between KW₄ and Bulrush millet) are available. *Pennisetum* 99 variety is high yielding with higher protein content (average, 20 Mt/ha/year and 12% Crude protein) at 8 weeks after planting compared to the local variety commonly found along the roadside (<5Mt/ha/year and about 5% CP)
3.3.5 How to plant Napier grass
Two methods may be used, namely:

(a) Conventional method
- Dig up a width of 15-20 cm and a depth of 15-20 cm at a spacing of 3 ft (90 cm) between rows x 2 ft (60 cm) between plants.
- In each hole apply one or two handfuls of farm yard manure (10 tons/ha FYM) or (20 to 40 Kg P205 /ha)
- Place a 3-node cane at a slanting position in the soil, ensuring that two nodes are covered by the soil.
- Place the root splits into the planting holes and cover with soil

(b) Tumbukiza method
This method gives higher herbage yields even during the dry season than the conventional method. There are two types of Tumbukiza, namely the round pit type and the rectangular pit type. For round pits dig up a diameter of 60 cm and a depth of 60 cm. The rows of pits should be 60 cm apart.
(c) Intercropping with forage legumes
Vigorous forage legumes like Centro, Siratro and Desmodium can be planted with elephant grass to improve its feeding value.

Napier grass intercropped with forage legumes

The legume should be planted at a spacing of 1 m x 1 m and a seed rate of 1 -4 kg/ha near the grass rows. The legume helps to control the weeds and contribute to herbage production without competing with the grass. It also improves the Nitrogen content of the soil and the grass.

(d) Fertilizers
Napier grass is highly sensitive to soil fertility conditions and it gives large responses to nitrogen fertilization, especially during the second and third years of growth. Suggested rates of application are 100 – 200 kg per hectare of NPK fertilizer. Other fertilizers are Sulphate of ammonium, Calcium Ammonium Nitrate (CAN) and Urea. Cow dung and cow urine are the cheapest source of Nitrogen.
(e) Weeding and inter-Row Cultivation
Weeding is essential during the establishment of the crop, and also later, to maintain the grass in a vigorous and productive condition. Napier grass is very sensitive to weeds after cutting.

(f) Harvesting
Napier grass is ready for harvesting 3-4 months after planting and harvesting can continue at an interval of 6-8 weeks for 3 - 5 years. Leave a stem length of 10 cm from the ground at harvesting. Napier grass is fed green to livestock. Excess green feed can be preserved in the form of silage.

(g) Potential Yields
Yields depend on agro-ecological zone and management but on average Napier grass can give 12 to 25 tons/ha of dry matter yield.
(h) Feeding management

- Chop the harvested Napier grass to reduce wastage while feeding to animals.
- Do not graze animals directly on Napier grass.
- Feed 70 kg of fresh Napier grass to a dairy cow (about 450 kg live weight) per day.
- Two acres of Napier grass planted by the conventional method can give enough feed for 1 dairy cow and its heifer for one year.
- One acre of Napier grass planted by the Tumbukiza method can give enough feed for 2 to 3 dairy cows for one year.

3.3.6 Common Napier grass diseases

The diseases are commonly observed on cultivated elephant grass are;

3.3.6.1 Napier stunt disease

With the expansion of elephant grass crop has come a new disease called ‘Napier Stunt’. The disease causes healthy thick Napier grass leaves to turn thin, yellow and weak. Affected elephant grass plants remain stunted, have short internodes, bunchy appearance and produce very low biomass yields. Leaves of some affected plants begin to dry at the edges and have a ‘torn’ appearance. Yellow/purple streaking starting at leaf tips. The yellowing should not be confused with yellowing due to poor soils. Eventually the stool may be completely destroyed.
Cause and spreading of Napier stunt disease
The disease is caused by phytoplasma- microscopic bacteria without a cell wall (class mollicutes) found in phloem cells of plants. Transmission is mainly by insect vectors (Leafhoppers) and planting canes or root splits from infected plants.

Leafhoppers

- Insects acquire the disease by feeding on infected plants
- Insects get infected with the phytoplasma
- Phytoplasma multiply in the insect
- When insects feed on healthy plants phytoplasma are introduced into the phloem tissue

Effect of the disease on fodder yield and animal production
The plant height of Napier grass is reduced from about 1.2 to 0.6 meters; root length is reduced from about 18 cm to 9 cm; while herbage biomass yield is reduced from about 19 to 7.5 tons per hectare.
While a healthy acre of Napier grass when properly supplemented should provide feed to sustain one productive cow for about six months, plots affected by the disease may support the same animal for less than 3 months, greatly reducing milk yields and household income. Surveys conducted by scientists at the National Crop Resources Research Institute and the National Livestock Resources Research Institute have shown that over 90 percent of elephant grass fodder fields in Uganda are affected. The reduction in fodder yield forces farmers to buy grass to compensate for declining production or to reduce the number of animals.

**On-farm spread of Napier stunt disease**

Major methods of spreading Napier stunt disease on-farm are:

- Sale of Napier grass in market places
- Movement of planting materials by farmers
- Insect vectors of Napier Stunting Disease
- Phytoplasma is transmitted vegetative propagation methods
• Infected planting materials
• Ignorance on symptoms and mode of transmission
• Specific phloem feeding insects, especially leaf hoppers and plant hoppers

**Methods of Napier stunt disease management**

• Uproot and burn diseased plants and fill the gap with clean disease free planting materials
• Use tolerant varieties
• Plant disease free cuttings or splits
• Use recommended agronomic practice (spacing; fertilizer application; proper cutting intervals and cutting heights)
• Farmers are advised to contact their extension staff or NARO researchers

**3.3.6.2 Snow Mould Fungal Disease**

**(a) Symptoms**

It is fungal disease that causes white mould on attacked leaves and stems of most Napier grass varieties. It is caused by *Beniowskia sphaeroidea*. Affected Napier grass do not lose the vigour of the plants and feeding livestock on the diseased leaves has no adverse effect.
Management and Control

- Use of disease resistant varieties
- Obtain planting materials from crops free from the disease preferably at KARI centers.
- Improvement heath of the crop by applying manure and fertilizer.
- Avoid using manure from livestock fed on smut infected plants.
- Observe routine agronomic measures

3.3.6.3 Napier grass head smut disease

Head smut disease, caused by the fungus *Ustilago kamerunensis*, has a devastating impact on Napier grass, turning vigorous, impenetrable clumps of valuable livestock feed into thin, shrivelled stems. The problem is currently confined to relatively small areas, but the risk of spread throughout the region has made finding a solution a matter of urgency.

Symptoms

Early flowering with smutted heads, stunted plant with thin leaves and lots stems, these lead eventually to tillers dying. Symptoms start on some tillers and eventually affect the whole plant.
**Napier head smut disease**

Infected plants flower early, the flower head is a mass of black spores and the stems are smaller and produce much less leaf than healthy plants.

Transmission of Napier head smut disease is mainly by planting canes or root splits from infected plants and through manure and wind. Farmers whose Napier grass has been infected can lose up to 1/3 of the crop to the disease (5 to 6 t of dry matter from 1 acre of Napier in a year). Some Farmers in Kenya have had to sell their cattle because they did not control the disease.

**How to control Napier grass head smut disease**

- Inspect your crop regularly and remove the diseased parts of plants. Burn the diseased Materials. Do not feed them to cattle because the disease might be returned to the farm in the manure.
- Obtain planting material from areas free from the disease. Select healthy-looking plants that do not have black flowers. Avoid plants whose stems look thinner than normal.
- Improve the health of the Napier grass by applying...
manure or fertilizer. Use 1 heaped
• Shovel of dry manure per stool twice a year, or 2 bags of NPK 20:1 0:1 0 per acre every year. Apply 1 bag in the middle of the long rains and 1 bag at the beginning of the short rains.
• Weed your grass after every harvest.
• Plant Napier grass like Kakamega 1 that resists the smut disease. Ask your extension officer about alternative fodder crops, such as Guatemala grass, Giant Panicum or Giant Setaria.

Sources of good disease free Napier planting material
Efforts have been made under the Eastern Agricultural Productivity Project (EAAPP) to multiply Napier grass clones that are tolerant to Napier stunt disease at the following places:

• Zonal Agricultural Research and Development Institutes (ZARDIs)
• Kamenyamiggo District Agricultural and Information Centre (DATIC) in Masaka district
• Mafubira sub-county, Jinja district
• The National Livestock Resources Research Institute, Tororo
• National Crops Resources Research Institute, Wakiso district
• Buginyanya ZARDI in Sironko district
3.3.7 Establishment of Guatemala (*Tripscum laxum*)

Guatemala grass is a fodder that grows well in areas where Elephant grass or Napier and other fodder crops that withstands Napier stunt disease which can be grown to increase livestock production. The grass grows well in mid to high altitude agro-ecological zones.

*Guatemala grass*

**Establishment of Guatemala grass**

- Prepare root splits of 30 cm length
- Plant 1 root per hole
- Plant with either Single superphosphate fertilizer (consult your extension staff for the fertilizer rates). Using compost cow manure (about 2 handfuls per hole) from the grazing unit will minimize the cost of applying fertilizers
• Cover with soil firmly

Management of Guatemala grass
• Remove the weeds.
• Harvest Guatemala grass first at 3-4 months after planting.
• Maintain a stubble height of 10 cm to encourage quick re-growth and harvest every 8-12 weeks intervals.
• Top dress with Nitrogen fertilizer at the beginning of the rain season.

Utilization of Guatemala grass
• Well managed Guatemala grass produces 4-6 tons of dry matter per acre and this can be enough to feed one dairy cow per year.
• Harvest and chop to 2-3 cm and feed fresh to livestock.
• Make silage when plenty for dry season feeding.

Benefits of Guatemala grass
• It is easy to establish using root splits
• Is not affected by Napier stunt disease
• Grows well in many parts of East Africa
• Produces high fodder yield (about 70% of the forage produced by Napier grass)
3.3.8 Establishment of *Brachiaria* hybrid cv. Mulato 1

*Brachiaria hybrid cv* Mulato 1 (Signal grass) is a hybrid between *Brachiaria brizantha* × *Brachiaria ruziziensis*. *Mulato* is a semi-erect perennial grass that can grow up to 1.0 m tall.

*Brachiaria* Mulato combines high protein content (13%), herbage fodder yield, drought resistance and adaptation to infertile soils. Improved *Brachiaria* grass cultivars for example, cv. Mulato II were developed to adapt to the low rainfall and acidic soils to help farmers tackle the issue of forage shortage under these conditions. These *Brachiaria* grasses have also shown good agronomic characteristics in areas such as Uganda and Rwanda. *Brachiaria* can therefore be used to supplement...
Napier grass fodder especially during the long drought when Napier grass productivity is affected by Napier stunt disease.

**Establishment, management and utilization of *Brachiaria***

*Brachiaria* requires well-drained soils of medium to high fertility with pH 4.5–8.0 but can grow in less infertile acid soils. Mulato can be established from seed planted into a well-prepared seedbed at 6–10 kg/ha seed and spacing of 1 x 1 m. *Brachiaria* can also be established vegetatively from stolon cuttings and splits. The rooted stems are planted at a spacing of 1 m x 1 m.

The grass responds well to additional nitrogen fertilizer from organic and inorganic fertilizers. It establishes rapidly, achieving 85% ground cover at 2 months after seeding. The nutritive quality of *Brachiaria* grass is improved when intercropped with forage legumes such as *Centrosema pubecens*, *Clitoria ternatea* and others. Weed control is important in improving fodder yield and quality. The grass can be lightly grazed after 3–4 months or used for cut-and-carry production system. Mulato makes good quality (10-14% CP) hay; is more palatable and easier to conserve than other grasses.

**Fodder yield of *Brachiaria***

Studies conducted in Masaka district of Uganda showed dry matter yields of 15-25 tonnes/ha/year. Table 2 shows dry matter yields of three forage species and number of days a mature cow of about 470 kg live weight can be sustained on fodder from one hectare (2.5 acres) of *Brachiaria* and forage legume mixture. The average protein content of Mulato
ranges between 9 to 17\% while that of elephant grass ranges between 7-12\% depending on the variety.

Table 3.3.8.1: Fodder production and feeding period of different forage banks in Masaka district of Uganda

<table>
<thead>
<tr>
<th>Forage species</th>
<th>Napier grass and Centro mixture</th>
<th>Brachiaria and Clitoria mixture</th>
<th>Napier grass monocrop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
<td>Mean DM yield (tonnes/ha)</td>
<td>Feeding period (days) from 0.5 ha</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.8</td>
<td>254.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.2</td>
<td>195.5</td>
<td>167.0</td>
</tr>
</tbody>
</table>
| Source: Kabirizi et al., 2013

The forage legume acts as a cover crop to control weeds and conserve soil moisture during the dry periods, apart from the possibility of augmenting Nitrogen supplies to the grass component through symbiotic nitrogen fixation. Results from this study shows that the currently recommended acreage of 0.5 ha of a mixture of Napier grass and forage legumes for dairy cow under stall-feeding system cannot sustain an economically producing dairy cow and its calf for a full year. Introducing 0.5 ha of a mixture of Brachiaria and forage legumes on farms previously dependent on 0.5 ha of a mixture of Napier grass and forage legumes, provides year round feed supply.
Other attributes of *Brachiaria hybrid* cv Mulato are shown in Table 3.3.8.2

**Table 3.3.8.2: Comparison of *Brachiaria* and Mulato**

<table>
<thead>
<tr>
<th><em>Brachiaria hybrid</em> cv Mulato</th>
<th>Napier grass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal wastage (over 90% of the fodder is consumed)</td>
<td>Over 30% is wasted because of the stems that cannot be easily digested by the animals</td>
</tr>
<tr>
<td>Can be conserved as hay and silage</td>
<td>Can only be conserved as silage</td>
</tr>
<tr>
<td>Easier to handle due to softer leaf blades</td>
<td>More difficult to handle due to stiff hairs</td>
</tr>
<tr>
<td>Cutting frequency of 8-10 weeks</td>
<td>Cutting frequency of 8 – 10 weeks</td>
</tr>
<tr>
<td>Drought tolerant</td>
<td>Napier grass requires fertile soils</td>
</tr>
<tr>
<td>Resistant to spittlebugs and adapted to acid infertile soils</td>
<td>Many of the varieties are susceptible to Napier stunt disease</td>
</tr>
</tbody>
</table>

### 3.3.9 Giant Setaria (*Setaria sphacelata var. splendida*)

Giant Setaria is a good fodder that is not affected by Napier stunt disease. It is an alternative fodder crop which does well in low to high altitude areas of East Africa.
Giant Setaria

Giant setaria produces a biomass yield of up to 20 tons/ acres of fresh material with a crude protein content of about 10%. Setaria can be used for fodder production and soil conservation when planted along contour lines. Setaria grows well in areas where Napier grows.

Establishment of Setaria

- Get planting material from an already established healthy Setaria field. It is usually established from splits.
- Plant single not split per hole at a spacing of 50 cm x 50 cm between plants and between rows.
- Use Di-ammonium phosphate (DAP) fertilizer or cattle manure.
- Cover firmly with soil.

Management of Giant Setaria

- Harvest 3-4 months after establishment.
- Leave a stubble height of 5 cm from ground level.
- Harvest at a frequency of 8-12 weeks thereafter depending on soil fertility and soil moisture.
- Top dress with Nitrogen fertilizer.
Utilization of Giant Setaria
- Harvest and chop before feeding to the animals.
- Setaria is not good for hay but produces good silage.

3.3.10 Panicum maximum (Guinea grass)
Guinea grass is a perennial grass which can be directly grazed or cut, chopped and fed to the animals.

Establishment of Guinea grass
- Prepare the land well before the rain season starts.
- Dig holes 15-20 cm at a spacing of 50 x 50 cm.
- Apply fertilizers using recommendations from the extension staff.
- Plant 2-3 Guinea grass splits per hole.

Management of Guinea grass
- Remove all weeds.
- Top dress with Nitrogen fertilizers.

Utilization of Guinea grass
- Directly graze or cut and feed 4-5 months after germination.
- Maintain cutting or grazing frequency of 6-8 weeks.
- Conserve the grass as hay to feed during periods of feed scarcity.
- A well-managed Guinea grass field can produce 5-10 tons/acre Guinea grass of dry matter per year.
3.3.11 Sorghum
Sorghum is a food and fodder crop which is being promoted in many parts of countries in East Africa. The sorghum is not affected by Napier stunt disease. It performs well in low to mid altitude areas and produced high forage. Sorghum is drought tolerant and can be conserved as hay and silage.

Establishment of Sorghum
Sorghum grows well in areas receiving rainfall of 700-2500 mm. Sorghum requires finely prepares seed bed similar to that for other food and fodder crops. Seed rate of 10-14 kg of sorghum seed per acre and a spacing of 30-40 cm between rows. The seed can be broadcasted.

Sorghum can be intercropped with forage legumes such as Lablab to improve the protein content of sorghum fodder. Lablab should be introduced into the sorghum crop about 3 weeks after germination of sorghum seed.

Crop management
- Keep the crop free from weeds.
- Thin after first weeding to 5-15 cm depending on the variety.
- Top dress with Nitrogen fertilizers.
- Control common pests such as shoot fly, stem borer with insecticides such as Duduthrin three weeks after germination.
- Sorghums are harvested for forage at start of flowering to avoid prussic acid poisoning.
Utilization of sorghum as a fodder
(a) Using fresh sorghum fodder
- Cut the crop at the start of flowering.
- Pre-wilt to reduce effect of pruccic acid and allow any unwanted organism to escape.
- Chop the material into small pieces of 2 cm before feeding.
- Cut after 6-8 weeks this at the start of flowering.
- A well-managed sorghum field can produce 200 bags of 50 kg each fresh material per acre per harvest

(a) Using sorghum stover as a feed resource
- Sorghum stover is harvested after harvesting the sorghum grain.
- If the farmer’s objective is to produce food and fodder, the farmer must control the birds since these are responsible for a reduction of over 50% in grain yield.
- Chop the sorghum stover into pieces of about 5-10 cm long.
- Store the chopped stover in a well-ventilated constructed structure.
- Dry matter intake of sorghum stover is improved when a mixture of molasses and water (1:2) or salty water is sprinkled on the stover.

3.3.12 Lablab purpureus (lablab)
There are two varieties of lablab found in Uganda, Highworth and Rongai. Rongai produces white flowers with white and brownish seeds. It produces high herbage biomass while
Highworth plants produce purple flowers and black seeds. It herbage is fibrous and is therefore not suitable as a forage crop.

**Sowing and management**
Lablab seed is planted at a spacing of 1m X 1m, a sowing depth of 2.5 cm and a seed rate of 7.5kg per ha using two seeds per hill. A blanket fertilizer application of 50 kg of single super phosphate per ha before sowing is necessary to improve the phosphorus (p) content of the soils and to improve establishment. The field should be kept free from weeds.

**Cutting and feeding management**
For maximum feeding value, lablab herbage should be cut at the beginning of flowering. Cutting any time after flowering results in forage with a higher stem percentage than the leaves and therefore a lower protein value. Lablab stems have lower digestibility and are not palatable to the animals. The best cutting height is 30 cm above the ground and should be above the branches to allow growth when properly cut, a farmer can have three crops in a year. Top dressing the field with single super phosphate and weeding after cutting is very important.

Lablab forage produces off-flavours in milk if fresh herbage is fed to lactating cows a few hours before milking the cows. Wilting the herbage or drying it before it is offered to the animals overcomes this.
3.3.13 Fodder trees establishment and management

Fodder trees also commonly known as Multi-purpose trees (MPTs) are very good sources of protein for dairy animals. They are easier to manage than forage legumes and besides, they have other advantages compared to forage legumes. The common fodder trees are: Calliandra calathysus (calliandra), Gliricidia sepium (Gllicidia); Leucaena leucocephola (Leucaena) and Sesbania sesban (Sesbania). Uses and advantages of fodder trees/MPTs include:

(i) Firewood

Fodder trees meet farmer’ needs for fuel. Their wood is sometimes too small in diameter for timber, but it is dense, burns well, and is ideally sized for domestic cooking needs. It can also be used for firing brick and for fuelling tobacco dries.

(ii) Reforestation and soil improvement

They are particularly promising for improving soil and preparing the site for crops. The combination of a deep and well-developed lateral rooting habit provides a structure to stabilise the soil. Through biological nitrogen fixation, erosion control and green manure leaf, Gliricidia and Calliandra can improve soil fertility and yields from associated crops.

(iii) Alley cropping

Inter-cropping fodder trees like Calliandra with elephant grass has been demonstrated in Kenya to give greater productivity. Maximum fodder yields can be obtained from a row of Calliandra planted between 3-4 rows of elephant grass. But most farmers prefer not to do this because after a few years
of elephant grass, they like to remove the grass and plant food crops, and the trees would then be in a way. For this reason, farmers prefer to plant the trees would then be in a way. For this reason, farmers prefer to plant the tree single lines as hedge—rows around the elephant grass or around the farm.

(iv) **Fodder**

They are potential valuable forage species for humid locations within the tropics. In comparative studies conducted at the National Livestock Resources Research Institute in Tororo, Calliandra out yielded other fodder tree legumes like *Gliricidia sepium* (*Gliricidia*) *Leucaena leucocephola* (*leucaena*) and Sesbania. The nutritive value of calliandra leaves is high (22% crude protein; 30-70% fibre; 4-5 ash; 2-3% fat). However, fresh calliandra leaves a high content of condensed tannins (up to 11%). These levels have been responsible for rather low digestibility. The advantage of tannins is that it ensures protected (by-pass)protein but high levels of tannin may reduce the digestibility of protein for livestock. The tannin content is reduced if calliandra leaves are wilted or dried before feeding them to the animal.

The palatability of fodder trees appears to be variable but it is accepted when mixed with other feeds like maize bran and soyabean cake by most livestock including sheep, goats, pigs and cattle. It has been classified as unpalatable to rabbits, although they consumed significant amounts when with grass and herbaceous leaves.
(v) Amenity planting
Fodder trees can be cultivated as a border crop along roads, rivers and village boundaries. There it may act as fire barriers or a screen to prevent unwanted grazing—particularly where forests border villages. It also provided shade and beautification.

Establishment of fodder trees

(i) Use of seeds
Most of the fodder trees (with the exception of Gliricidia) do not grow well from stakes and are therefore propagated from seed in field or raised in a nursery. Seed rate of 4-10kg/ha and a spacing of 40-50 cm between plants are used. Seedlings are commonly produced by two methods. In the first, the seeds are planted in plastic bags filled with topsoil. Two seeds are sown in each bag (if both develop, the smaller seedling is removed). Seedlings are allowed to grow until they are about 20-50 cm tall with a root collar diameter of 5-1.0 cm. They are then ready for transplanting. Depending on the amount and type of vegetation in the area to be planted, some site preparations is necessary before planting seedlings. This may include the completer area, or just clearing strips or spots.

(ii) Use of stumps
Stumps are useful for inter-planting among other trees or for planting directly into weeds. On steep slopes or river banks stumps are also often to ensure satisfactory establishment. Planting is done at the beginning of the rainy season, and spacing varies according to purpose.

- Improved fodder bank of Napier (elephant) grass (Pennisetum purpureum) and fodder trees: A line of fodder trees like
Calliandra calothyrsus is spaced at 50 cm between plants and at 4 meter between rows of Napier grass.

- *A line of Napier grass cuttings spaced at 60 cm from each other and 90 cm to the next row:* There are three rows of elephant grass in between every two rows of fodder trees.
- *Block planting:* This is the planting of fodder trees as a sole crop (fodder bank). The spacing is 50 cm between plants and 90 cm between rows.
- *Hedgerow planting:* This is when one intends to plant for either fodder or soil improvement in case of erosion occurs in a steep area. This is done at 50 cm from plant to plant reducing up to 30 cm depending on the angle of the slope. The row to row spacing also reduces to 60 cm in such a case.

**Harvesting of fodder trees**

When fodder trees are older at first cutting, high rates of regrowth will be observed. *Calliandra* trees are ready for first cutting from about 6 months after establishment depending on the climate and soil type. High yields have been obtained from cutting height of 5-300 cm above ground level. Total yield is increased by longer cutting interval; there is a less pronounced effect of cutting interval on leaf yield.

3.4 Fodder Conservation

3.4.1 Introduction

Herbage availability during the wet season often exceeds animal requirements; however the accumulated forage becomes lignifies and loses most of its nutritive value with
maturity. The excess herbage harvested at optimum nutritive value could be conserved for dry season feeding when pasture is very scarce so as to sustain milk production. In addition to dairy farming, farmers also produce crops like maize, sorghum, cassava, sweet potatoes, beans whose by products may also be conserved. Fodder may be conserved as hay or silage.

3.4.2 Hay Making
This is whereby fodder is harvested at a time when the feeding value is still high, wilted and stored for future use. The grass or legumes is cut and wilted before baling.

3.4.2.1 Hay baling and drying
When the material is dry, a bottomless wooden box (baling box) with dimensions of 75 x 50 x 40 cm is prepared for packing the material and sisal string of about 10 ft are prepared, two across each facing sides of the box to tie up the packed material. The material is then packed as tightly as possible in the box to ensure tight packing, the material can be stepped on with force. Children can do this. When the box is full the strings are tied securely and the box is lift to leave the compacted pack. The bales must be stored lifted off the floor, kept free of moisture. Do not store the hay in a room that leaks. Adequate aeration to prevent growth of mould is important.
The hay is put in the box and tied with sisal strings.

A bale of lablab hay

A rack constructed below the roof to store bales of hay.
3.4.2.2 Hay requirements

Intake of hay depends on hay quality and whether or not hay is the only constituent in the diet. As a guideline-excluding wastage- the requirement is as indicated in Table 4:

Table 3.4.2.2: (dry matter (kg/day) of hay by different types of stock

<table>
<thead>
<tr>
<th>Animal</th>
<th>Grass</th>
<th>Legumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow</td>
<td>7-13</td>
<td>3.5</td>
</tr>
<tr>
<td>Heifer</td>
<td>5-9</td>
<td>1-3</td>
</tr>
<tr>
<td>Young dairy stock</td>
<td>2-3</td>
<td>1</td>
</tr>
</tbody>
</table>

Legume leaf meal

Leguminous fodder trees such as Calliandra have high protein content which is lacking in many of the grasses during the dry season. Hence when these fodder tree leaves are preserved, they will provide the nutritional requirement for maintenance and production of the animal.

How to make leaf meal

- Cut and dry the branches of the trees on a clean floor in a shade.
- Collect the dry leaves and store in sisal bags under shade or in a dry room.
- At feeding time, wet the dry leaves with water to reduce water through spillage or mix the dry leaves with maize bran in a ratio of 2:0.5 (dry leaves:maize bran).

The dried leaves are fed to the animals as a protein supplement either along or mixed with dairy meal, maize bran or soya.
bean cake. The mixture must be mixed thoroughly and some water added in it to allow it to stick together and prevent waste through spilling. The mixture can be offered at milking wastage through spilling. The mixture can be offered at milking time.

3.4.3 Silage making

3.4.3.1 Introduction
Herbage availability during the wet season often exceeds animal requirements; however the accumulated forage becomes stemmy and loses most of its nutritive value with maturity. The excess herbage harvested at optimum nutritive value could be conserved for dry season feeding when pasture is very scarce so as to sustain milk production.

3.4.3.2 What is silage?
Forage which has been grown while still green and nutritious can be conserved through a natural ‘pickling’ process. Lactic acid is produced when the sugars in the forage plants are fermented by bacteria in a sealed container (‘silo’) with no air. Forage conserved this way is known as ‘ensiled forage’ or ‘silage’ and will keep for up to three years without deteriorating. Silage is very palatable to livestock and can be fed at any time.

3.4.3.3 Why silage not hay?
Forages can be made into hay to conserve the nutrients, especially protein, before they decline in the plant. However it is often too wet to dry the forages successfully and special machinery has to be used to assist the forage to dry quickly.
Forage crops such as maize and Napier grass, are too thick-stemmed to dry successfully as hay. Silage is considered the better way to conserve forage crops. A forage crop can be cut early and only has to have 30% dry matter to be ensiled successfully. There is no need to dry out the plant material any more than that, so wet weather is not such a constraint as it is with making hay.

### 3.4.3.4 Advantages of silage

- Stable composition of the feed (silage) for a longer period (up to 5 years).
- Plants can be harvested at optimal phase of development and are efficiently used by livestock.
- Reduction of nutrient loses which in standard hay production may amount to 30% of the dry matter (in silage is usually below 10%).
- More economical use of plants with high yield of green mass.
- Better use of the land with 2-3 crops annually.
- Silage is produced in both cold and cloudy weather.
- The fermentation in silage reduces harmful nitrates accumulated in plants during droughts and in over-fertilized crops.
- Allows by-products (from sugar beat processing, maize straw, etc.) to be optimally used.
- Requires 10 times less storage space compared to hay.
- Maize silage has 30-50% higher nutritive value compared to maize grain and maize straw.
- 2 kg of silage (70% moisture) has the equal nutritive value
3.4.3.5 Disadvantages of silage

- Silage is not interesting for marketing as its value is difficult to be determined.
- It does not allow longer transportation;
- The weight increases manipulation costs;
- Has considerably lower vitamin D content compared to hay.

3.4.3.6 Principle of silage making

- At harvest, plant cells do not immediately “die”; they continue to respire as long as they remain adequately hydrated and oxygen is available. The oxygen is necessary for the physiological process of respiration, which provides energy for functioning cells.
- Once in the silo, certain yeasts, moulds and bacteria that occur naturally on forage plants can also reach populations large enough to be significant sources of respiration. In the silage mass, the heat generated during respiration is not readily dissipated, and therefore the temperature of the silage rises.
- Although a slight rise in temperature from 80° to 90°F is acceptable, the goal is to limit respiration by eliminating air (oxygen) trapped in the forage mass.
- Some air will be incorporated into any silo during the filling process, and a slight increase in silage temperature is likely. These temperature increases can clearly be limited by harvesting at the proper moisture content and by increasing the bulk density of the silage. Generally, it is desirable to limit respiration during the fermentation process by using common sense techniques that include...
close inspection of the silo walls prior to filling, harvesting the forage at the proper moisture content, adjusting the chopper properly (fineness of chop), rapid filling, thorough packing, prompt sealing and close inspection of plastics for holes. Ideally, corn silage should be harvested at the moisture content appropriate for the type of silo used.

- Recommended moisture contents are 65–70 percent.
- Corn silage yield and quality as influenced by growth stage.

### 3.4.3.7 Ten steps of silage making

- Harvest the forage when excess to feed requirements and high in quality.
- Wilt the forage to about 30% dry matter content.
- Add fermentable substrate at ensiling.
- Chop the forage into small pieces of about 1-3 cm long before ensiling.
- Compact the silage as tightly as possible.
- Complete the entire storage as quickly as possible.
- Seal storage airtight as soon as possible after filling.
- Maintain airtight seal until feeding time.
- Feed out a whole face of storage to a depth of at least 20 cm each day.
- If the silage is unsatisfactory, determine the reason for the next season
Pit silage making

A silo pit

Covering the silo pit

Compressing the material before to keep out air

A silo pit
3.4.3.8 Plastic silage bags for small-scale farmers

Advantages

- Plastics silage bags are an economical alternative to traditional silage storage systems, such as pits and silos when related, harvest and storage losses are considered.
- It is an effective way for preserving feed with minimum nutrient loss. (The anaerobic environment that is created eliminates spoilage from the growth of yeasts, moulds and adverse bacteria while maintaining essential proteins and nutrients).
- Allows farmers to store silage anywhere they need it. A well graded and well drained ground surface is all that is necessary.
- The silage is completely sealed in the bag. This means that all the acid is retained in the silage, unlike that in pit silage when it seeps out through the bottom of the pit as effluent. This compensates for the longer pieces of forage and poorer compaction than that found with silage machinery, so that the quality of the silage is just as good.
- Ensiling in a bag avoids the hard work of having to remove silage, as it has to be from a pit, when it has to be dug out every day.
- Because the whole bag is fed out to the animal, it means the rest of the silage which is in the other bags is not exposed to air at removal and is therefore unspoiled. Much of the silage in pits has been found to be spoiled due to poor sealing and exposure to air every day when the silage is removed for feeding.
- The bag is easily stored and easily portable so that any member
of the family can carry it to the feed trough for the cow.

**Disadvantages**

- The importance of pest control to prevent damage on the bags,
- Containment and disposal of the plastic, once silage is removed from the bag,
- The need to chop the green mass, as chopped material tends to make much better silage, because more air can be squeezed out of it during the packing process, and the small pieces cannot puncture the bag

Most loses of silage during the process occur due to:

- Seepage losses when dry matter is less than 32 %.
- Unnoticed bird/rodent damage to the bags resulting in spoilage loss.
- Too wet (gaseous/seepage losses) or too dry silage (spoilage).

**Table 3.4.3.8: Rations for molasses and maize bran used for different forages**

<table>
<thead>
<tr>
<th>Forage species</th>
<th>Molasses (kg)</th>
<th>Maize bran (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forage legumes such as Lablab</td>
<td>35-40</td>
<td>15</td>
</tr>
<tr>
<td>Grass</td>
<td>15-20</td>
<td>40</td>
</tr>
<tr>
<td>Grass and legume mixture</td>
<td>15-30</td>
<td>55-70</td>
</tr>
</tbody>
</table>
Chopped forage is put in a silo and compacted to remove air (top) and the silo is tied (bottom)

3.4.3.9 Rodent control
Silage bags, especially silage from fodder maize attract rodents. Once in, rodents could easily hide between bags, chewing through the plastic bags, and resulting in aerobic spoilage. Monitor the silage bags on a regular basis for any rodent, bird or livestock damage;
Silage assessment
Step 1: Collect a sample of silage that is representative of what is to be fed to the animals.
Step 2: Make an assessment of the silage on physical appearance and texture.
Step 3: Make an assessment of the silage on the basis of color.
Step 4: Make an assessment of the silage on the basis of the aroma of the silage.

Table 3.4.3.9: Assessment of silage quality

<table>
<thead>
<tr>
<th>Physical appearance and texture of silage</th>
<th>Characteristics and Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leafy, soft texture</td>
<td>Likely to have high ME. Crude protein is probably high. Metabolizable energy (ME) for leafy tropical pasture silages is lower than for temperate pasture silages at the same growth stage.</td>
</tr>
<tr>
<td>Leafy, but leaves more fibrous</td>
<td>Lower digestibility and ME. More typical of tropical grasses.</td>
</tr>
<tr>
<td>Stemmy, fibrous; seed heads present</td>
<td>If high proportion of stems/or seed heads are present, ME and crude protein are likely to be low. Crop cut too late.</td>
</tr>
<tr>
<td>Proportion of legume present in silage</td>
<td>As the proportion of legume increases, silage crude protein content (and often ME content) will increase.</td>
</tr>
<tr>
<td>Presence of mould or rotten silage</td>
<td>Air has entered the silage. DM has been lost and silage quality (ME content) will have declined during storage.</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Very wet; effluent seeping from stack or ponding in bottom of wrapped bales</td>
<td>Moisture easily squeezed out of the silage. Forage was ensiled at too low a DM content. There is a high risk of poor fermentation and significant losses (quality and quantity).</td>
</tr>
<tr>
<td>Very dry, even brittle</td>
<td>Silage was ensiled at too high a DM content. The forage was probably poorly compacted and there is a high risk of overheating during storage, increased silage losses, reduced ME and protein degradation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Colour of silage</th>
<th>Characteristics and Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very dark olive green</td>
<td>Weather damaged, and/or very wet silage with a poor fermentation. Sour or putrid aroma. Usually occurs if high legume content, or immature grass that may have been fertilized with a high rate of nitrogen</td>
</tr>
<tr>
<td>Colour</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Dark olive green/brown</td>
<td>Normal colour for wilted legumes, which are usually a darker colour grass silages.</td>
</tr>
<tr>
<td>Light green to green/brown</td>
<td>Normal colour range for grass, cereal and maize silages.</td>
</tr>
<tr>
<td>Pale green/straw yellow</td>
<td>Normal colour range for wilted grass silages. Heavily wilted silages with restricted fermentation tend to be greener.</td>
</tr>
<tr>
<td>Light amber brown</td>
<td>Typical of late-cut grass and cereal silages. Can occur with low DM silages, and weather-damaged grass silages. Bottom layer of wet silage can be yellow with fruity aroma.</td>
</tr>
<tr>
<td>Brown</td>
<td>Some heating has occurred during storage or due to aerobic spoilage during feed out. Some loss in digestibility and heat damage of protein. More common with wilted silages.</td>
</tr>
<tr>
<td>Dark brown</td>
<td>More extensive heating. May also be some black patches of silage on the surface. Significant loss in digestibility and high proportion of protein is heat damaged and unavailable to the animal. Inadequate compaction, delayed sealing or poor air exclusion. Usually accompanied by significant proportion of waste (mouldy) silage.</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Aroma</strong></td>
<td><strong>Silage Characteristics and Interpretation</strong></td>
</tr>
<tr>
<td>Mild, pleasantly acidic, sour milk or natural yoghurt smell</td>
<td>Normal lactic acid fermentation – desirable</td>
</tr>
<tr>
<td>Very little smell, but slight sweet aroma</td>
<td>Heavily wilted silage with little fermentation, especially from crops with low sugar content. Stronger aroma as DM content falls</td>
</tr>
<tr>
<td>Sweet, fruity alcoholic aroma</td>
<td>Yeasts have played an active role in the fermentation. Ethanol levels high. These silages are often unstable during feed out.</td>
</tr>
<tr>
<td>Sour vinegar smell</td>
<td>Poor fermentation dominated by bacteria producing acetic acid. Common with low DM, low sugar</td>
</tr>
</tbody>
</table>
Rancid butter, putrid aroma | Poor fermentation dominated by clostridia bacteria that produce high levels of butyric acid. Silage wet and sometimes slimy. Rub silage between fingers, warm the hand for a few seconds and then smell. The presence of butyric acid is easily detected

Strong tobacco or caramel smell, with flavour of burnt sugar | Heat damaged silage, dark brown in colour. Often palatable to stock but nutritive value very low.

Musty or mouldy aroma with only mild fermentation aroma | Mouldy silage due to poor compaction and sealing. Also evident in aerobically spoiled silage, which can be warm and have a compost aroma

3.4.3.10 Feeding silage to cattle
Silage should be fed as soon as possible, preferably within a few hours. After feeding, the feed troughs must be cleaned out to prevent any remaining silage, which will spoil, contaminating the next feed out. Silage can be provided to animals in number of different recipes based on its composition and the breed and use of the animals. In general silage should be used up to 25 kg per day for 550 kg animal and up to 5 kg for sheep and goats (Table 3.4.3.10).
Table 3.4.3.10: Utilization of silage for different types of stock

<table>
<thead>
<tr>
<th>Stock</th>
<th>Quantity (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactating dairy cow</td>
<td>10-20</td>
</tr>
<tr>
<td>Dry cows</td>
<td>10-15</td>
</tr>
<tr>
<td>Dairy heifers</td>
<td>5-8</td>
</tr>
<tr>
<td>Beef breeding cows</td>
<td>12-20</td>
</tr>
</tbody>
</table>

To avoid off flavours in milk, silage should be fed to lactating cows after milking the animals.

3.4.4 Crop Residues in Sustainable Smallholder Dairy Cattle Farming

3.4.4.1 Introduction

Proper understanding of the basic principles of dairy cattle nutrition is essential for optimizing milk production and maintaining good animal health. Basic knowledge of the characteristics of various feeds and of the nutritional requirements of dairy cow during lactation are essential prerequisites for profitable milk production.

There is great potential for the use of crop residues as animal feed for ruminants only if appropriate crop residue and animal feeding strategies are known and implemented. These should be based on existing livestock production system and farmers’ production objectives. The potential of crop residues as a feed resource for ruminants will only be fully realized if their use proves to be economically beneficial.
Animal nutrition has great influence on the profitability of the dairy farm. Therefore dairy cows should be fed well-balanced rations as a prerequisite for optimal milk production. With good nutrition, dairy cows can demonstrate their full genetic potential whilst maintaining their good health. The ration should meet the cow’s energy and protein requirements for maintenance, milk production, growth and reproduction. A successful ration should be nutritionally complete, with adequate amounts of minerals and vitamins. Nonetheless, the potential of crop residues as livestock feed has not been fully exploited, particularly given the expansion in arable land that has taken place due to increased demand of food for humans. This is due to the fact that crop residues have low contents of metabolizable energy and crude protein. Consequently, research programmes to improve the nutritive value and utilization of crop residues have been launched. Emphasis in this work has been on improving crop residue intake and digestibility in ruminants through upgrading or supplementation.

In feeding livestock, the aim is to provide the animals with a balanced ration throughout the year with sufficient nutrients to meet the animal’s nutrient requirements for maintenance and production. Most crop residues are fibrous and low to moderate nutritive value; some have physical and chemical characteristics that make them unpalatable to animals. Seasonal variations in production of crop residue have a marked effect on spatial and temporal availability. However,
in the absence of quality feeds they provide staple energy feed for ruminant animals. On the other hand, leguminous crop residues may contain higher levels of nitrogen adequate to meet maintenance requirements of ruminant animals.

3.4.4.2 Nutritional Values and Constraints of Crop Residues

The nutrients the animal receives are not those chemically determined in the feed but are the products of a variable fermentation process in the rumen and intestinal digestion. The prediction of nutrient yield is inaccurate, but it is possible to identify probable nutrient balances. Among the organic substrates necessary to support maintenance, growth, reproduction and lactation, the balance between glucose, amino acids and the remaining metabolizable compounds is critical. The nutrient needs of the animal expressed in these terms are recognized as variable, depending on physiological state, body condition and the level of production being achieved. Both level and balance of nutrients interact with the capacity to draw on body reserves of fat and, less readily, protein. These aspects of metabolic efficiency and product/substrate quotients are addressed in classification and specification statements. They are built up gradually and most of the cereal crop residues are fibrous, high biomass, low in nitrogen content and low to moderate in nutritive value. However, there are those that are more nutritious such as the legumes and can therefore be used prudently to improve the overall diet. The feed value of a crop residue depends on the biomass produced, its intake by animals and digestibility.
Maximizing intake is the first precondition. This is linked to the potential of a feed to supply, through microbial degradation, quantities of nutrients which, together with those provided through supplementation, can produce a balanced diet.

The main determinants of intake and digestibility in crop residues are the morphological characteristics of the plant that include proportions of different plant parts (leaves, stems and stubble), the composition and proportions of different cell types in the various plant parts, the relative amounts of cell contents and cell walls in those tissues and the physical and chemical nature of the cell walls. These factors influence the animal’s chewing behavior and the extent of fragmentation in the rumen.

There is considerable variability in the morphological characteristics within and between crop residues. The proportions of leaves and stems vary, which explains why there is no consistency.

Analyzing the chemical composition of crop residue is a first step in identifying the residual amounts of cell wall contents a major factor determining variability in nutritive value. The variability influences such parameters as intake and retention time in the rumen, which in turn determine the supply of nutrients for maintenance and production by animals. The high fibre content of most crop residues is important because fibre slows down fermentation rate leading to reduced voluntary intake and plays a role in the overall efficiency of energy utilization. The cell wall constituents of fibrous crop
residues are fermented more slowly than the cell contents of the same plant material. The rate of fermentation crop residues can be increased by processing techniques that employ physical and chemical processing. They increase both the digestibility and rate of intake of most of the crop residues. Digestible nutrients in high-fibre diets are used less efficiently for productive purposes than those in low fibre diets. It is therefore important to consider the fibre content of any crop residue in order to make appropriate adjustments in formulating rations with such crop residues to enhance intake, digestibility and thus optimum utilization. At the level of digestibility, crop residues contain mainly structural carbohydrates (cellulose, hemicellulose, lignin) as opposed to non-structural carbohydrates (starch) with low digestibility giving rise to high concentrations of acetic acid (>60% molar). A high content of soluble sugars such as in molasses produce high concentrations of butyric acid (30-40% molar) while digestible energy derived from cereal grains produce propionic acid (25-30% molar). Being aware of rumen fermentation patterns of crop residues enables appropriate manipulation of feed formulation to enhance their optimum utilization.
Table 3.4.4.2: Constraints to better utilization of crop residues and suggested remedies

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Suggested remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low digestibility</td>
<td>Treat with alkali or urea or fungi to increase digestibility</td>
</tr>
<tr>
<td>Low fermentable nitrogen</td>
<td>Supplement with urea</td>
</tr>
<tr>
<td>Low by-pass protein and dietary fat</td>
<td>Supplement with by-pass protein like cotton seed cake, fish meal, oil seed meal</td>
</tr>
<tr>
<td>Low minerals</td>
<td>Add mineral nutrients especially sulphur</td>
</tr>
<tr>
<td>High fibre and low rate of passage</td>
<td>Supplement with legume fodder or young grass at 2kg DM/100kg LWt</td>
</tr>
</tbody>
</table>

3.4.4.3 Nutritional Deficiencies

The nutritional requirements of ruminant animals are best understood by considering first and foremost the needs for efficient rumen fermentation and then the complimentary needs of the animal as an entity. This requires prioritization as follows:

- Fermentable energy
- Fermentable nitrogen
- Micronutrients (minerals and vitamins)
- Roughage (for adequate rumen function)
- Bypass protein (UIP or RUP)
- Bypass energy
Insufficiency of any of the above factors will affect dairy cattle productivity directly through effects on feed intake. It is recognized that most crop residues when fed alone cannot meet all of the above factors. It is therefore important to determine the nutritional deficiencies that may exist within individual crop residues and appropriate corrective measures undertaken if the crop residues are to be fed. Low voluntary feed intake as a result of slow fermentations a factor associated with most crop residues. There is therefore an obvious need to complement crop residues by providing other required nutrients and to ensure a desirable balance of digestion and products for improved productivity. Correcting major nutrient deficiencies such as supplying fermentable nitrogen is of the utmost priority. However, all other components of the rumen ecosystem must be put right for enhanced rumen microbial turnover. The most economical way of improving energy intake and animal performance on crop residues is to supplement the above two with good quality forage. This may result into positive associative effects since the rate of fermentation of the basal feed is often increased. In other situations, digestibility appears to be unchanged and there is simply a direct effect on feed intake, probably because of increased passage rate. Dairy cattle fed on crop residues must be supplemented with by-pass protein supplement for increased productivity. Some of the effective supplements are fish meal and cotton seed cake processed to protect them from extensive and excessive rumen microbial degradation. The proteins they contain become available for enzymatic hydrolysis in the small intestine to release various amino acids. The importances of bypass energy in improving productivity probably arise from changes in the balance of digestion and
products. It should be noted here that it is more efficient to raise glucose status and metabolic efficiency via gastric digestion of starch to glucose than by rumen fermentation to propionate (precursor to glucose) especially when rumen contents are at a high well buffered pH, as is the case in diets based on crop residues.

By their description, crop residues tend to have a low opportunity cost considering that they can also be used as mulch or incorporated into the soil to conserve moisture and control weed growth. After consideration of all these aspects, crop residues remain a low cost energy source feed compared to other energy source feeds like grains. In formulating diets based on crop residues, it is desirable therefore, that they form the basis of the diet and that high cost supplements be used in minimal amounts. In doing this, it is required that decisions must be taken in recognition of what kind of supplements should be used and what type of animal production system will be most appropriate. The least cost supplements are by ranking minerals (required in small amounts), fermentable nitrogen (urea), good quality forage (grown on farm). Legume forages may partially provide mineral and fermentable nitrogen. Providing bypass protein (rumen un-degradable protein or un-degradable intake protein) is the next supplement to consider and such supplements have to be purchased and their cost will depend on alternative uses. Adding these to the basic diet (crop residues) will certainly increase animal productivity. If the supplement has a high organic matter digestibility (OMD), with good bypass energy characteristic, it is an added advantage. However, these advantages will only be adopted if they are relatively simple
to use, can be relied upon to bring tangible benefits to the smallholder farmer without undue levels of risk, and fits the farmer’s resources and goals.

3.4.4.4 Improving quality of crop residue
The potential of crop residues as a feed resource can only be fully realized if their use proves to be economically beneficial and compatible with the resource endowments and production goals of smallholder dairy farmer. Limitations to the use of crop residues as dairy cattle feed include; low levels in protein, energy, minerals and vitamins, with high fiber content resulting in low digestibility and voluntary intake. Crop residues can only provide enough nutrients for general body maintenance rather than production. They are bulky, making their transportation and storage difficult. Some crop residues contain anti-nutritional factors like tannin and silica. Such limitations have led to the development of various technologies to improve the quality and utilization of crop residues. The technologies include;

- Crop management practices
- Variety selection
- Chemical processing of crop residues
- Physical processing of crop residues
- Biological processing of crop residues
- Supplementation
- Feeding strategies, such as excess feeding
- Food-feed intercrop

3.4.4.5 Crop management practices
Crop management practices involve developing improved varieties and cropping systems that provide higher yields with
limited use of purchased inputs. Based on the production of crop, the amount of crop residue to be produced is a function of biomass production and translocation. Crop biomass production is determined by the biophysical environment and the genetic makeup of the crop. Crop management practices include incorporating the existing improved crop varieties that are resistance to diseases, insect pests and parasitic weeds, as well as adaptive traits such as drought tolerance, better nitrogen fixation, enhanced and rapid growth under low soil fertility conditions. Breeding lines as sole or intercrops with potential grain and fodder yields as well as superior nutritional quality. Crop management system also involve utilizing improved cropping systems and planting patterns with high crop densities to maximize grain and fodder production for increased overall economic output per unit area and time. Other factors contributing to variability in quality include genetic differences between and within crop species, post-harvest handling that involves manipulating harvest time for high moisture grain which leaves behind good quality residue.

3.4.4.6 Variety selection

Variety selection is another approach to improve the feed value of biomass production of crop residues. Several researchers have conducted studies on crop residues which have shown varietal differences in crop residue quality and biomass, the effects are greatly influenced by environmental factors, such as soil fertility and climate. Selection for crop residue quality should be dependent on crop breeding programmes alongside grain quantity and quality. The differences in the utilization of a crop, and especially of its by-products
under different input levels, are one reason why the modern varieties of the Green Revolution have contributed little to the low-input agricultural systems characteristic of many developing countries. They have shown that the adoption of modern cereal varieties with high grain yields but lower straw yields has been slow in some developing countries where crop residue (straw) is a valuable source of animal fodder. The relationships between soil organic matter, soil structure and erosion processes, with a view to developing new management crop management practices must be well understood. Crop varieties that respond to the need of producing sufficient human food and crop residues to sustain the soil and provide fodder for ruminants must be promoted.

3.4.4.7 Physical Processing of crop residues
Physical processing of fibrous crop residues improves intake and digestibility. It covers a range of different methods that include chopping, soaking in water and ensiling. Physical processing is a fairly common practice among smallholder dairy farmers, who thereby improve the feed intake of their animals and reduce fodder wastage at feeding. Although these technologies may, in some cases, have become locally important, overall adoption by farmers is extremely low, especially considering the information available in different processing methods on the nutritive value of crop residues. Adoption is severely hampered for several reasons, including the high costs of the technology and additional labour requirements.
3.4.4.8 Chemical processing of crop residues

Chemical processing mostly refers to the treatment of crop residues with various alkalines, of which treatment with urea appears to be the most common. The alkali treatment of crop residues has received a great deal of attention from researchers. Han and Garret (1986) have listed 26 chemical processing that can be used to improve the quality of crop residues. These have been variously tried in different countries. Alkali treatment using sodium hydroxide at 4g/100g DM of crop residue (30% w/vol) delignifies and solubilises hemicelluloses to improve the digestibility of the crop residue. The value of individual crop residues in effective feeding systems can only be defined in terms of their ability to promote consistently good response in animals which vary according to species and function, with services such as the provision of manure in addition to milk and meat.

Urea treatment improves the digestibility and nitrogen levels of crop residues. The recommended ratio is 40-60 grams for every kg of stover. Water should be in the same ratio as the stover being treated. For example, if you have 400 kgs of stover, use 400 litres of water and 24 kg of urea. The technology is not popular because of risk of poisoning if excess urea is fed, high cost of urea and high labour requirement. The main variables affecting the efficiency of urea treatment are level of urea, physical form of crop residues (long or chopped form), method of application (spraying or impregnation), moisture content of the crop residue, storage (open or closed), method of feeding (with or without additional ingredients), species of animal and objective of production.
Processing crop residues with urea is based upon on its transformation into ammonia, which is a technique that can easily be utilized by ordinary smallholder dairy farmers. In order for the treatment to succeed, most of the urea must first be hydrolysed into ammonia, and then diffuse fixing itself to the crop residue and modifying it chemically. Practical conditions affecting successful treatment include the presence of urease. This consists of spraying a solution of urea onto the dry mass of crop residues and covering to form a hermetic seal with materials available locally. In the presence of water and the enzyme (urease), at appropriate temperature, urea hydrolyses into gaseous ammonia and carbonic gas. The ammonia generated thus initiates the reaction which gradually spreads to process crop residues by dissolving the parietal carbohydrates (hemicelluloses), swelling the vegetal matter in an aqueous environment, and easing access by the rumen’s cellulolytic microorganisms, reducing the physical strength of the cells, to ease mastication by the animal and digestion by the microbes. This enriches the crop residue with nitrogen and net effect is increased digestibility. These factors are interdependent, and it is difficult to dissociate one from the other.

3.4.4.9 Biological Processing
In Uganda, agricultural crop-residues are abundantly available and constitute a major part of the diet of ruminant animals. Although the cellulose and hemicellulose present in these materials have their value for feeding cattle, their bioavailability requires the breakdown of the bonds with indigestible lignin. The rumen microbial utilization of the energy-rich cell walls of these crop residues is hindered by the presence of lignin,
which limits its overall digestion process and can significantly influence the animal performance in livestock production systems. Thus, for the maximum utilization of crop residues as cattle feed either complete or partial degradation of lignin from the lignocellulosic complex is necessary. Amongst the various methods used to improve the digestibility of crop residues, biological delignification has several advantages over chemical and physical treatments, including mild reaction conditions, avoidance of toxic and corrosive chemicals, higher product yields, fewer side reactions, less energy demands and less reactor resistance. Fungal bioconversion can lead to a loss of total organic matter, particularly cellulose, and therefore, selective degradation of lignin is important. White-rot fungi have been studied for degradation of crop-residues under solid-state fermentation, as they are reported to degrade lignin more efficiently than any other group of microorganisms. They mainly degrade polysaccharide by hydrolytic enzymes (cellulases and xylanases) and lignin by oxidative ligninolytic enzymes such as lignin peroxidase, manganese peroxidase and laccase. A majority of white-rot fungi degraded polysaccharide and lignin simultaneously, while some degrade lignin selectively. However, there has been an increasing trend towards the use of the solid-state fermentation technique to produce several enzymes. This process allows the production of lingo-cellulolytic enzymes that can be utilized to liberate cellulose that can be utilized as animal feed.

3.4.4.10 Supplementation

Feeding on crop residue alone results in perpetual low productivity in dairy cattle, delayed age at first parturition, increased interval between parturitions, increased non-
productive time of the animal and high mortality. Supplementation includes adding forage legumes, concentrates like cotton seed cake or soaking feeds in water or molasses to increase palatability and provide additional energy, protein and minerals. These supplements promote efficient microbial growth in the rumen and increase protein supply for digestion in the small intestines (bypass proteins). While crop residues, provide the bulk of livestock feed, their nutritive value is often so low at present that farmers must supplement them with feed grains and other concentrates. Improving the nutritional value of crop residues and the efficiency of their use in mixed diets is an important option for increasing livestock production in the region.

3.4.4.11 Feeding strategies
Offering adequate crop residues allows the animal to select the more nutritious parts of the plant. This will lead to higher feed intake and hence higher production. However, excessive feeding leads to wastage and is expensive especially when the crop residue is transported over a long distances from the source to the animals. Smallholder dairy farmers use various methods to feed crop residues to their animals. Arranged in increasing order of labour requirements, these methods include; open access to whole residues on harvested fields, harvest and removal of stalks, with subsequent open access to stubble on harvested fields, harvest and removal of stalks with subsequent restricted access to stubble on harvested fields, transport and storage for feed or sale and harvest of thinings from cultivated fields for selective feeding before the main harvest.
The pattern of residue use is often dictated by population density, herd management practices and level of transport and marketing infrastructure. Open access to residues occurs in areas with low population densities and where animals are herded communally. In densely populated and heavily stocked areas, farmers restrict access to crop residues. The availability of labour, large livestock populations and easy access to markets encourage the removal of crop residues from fields. Direct grazing, through open or restricted access, allows farmers to use residues as feed without incurring storage and processing costs. This method of feeding results in low utilization rates due to trampling and spoilage, but allows for the consumption of most nutritious plant parts and the return of nutrients to the soil. Methods of residue feeding that involve harvesting (i.e. cut-and-carry systems) are more demanding in terms of labour, transport and storage facilities. The returns to these methods have to be reasonably high before they appeal to farmers.

3.4.4.12 Food-feed Intercropping
Food-feed intercropping is not a new concept, but rather the extension and intensification of the traditional intercropping systems long practiced in the region’s more favored environments. New technology, in the form of shorter-duration crops and new or improved irrigation schemes, has contributed greatly to this process. At first, scientists tended to view such systems solely from the point of view of their potential contribution to human food supplies in the short term. Nowadays the perspective also includes the system’s contribution to animal feeds and its sustainability over the long term.
The strategy is to integrate other food and feed-producing crops by intercropping forage legume where another crop is already growing. Use the intercropping technique if the cereal stover is to be used for animal feeds. When the cereal is harvested, forage legumes will have started climbing onto the cereal plant such that at the time of harvesting, the forage legumes are cut together with the stover. Since the forage legume is higher in protein and digestibility, the animal gets a better quality diet than when the stover is fed alone. The general principles to be followed are: Plant the main crop in row, Sow the legume fodder after weeding the main crop, plants the forage legume in between the cereal crop rows and do not disturb existing crop growth pattern.

The aim in food feed intercrop is to diversify the diet and spread the risk of crop failure, notably by mitigating the losses that may be caused by drought. Other criteria for the alternative of intercrops include their compatibility in terms of competition for light, nutrients and moisture, their contribution to soil fertility, their potential forage or crop residue biomass yield, the type of animals to be fed, the ease with which they can be eradicated and the labour requirements for planting, weeding and harvesting.

Plant breeders have tended not to select for straw quality not just because they have considered this trait to be an unnecessary sidetrack but also because appropriate tests for straw quality have been lacking.
3.5 Small scale Pasture Seed Production
3.5.1 Introduction
The demand for high quality forage seed for development of livestock feed resources is increasing rapidly in Uganda. This demand is fuelled by the expanding beef and dairy production occasioned by the increased demand from rising population and improved income particularly in the urban centres. Availability of adequate and good quality forage seed is critical to meet the expanding meat and milk demand in the Country. Further, the need to restore degraded natural pasture (the major source of livestock feed) through reseeding and/or over-sowing interventions emphasize the urgency for concerted efforts to ensure availability of large quantities of good quality seeds. However, production of adequate quantities of good quality seed is greatly constrained by inadequate knowledge on appropriate agronomic practices among livestock farmers. Documentation and dissemination of already synthesized and simplified information on appropriate forage seed production techniques to farmers is thus critical in ensuring availability of adequate quantities of good quality seed.

3.5.2 Establishing a pasture seed crop
Establishment of an excellent, uniform stand of forage in a short period of time is important. If a sparse stand initially develops, many of the perennial grasses have the ability to cover bare spots and achieve complete ground cover, especially if planting was done on virgin land. If planting is on old pasture land contaminated with aggressive grass weeds such coach grass, the ability of the planted forage seed crop to provide complete ground cover is lessened. The producer needs to do everything possible to ensure successful establishment
3.5.3 Land Preparation
Efforts to prepare an appropriate seedbed for production of forage seed should aim at producing a seedbed that ensures the requirements for appropriate seed germination as well as establishment. The seedbed should thus facilitate adequate water infiltration and root development. Seedbed preparation should also be intended at eradicating weeds (especially of graminae family) as much as possible. The initial ploughing should be conducted early enough (usually at end of the previous rain season) to give ample time to the cleared vegetation to decompose and to ensure adequate mineralization of nutrients. Secondary ploughing is also necessary to produce a fairly fine seedbed as well as to remove any weeds that might have emerged after initial ploughing. Once the first and second ploughing are properly done, the seedbed will be reasonably fine and may not necessitate disc-harrowing. In cases where timely ploughing operations fail, first and second ploughing may be conducted at the onset of rains and then the sites sown to seeds. The problem with this method of seedbed preparation is that weeds will have developed seeds at the time of ploughing and as they are ploughed into the soil, they instead germinate taking advantage of the available rain. A lot of resources shall thus be directed towards weed control.

3.5.4 Fertilizer requirements
Adequate soil nutrients are required to promote plant growth, tillering, branching and subsequent seed production. Nitrogen (N) is the main nutritional determinant of forage grass seed yield and split applications after one month of sowing and at flowering, each of 50-100 kg/ha N, are commonly used
based on the fertility of the soil. This implies that after application of the two split dozes, the total application rate of nitrogen will range between 100-200 kg/ha N. Single dose application of nitrogen is discouraged as the plant will not have adequately developed to effectively utilize all the applied nitrogen. As such, much of the nitrogen is often wasted and is not channelled into vegetative and seed production. At times, the grass seed crop benefits from application of phosphate fertilizers at sowing if phosphorus is limiting however, the farmer is advised to consult a local extension staff before such a decision is taken.

In case of forage legume seed crops, N is often not limiting because the nitrogen fixing bacteria found in the root nodules of legumes have the capacity to utilize atmospheric nitrogen and fix it into soil. The fixed N is then utilized by the leguminous plants. However, root and nodule development is dependent on the quantity of phosphorus in the soil. Yet, seed production in forage legumes is greatly influenced by the extent of root and nodule development. As such, ensuring adequate availability of phosphorus is crucial if adequate seed yields are to be realized. It should be noted that the rate of application will depend on the Phosphorus (P) content and pH condition of the soils. When the soils are strongly acidic, application of P is merely a waste as most of it is simply fixed and rendered unavailable for plant uptake. Under such conditions, amendment of the soil with lime shall improve the soil pH conditions and hence prevent fixation of applied phosphorus. In Uganda, Mugerwa et al. (2011) noted that 30kg P_{2}O_{5} ha^{-1} is the most economically viable rate for lablab seed production. Fertilizers should not be mixed with lablab
seed as this can result in complex chemical reactions between fertilizer and seed components leading into reduced viability. Where area and legume specific studies on appropriate phosphate fertilizer regimes have not been conducted, a bracket application rate of Single Super Phosphate (SSP) (100 Kg/ha) is used for nearly all legumes.

3.5.5 Time of sowing
Planting should be done at the onset of the rains. In case of late flowering cultivars (e.g Lablab cv. Rongai), planting should be timed to ensure that peak rains of the subsequent season occur during seed/pod development. Once peak rains occur during flowering, most of the flowers are usually lost.

3.5.6 Planting material
Forage crops can be propagated using vegetative materials or from seed. Vegetative planting materials are often used for forage grasses because: (1) adequate grass seed of good quality is often not available; (2) grass seed is too expensive and often beyond the reach of most farmers; (3) the viability of most grass seed is often too low; (4) some fodder grasses do not produce seeds e.g. Napier grass and Brachiaria hybride mulato. Vegetative materials help to offset problems associated with poor quality seeds (non-viable seed) and the high costs of purchasing grass seeds in Uganda. The vegetative materials can be obtained by breaking up larger clumps into pieces, or using the small tussocks along the stolons that establish readily.
The vegetative materials may be in form of rhizomes, stolons, stems, splits, cuttings, potted seedlings and rhizomes. In case seed is used, it is desirable that the germination percentage do not go below 75 and 30% for legumes and grasses respectively.

3.5.7 Sowing
(a) Sowing rates
High sowing rates may depress yields especially in legume seed crops. Recommended sowing seed rates for some of the common forage grasses and legumes used in Uganda are shown in Table 9.

Vegetative (stem cutting) propagation
Table 3.5.7: Recommended sowing densities for some of the common grasses and legumes

<table>
<thead>
<tr>
<th>Pasture species</th>
<th>Common name</th>
<th>Seed rate (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Chloris gayana</em></td>
<td>Rhodes grass</td>
<td>10-14</td>
</tr>
<tr>
<td><em>Panicum maximum</em></td>
<td>Guinea grass</td>
<td>15-25</td>
</tr>
<tr>
<td><em>Centrosemum pubescens</em></td>
<td>Centro</td>
<td>2-4</td>
</tr>
<tr>
<td><em>Macroptilium atropurpureum</em></td>
<td>Siratro</td>
<td>2-4</td>
</tr>
<tr>
<td><em>Lablab purpureus</em></td>
<td>Lablab</td>
<td>12-20</td>
</tr>
</tbody>
</table>

The seed rates will depend on the method used in sowing the seed crop.

(b) Sowing methods
There are two types of sowing methods namely: **row spacing** and **broadcasting**

(i) **Row spacing**
Sowing in rows has several advantages
- A lower seeding rates is used
- Weeds can be easily be identified and controlled
- Harvesting is usually a lot easier
- With climbing legumes such as Centro and Siratro, better yields are harvested from row-spaced trellises.

(ii) **Sowing in swards (Broadcasting)**
Sowing in swards has a disadvantage of using a higher seed rate. However, it has advantages of producing more forage
for livestock and of controlling soil erosion.

(c) Pre-planting seed treatment
Many forage legume seeds have hard seed coats which are impermeable to water. This results in poor germination and establishment. To achieve good seed establishment, rapid and even germination, some pre-planting seed treatment may be undertaken. Pre-planting treatments include mechanical scarification, hot water treatment and inoculation of legume seed with appropriate rhizobia strains to induce nodulation. These pre-planting operations are described in the proceeding sections.

(d) Mechanical scarification or abrasion of the seed coat
This is the most common treatment for small quantities of legume seeds. It involves rubbing gently small quantities of seed between two sheets of sand paper held in the palm of the hand. For larger amounts, a mechanical scarifier (i.e a cement mixer containing some gravel) can be used.

(e) Hot water treatment
i) Boil about one litre of water.
ii) Put 1-2 kg of seeds into a cloth bag and dip it into the boiled water removed from boiling place for 3-5 minutes.
iii) All the seeds must be submerged and in contact with the boiled water.
iv) Soak it in cold water for 12 hours.
v) Dry the seeds for 1-2 hours.
vi) Treated seed should preferably be sown soon after treatment.
(f) Inoculation of legume seed

Inoculation of forage legumes prior to sowing is recommended when introducing new species into new areas. Many legumes are specific in their Rhizobium requirements and special inoculum is required. If the specific Rhizobium is not available, then the soil from rhizosphere of nodulating plants of the same species should be mixed with the seed. The rhizobium is commercially available mixed in a peat culture, which ensures the survival of the rhizobia until seed germination. Improved survival is obtained by using an adhesive or sticker to attach the inoculum to the seed. The most readily available form of sticker is a 10% sugar solution (i.e. 10 gm sugar in 100 ml water). Seed is wetted with the solution and the peat culture mixed with the seed and allowed to dry in the shade - direct sunlight will kill the rhizobium. The following should be noted when inoculating and handling inoculated seed:

- Make sure that the seed has not been treated with chemical and that containers used do not contain toxic substances such as oil, petrol, chemical pesticides;
- Do not mix inoculated seed with acid fertilisers such as superphosphate;
- Ensure that the peat culture used is within the expiry period;
- Store inoculum in a refrigerator - up to 2 months maximum.
- Sow into moist soil.
- Spraying a peat/inoculum mix onto established legumes during cloudy weather can partially or completely overcome nodulation failure.
3.5.8 Forage seed crop management
The overall aim of managing a forage seed crop, whether for grasses or legumes is to produce high yield. The local environment sets the broad growing conditions which are then manipulated through management to meet the needs of particular crops. The management of grasses and legumes differ remarkably.

(a) Weed control
The time and frequency of weeding operations entirely depends on method of seedbed preparation and amount of rainfall in the area. With frequent rains, the weeds re-grow within a short period and therefore weeding will be required more frequently. When the first ploughing is done early enough (at the end of the rain season), the cleared vegetation will be incorporated into the soil, dried and decomposed during the dry season. As the rains begin, some weed seeds that had developed and dropped on the soil surface at the time of the first ploughing will germinate. These weeds should be left to establish and then be sprayed before the second ploughing is conducted. These operations will greatly reduce weed infestation in the forage seed crop field. Hand weeding is the commonest method of weed control but the method is very expensive. The difficulties encountered in differentiating grass weeds from forage grass crops especially in the early stages of development make manual operations very expensive yet chemical and mechanical weed control in established grass swards is impossible. As a practical rule of thumb, the height of weeds should not surpass that of the forage crop otherwise, the crop will be out competed.
A well weeded lablab field during establishment

Weeding out woody species from a *Chloris gayana* field
3.5.8.1 Pests and disease control
Pests and diseases are generally more severe with legumes than grasses. Insect pests include moth caterpillars, sucking bugs and butter flies that are seen feeding on pods and flowers. A wide range of diseases can affect different legumes. The more important ones are Rhizoctonia, Anthracnose in Stylo, rust on Siratro and viruses on may species. Siratro and Lablab must be regularly sprayed to protect the pods and young leaves from aphids and thrips. A regular application of one litre per hectare every fortnight using appropriate pesticides such as Ambush and Rocket helps to control most of these pests. The most serious pest of forage seed grasses are birds that consume enormous quantities of seeds once they are not controlled. As such, birds should be scared out of forage grass seed crops during seed development and setting stage.
(b) Staking/use of trellises
Staking is the provision of vertical support for creeping and climbing legumes. This can be done using sticks or trellises comprised of timber poles and wires in between as often done for passion fruits. Trellises are more effective and long lasting than the sticks; however, they are more costly. Staking increase seed yields by as much as two times in forage seed crops.

(c) Seed harvesting
The decision to harvest the crop depends on how the head or the pods look like. A number of visual indicators have been proposed for grass seed crops to fix the optimum harvesting time more closely. Crops should generally be harvested when the bulk of seed is not far from shedding. At this stage, ripening seed can be easily removed by gently rubbing or by stroking from the base to the apex of an inflorescence. Samples should be checked to ensure that the florets contain seeds by biting individual seeds, or by rubbing in the palm of
the hand to remove seed. In *Chloris gayana* forage seed crop, a golden color appearance of the field is an indicator of seed maturity and hence appropriate time for harvesting.

In grasses the principle tools to be used by small-scale farmers are the knives and sickles. Harvesting may be on the entire plant or, if necessary, selectively remove seed heads. *Panicum maximum* (Guinea grass) seed will produce high yields of high quality seed if the freshly cut seed heads are placed in a stack and then sweated for two to three days before threshing and drying. The main aims of sweating are to detach the seed from the heads and to allow marginally mature seed to mature fully. Mature seed pods of Siratro, Centro and Lablab can be hand-picked every two to three days.

### 3.5.8.2 Post-harvest handling

**(a) Sweating**

Ripe grass seed heads are cut in the field, tied into loose bundles and taken to a shed. Long stems and leaves should be removed as their high moisture content can spoil the seed during sweating. When the stack is opened after two to three days most of the mature seed has undergone abscission. A light threshing on the floor will loosen more mature seed. Sweated seed should then be dried slowly over several days to the required storage moisture content (8-10%).

**(b) Threshing and winnowing**

Threshing involves separating the seeds from panicles and straw, and winnowing the chaff from the seeds. Small-scale farmers employing this method often use a sample stick or flair to separate the seed from the inflorescence and straw by
beating the crop repeatedly on the floor.

(c) Seed drying and cleaning
Newly harvested seed especially the grasses and at times the legumes is quite moist. Freshly harvested grass seeds must therefore be dried to a safe moisture content to prevent loss due to germination, heating and infestation during storage. The seed is spread on a floor, racks, mats, tarpaulins etc in the sun or shade to dry.

(d) Seed storage
Dry legume seed must be dressed with an insecticide e.g. Actellic to prevent damage by insects. The seed can be stored in jute bags to allow further drying and to reduce the sweating that can lead to rotting. The seed is then stored in well ventilated stores free from rats.
CHAPTER 4

BREED IMPROVEMENT

By
Helen N. Nakimbugwe, Jackson Mubiru, Sheila Butungi, Dan K. N. Semambo, James Oluka, Henry Mulindwa, Joseph Masaba and Swidiq Mugerwa

4.1 Cattle Breeding

4.1.1 Introduction
Breeding is defined as “man” (individual farmer, group of farmers or community) controlling the conception and the heredity (which genes are passed on) of animals to produce and raise those animals with the desired traits (improved milk production, ease of milking, docility, low disease susceptibility, longevity etc). This is done through selection which is the allowing of only a few “superior” animals (both females and males) to be the “parents’ of the next generation. These parents may either be indigenous, exotic or a mixture of the two. Multiplication of these desired animals is done through a process known as reproduction that can be achieved artificially, artificial insemination (AI) or naturally by use of a bull. The cattle population in Uganda consists predominantly of the indigenous breeds which are popular for their hardiness, ability to survive under difficult or poor management conditions, relative disease resistance and good mothering ability. However, they are low producers in terms of milk yield, growth rates and carcass yield. The exotic dairy breeds of and their crosses, on the other hand, are high yielding
but are more susceptible to diseases and require high levels of management and nutrition for satisfactory production.

4.1.2 Common Dairy breeds in Uganda

4.1.2.1 Indigenous breeds
These are basically dual purpose breeds, that is, milk production is as important as beef production.

(a) Ankole (Bahima or Watutsi) Cattle

Ankole cattle, whose well developed horns are their most outstanding characteristic, are found mainly in the west and south western part of Uganda. They lack resistance to some local diseases especially tuberculosis to which they are very susceptible; hence, making their milk unsafe to drink unless boiled. On average, they produce about 1.5 litres of milk per day.

(b) Shorthorn Zebu cattle

The shorthorn Zebu are found mainly in the eastern part of the country and are very popular for traction, especially digging. On average, they produce about 0.5 litres of milk per day.
4.1.2.2 Exotic breeds

The most important temperate breeds that have influenced the dairy industry of East Africa are the Friesian, Channel Island breeds (Guernsey, Jersey), and the Ayrshire (Table 10). The levels of performance of these cattle in areas of high agricultural potential in Kenya, under conditions of good husbandry, compare favourably with those attained in the more advanced dairying countries of the world. However, records in Uganda show a great deal of variation attributable mainly to differing management practices.

(c) Nganda (Nsoga) cattle

The Nganda, are an intermediate between the Ankole and Zebu. They are found mainly in central Uganda and adjoining areas. On average, they produce about 1 litre of milk per day.
### Table 4.1.2.2: Some common exotic breeds

<table>
<thead>
<tr>
<th></th>
<th>Friesian</th>
<th>Jersey</th>
<th>Ayrshire</th>
<th>Guernsey</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>The Netherlands</td>
<td>Channel Island of Jersey, Britain</td>
<td>Country of Ayr, Scotland</td>
<td>Channel Island of Guernsey, Britain</td>
</tr>
<tr>
<td><strong>Coat colour</strong></td>
<td>Black and white, sometimes brown and white</td>
<td>Light brown</td>
<td>Brown with white markings</td>
<td>Light brown with white markings</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>Large</td>
<td>Small</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Average milk per day (in Uganda)</strong></td>
<td>13 – 15 litres</td>
<td>10 – 12 litres</td>
<td>12 – 15 litres</td>
<td>11 – 15 litres</td>
</tr>
<tr>
<td><strong>Remarks</strong></td>
<td>Compared to other exotic breeds:</td>
<td>Compared to other exotic diary breeds:</td>
<td>Compared to other exotic dairy breeds:</td>
<td>Compared to the Friesian:</td>
</tr>
<tr>
<td></td>
<td>Produces highest volume of milk</td>
<td>Produces less milk</td>
<td>Produces less milk</td>
<td>Produce less milk</td>
</tr>
<tr>
<td></td>
<td>Susceptible to parasites and diseases</td>
<td>Produces thicker milk (more butter fat)</td>
<td>Produces thicker milk (milk butter fat)</td>
<td>Produces thicker milk (more butter fat)</td>
</tr>
<tr>
<td></td>
<td>Affected a lot by hot climate</td>
<td>Easier to manage</td>
<td>Hardy, aggressive, performs well on all pastures</td>
<td>Adaptable to a wide range of conditions</td>
</tr>
<tr>
<td></td>
<td>Adaptable to a wider range of conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.1.3 Breeding methods

(a) Pure breeding
Pure breeding is the mating animals of same breed to maintain the desired attributes of each breed without mixing, “diluting” or infusing any genes from another breed. e.g., a Friesian female inseminated or mated by a Friesian bull, or an Ankole female with an Ankole bull. This is the preferred breeding method for purposes of conservation and industrial heifer production.

(b) Cross breeding
This is the mating of animals of different breeds to have an overall improved performance of the off-spring through utilizing the positive attributes for each breed in the cross-breeding scheme. For example, the high milk producing capacity of the Friesian can be combined with the high milk fat level and disease tolerance attributes of the Ankole through inseminating pure Ankole Cattle with semen from pure Friesian bulls. Improved performance will be in terms of having an off-spring producing over 12 litres of milk per day from about 1.5 -2 litres per day of its Ankole mother, and an animal with more resistance to diseases than the pure Friesian cattle. Cross breeding is usually done to take advantage of the hybrid vigour in the crosses (hybrids). Hybrid vigour is said to exist when the performance of the hybrid is better than the average performance of the parents. If for example, an ankole producing 2 litres per day is mated with a Friesian bull whose daughters are known to produce 20 litres per day making the average production of the parents to be \((2 + 20)/2\) which is 11 litres per day, there can be hybrid vigour only when the hybrids produce over 11 litres per day. If
this production level happens to be 13 litres, then the hybrid vigour will be 2 \((13 - 11 = 2)\).

(c) **Backcrossing**
This occurs when a crossbred is to the breed of any of the parents. This is done to increase the gene contribution of the parents’ side. For example, when a crossbred of Ankole and Freisian is inseminated with Freisian semen, then we say we are back crossing to increase the gene level of Friesian in the Off-spring. This is what farmers do as they upgrade their stock to exotic blood. And if it is the inseminating of the crossbred with Ankole semen, then we talk of a back-crossing to Ankole where we shall have more ankole genes in the off-spring.

4.1.4 **Appropriate Crossing Levels**
Failures of crossbreeding programmes are usually related to problems of not knowing the best gene mix (level) for maximising both production and survival. Care has to be taken in maintaining the right balance for adaptation and economic usefulness. The optimum breed combination varies according to the levels of management and environment. The more unfavourable the environmental and socio-economical cattle raising conditions are, the smaller the proportion of high performance breed should be.

50% **cross**. Such are crosses from two pure breeds leading to 50% contribution from each parent. Many community-based breeding programs aim at producing 50% crosses due to hybrid vigour and usually affordable management inputs.
**75% Crosses** – Refer to animals where back crossing has occurred to increase the gene contribution of either the father or mother side. For example, if the 50% Ankole-Friesian cross is inseminated by semen from pure Friesian bull, then the offspring will be 75% Friesian and 25% Ankole. Experience has shown that beyond this level of gene mix, farmers usually start having problems of diseases especially if management levels have not progressively improved with this sort of upgrading to exotic blood.

### 4.1.5 Herd Fertility Management

A farmer’s aim is to have a calf every year from each cow, therefore, it is important that sexually mature animals get pregnant and are able to produce a healthy calf. Animals can get pregnant either by using artificial insemination (AI) or by natural service using a bull. The fertility status of the farm depends on several factors which are related to either the farmer (farm management skills of the farmer), the AI technician (skills of the AI technician), the bull (fertility of the bull whose semen is used), the cow (health condition of the animal that is inseminated), the way semen is processed (care with which semen is collected, processed and stored), the environment (hot or cold) or a combination of these factors. Reproduction problems are mainly caused by poor management and by poor nutrition. Therefore, a low reproduction level on a certain farm is only for a small part caused by the cows themselves. The influence of the farm’s management is much bigger. Often the reproduction status is a measure of the quality of the management on a farm.
Schematic representation of Continuous grading up with exotic cattle (backcrossing with exotic cattle)

<table>
<thead>
<tr>
<th>Indigenous (♀)</th>
<th>Exotic (♂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>X</td>
</tr>
<tr>
<td>F1</td>
<td></td>
</tr>
<tr>
<td>50% exotic</td>
<td></td>
</tr>
<tr>
<td>75% exotic</td>
<td>3/4</td>
</tr>
<tr>
<td>87.5% exotic</td>
<td>7/8</td>
</tr>
<tr>
<td>93.75% exotic</td>
<td>15/16</td>
</tr>
<tr>
<td>96.87% exotic</td>
<td></td>
</tr>
</tbody>
</table>
4.1.6 Breeding techniques
Many farmers are reluctant to keep bulls, as they are costly and difficult to keep, and do not produce milk or offspring. The farmers prefer to sell or slaughter the male animals, and keep only the females. However, this may make it difficult to find a male for breeding. The National Animal Genetic Resources Centre and Databank (NAGRC&DB), formerly known as the Animal Breeding Centre, keeps bulls of improved breeds at its Bull stud (centre) in Entebbe. Semen from these bulls is used for artificial insemination (AI) services.

4.1.7 Artificial Insemination or breeding
Artificial insemination (AI) is the process by which sperms are collected from the male animal, processed, stored and artificially introduced into the female reproductive tract for the purpose of conception. AI has become one of the most important techniques ever devised for the genetic improvement of farm animals. It has been most widely used for breeding dairy cattle and has made bulls of high genetic merit available to all.

4.1.8 Benefits of artificial insemination
(a) Cows are bred to bulls of outstanding performance. The semen used is from top quality animals.
(b) There is rapid herd improvement in terms of milk and beef production as very good bulls are used.
(c) The farmer has a variety of bulls to choose from for breeding his cows.
(d) There is wide use and maximum utilization of the good bulls.
• One ejaculate collected from a bull serves many cows.
From this ejaculate, approximately 400 doses of semen can be got and used to inseminate 400 cows. On the contrary one bull is kept for every 25 – 30 cows.

- Frozen semen can be used over a long period of time. It is kept in liquid nitrogen at -196°C.

(c) It is safer to use AI. Bulls have been known to kill people and destroy infrastructure especially fencing, pens and buildings. There is no need to take chances with even a gentle bull.

(f) It is cheaper than using a bull. Bulls need a lot of feed, especially under stall feeding, and very strong infrastructure to restrain them.

(g) Many management aspects of the farm improve due to the demanded keeping of records.

(h) Transmission of diseases especially venereal diseases (e.g. Brucellosis) is avoided

4.1.9 Limitations of artificial insemination

(a) Needs proper or curate heat detection. Poor heat detection causes delay in conception.

(b) A skilled inseminator is required to carry out the proper insemination.

(c) Timely communication to the inseminator for timely insemination is needed.

(d) Lack of AI inputs, for example, liquid nitrogen is a major set back to the proper functioning of an AI system.

(e) If selection of A.I bulls is not done properly, undesired hereditary defects can be widely spread within a very short time
4.1.10 Natural service
NAGRC&DB has numerous AI centers all over the country, but the nearest may be a long way off. Farmers can overcome this by using a natural service bull owned by a group or an individual. One major setback of using bulls in a community based setting that is not well controlled is that the few males that are in the village mate with all the females, causing problems of inbreeding.

(a) The farmers’ group buys or is provided with a bull, possibly one of an improved breed.
(b) One of the group members feeds the bull and looks after it.
(c) When a cow comes on heat, its owner brings it to the bull for breeding.
(d) The owner of the cow pays the bull-keeper for the service in cash or in kind (feed, calf etc.).
(e) Every 2 years, the group sells the bull and buys another one or exchanges with another group. This is to prevent inbreeding.
4.1.11 Issues to consider in choosing a service bull for a community

(a) Should the male be a local or an improved breed? Local breeds may be more resistant to diseases, but improved breeds often produce more meat and milk.

(b) Who should own the male? Alternatives include ownership by the group (with some payment to the person keeping the animal), or ownership by an individual, who charges others for the breeding services of the male.

(c) Who should keep the male? Keeping a male animal involves quite a lot of work and responsibility: providing feed and water (more for a male than a female), keeping the animal healthy, and dealing with the females which come to be bred or serviced.

(d) How is the male animal fed? Some communities bring feed for the male, or set aside community land to grow fodder grass. Over feeding the bull may lead to overweight, which may result into failure to mount successfully. However, underfeeding may also result into loss of libido, therefore, it is necessary to strike a balance between the two. In the dry season, it is important to supplement the feeds with concentrates, vitamins and minerals.

(e) How is payment for the male’s service made? Payments can be made in cash or in kind (in the form of fodder, feed supplements, milk, or another animal).
(f) **When should payment be made?** Alternatives include on service (each time a female is served), on result (when the female successfully gives birth), or continuous (e.g., villagers take turns in bringing feed to the male).

(g) **What is the level of payment?** How much should the keeper get for caring for the male animal? In general, the benefits (in terms of cash, in-kind payments or prestige) should be high enough to be attractive for the keeper, but low enough for the group to want to contribute.

(h) **Are the animals healthy?** The group should make sure that both the male and the females are healthy, to avoid spreading diseases and parasites. The bull should frequently be checked for venereal diseases. Among reproductive diseases, contagious abortion (brucellosis) is the major venereal disease in Uganda. Routine testing once a year should be carried out, but three times screen test of cows should be carried out where it is suspected. In case of abortion, and the test shows the presence of brucellosis, then screen tests should be carried out in the surrounding area for the presence brucellosis. Therefore, screening of target cows before introduction of the bull should be carried out. Cows that had abortions should not be brought to the bull before proper testing is carried out. And if found diseased, proper treatment should be carried out first.

(i) **What sort of records should be kept?** These include, among others, the origin of the bull showing milk production of its mother (dam) and source of its father
(sire), cows brought to the bull, calves born to the bull, days for spraying/dipping/pour on, health of the bull, Income from the bull and expenses incurred, visitors records, money paid out to sustain the keeping of the bull by the group.

(j) **How often should the bull be rotated?** In case the bull is not diseased and not overweight, he can be taken to other farmers after 2.5 to 3 years. It is hoped that within this period of time the offspring heifers will have reached service age and not be mounted by their father. In case the bull is old and can no longer be used for breeding, he should be slaughtered and the money from the sale of meat is used to purchase and transport a replacement bull.

(k) **How many animals should the bull service per day?** Not more than three.

4.1.12 **Causes of poor herd fertility**
Good fertility means that every year a cow should get a calf (calving interval 365 days). Economic consequences of a good fertility are: higher average daily milk production, more calves born and more possibilities for selection among the female stock for higher production. It is not easy to reach and to maintain a high level of fertility on a farm. Many fertility problems that cause few calves to be born and longer calving intervals can be attributed to the following:
(g) **Poor management**

(i) **Poor record keeping.** With poor record keeping, problems like not coming on heat are not discovered on time. Without good records, one is simply handling cows like a blind man. When there are reliable records, they should also be used. Cows not coming on heat within 60 days after calving doan, should be checked. If possible, 6 to 8 weeks after the last insemination, a pregnancy diagnosis should be carried out.

(ii) **Poor feeding.** Good nutrition means sufficient energy, proteins, minerals and vitamins. Providing a balanced ration according to the needs of the animals, does not only mean more milk, but also means better reproductive performance. A better performance means calving for the first time at a younger age, shorter calving intervals and more animals coming in-calf. Animals should not be overfed; otherwise, they become too fat and this has a negative effect on reproduction. In many cases, mineral lick in addition to a normal ration should be provided, especially in case of high producing cows. Lack of vitamin A may be the cause of low fertility when there is not sufficient green roughage (the animals make vitamin A from carotene present in green roughage). A premix with vitamin A should also be provided to the animals.

(iii) **Poor handling of animals.** Often animals have to walk far before and after insemination. This raises the body temperature, which has a negative effect on conception.

(iv) **Poor heat detection.** Without good heat detection, many heats are missed and this causes longer calving intervals.
From the records (if well kept!) it can be learned whether heat detection is good or not. Heat intervals or intervals between two inseminations or services of around 42 or 63 days indicate that heats have been missed. In a healthy non-pregnant cow, a new estrus cycle begins every 18 to 24 days. This means such animals are seen on heat every 18-24 days. Good administration of breeding data can be an aid to the farmer (manager) in detecting animals on heat. In hot climates, heat length is short and signs of heat are often less obvious hence the need good skills and more time to observe heat. Most animals can be seen on heat during the cooler periods of the day. At noon, the hottest period of the day, heat signs are poor. Heat detection should preferably be done at the same times every day preferably in the morning before and after milking, in the afternoon before and after milking, and in the evening at around 10 o’clock. Besides this, all other opportunities to see animals on heat should be used. 15-20 minutes of observation time is needed to do a good heat check.
Figures showing signs of cows on heat

(b) Inseminating the cow at the wrong time. A cow should be inseminated during the middle part of the heat period, or within 6 to 8 hours after the end of the heat. If insemination takes place in the beginning of the heat or too late after the end of the heat, conception rates decline. Conception means becoming pregnant and it is the result of successful fertilisation following artificial insemination (AI) or natural service. Cows which are in standing heat early in the morning can be inseminated in the afternoon the same
day. Cows which come on heat in the afternoon or evening should be inseminated in the morning the next day. Never inseminate too early or too late.

(c) **First insemination takes place too late after calving.** With normal healthy cows on a good nutrition, insemination can take place from day 45 days after calving. Animals should be pregnant again within 3 months (90 days) after calving. Since not all animals are pregnant after the first insemination (average 60-70 % is possible) insemination should start before 3 months, so starting at 40 days is fine.

Reproduction parameters for a profitable farm enterprise, especially that of exotic stock, are shown in Table 10:

**Table 4.1.12: Reproduction parameters for exotic stock**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at first mating / service / conception /</td>
<td>15 - 20</td>
<td>months</td>
</tr>
<tr>
<td>Age at first calving</td>
<td>24 - 29</td>
<td>months</td>
</tr>
<tr>
<td>Calving interval (from one calving to the next):</td>
<td>12 – 15</td>
<td>Months</td>
</tr>
<tr>
<td>Calving to first heat less than:</td>
<td>35</td>
<td>Days</td>
</tr>
<tr>
<td>Calving to conception:</td>
<td>80 - 100</td>
<td>day</td>
</tr>
<tr>
<td>Calving to first service:</td>
<td>45 - 60</td>
<td>Days</td>
</tr>
<tr>
<td>Services per conception:</td>
<td>1 to 3</td>
<td>Services</td>
</tr>
</tbody>
</table>
(a) Calving Interval / Inter-calving Period (CI / ICP)
This is the period in a cow’s life between the birth of one calf and her next calf. The recommended targets for ICP are: Average of 365 days; range: 330 – 400 days. ICP is best understood if broken up into its component periods and events as illustrated in the Figure below. Farmers are advised to commit this diagram to memory because successful dairy farming is inextricably linked to a thorough understanding of the implications of the factors affecting the intercalving period and their management.

(b) Lactation Period
The time from calving until the cow is dried off, i.e. the time during which the cow is producing milk. Average/target: 305 days (43 weeks); range: 265 to 340 days (38 to 49 weeks). The length of the lactation period depends on the open period and level of production.

(c) Open Period (OP)
Open period is the time from calving to re-conception. The length depends on the voluntary waiting period and the breeding period. Average/target: 85 days (12 weeks); Range: 45 to 120 days (7 to 17 weeks). Most fertility problems occur during this time.

(i) Voluntary Waiting Period (VWP)
The minimum time the farmer decides to allow between calving and the first mating. Usually 45 to 60 days. It is not recommended to breed before 60 days (8 weeks) after calving. If the VWP is less than 60 days, then it must not be less than
45 days because the uterus will not have healed completely leading to many services per conception.

(ii) Breeding Period
The time from the end of the VWP until conception. Cows should be bred when they are clean and showing at least the second observed heat. The length depends on proper heat detection and timely insemination. Farmers must be very alert during this period.

(d) Gestation Period
The time from conception to calving ranges between 278 to 285 days and is dependent on the breed, sex of the calf etc. But for practical purposes, it can be taken to be 280 days (40 weeks). For the Holstein-Friesian it is 278 days.

(e) Dry Period
The time from the end of lactation until the cow calves down. In Uganda, 60 days are recommended. A period of less than 45 days will have a markedly deleterious effect on the next lactation. Low producers, cows which have been sick, or cows with extended open periods may reach uneconomically low levels of production before 60 days from when the next calf is expected, and thus have a longer dry period. This period is necessary to allow the cow time to replenish body reserves, especially minerals which were depleted during lactation and to allow the udder tissue to build up, and to be renewed before the next lactation.
(f) Pre-calving / Steaming up Period
Depending on the management level of the farm, 6 to 9 weeks before the anticipated calving date, the cow may be given extra feed for replenishment of body reserves to ensure that she calves in good condition (the cow should not be over-conditioned) and to ensure that her rumen micro-organisms are adapted to concentrate feeding.

(g) Environment
Sometimes there are seasonal influences on reproduction when the cows mainly depend on grazing for their nutrition. In the dry season, there may be reproduction problems because of especially low quality grasses for grazing or fodder. When the temperature and humidity are high, it may be difficult to detect heat. In case of high day temperature, heat detection should take place in the cooler periods of the day, with plenty of attention.

(h) Diseases
Diseases like brucellosis, vibriosis, trichomoniasis etc. affect reproduction. Use of AI helps in curbing such diseases. Bulls with breeding diseases should not be used. Uterus inflammation (metritis) reduces reproduction. This can be avoided by taking hygienic measures before, during and after calving. In case of metritis, a veterinarian should clean the uterus. Diseased or underfed cows may be difficult to detect in heat.

(i) Hormonal disturbances
In individual cows, hormonal disturbances can reduce reproduction efficiency. For example:
• The animal is constantly on heat. This is caused by the mature follicle not bursting open, hence the continued production of estrogen. A veterinarian can try to burst the follicles open.
• The animal is not pregnant, but will not come on heat making the farmer believe that it is pregnant. In this case the corpus luteum does not disappear.
• Pregnant cows are sometimes seen on heat. This is caused by insufficient progesterone production.
• Expulsion of the fetus. Because of, for example, brucellosis (infection of the placental membranes), the placental membranes die off. In this case, progesterone production stops and oxytocin is not blocked anymore hence causing expulsion of the fetus.
• Silent heat. The animal cycles normally and ovulation takes place but there are no heat signs or are not noticed.

(j) Other influences
• Bull semen which is not fertile. Such semen can be detected with the aid of a microscope. Only bulls with proved fertile semen should be used.
• Low quality semen. In case of AI, when semen is not correctly preserved, or when it is not correctly treated, many or the sperms die off.
• Wrong insemination techniques. These can be overcome by better training and monitoring of inseminators.
• Handling of animals. Attitude and approach of the cow are important matters for an inseminator. Rough handling of animals before, during and after insemination can cause the animal not to conceive.
4.1.13 Improving herd fertility

(a) Concentrate on reproductive management in the period right from calving up to 3 months later. Make sure the cow has conceived within that period if you are to maintain the calving interval of 12-15 months.

(b) Allow routine examination of the reproductive tract of your cows. This enables early detection of non-pregnant cows, diseases, and reproductive disorders, hence leading to timely treatment or intervention e.g., hormonal treatment.

(c) Do not breed cows too early (less than 45 days) after calving. This is because the uterus will not have healed completely something that could later lead to many services per conception.

(d) Correct timing of insemination, that is, 8 – 15 hours after the first true signs of heat such as mounting other animals have started. Please note that signs may be observed when they started along time ago.

(e) Good nutrition. Enough pastures/ fodder, protein source, mineral and vitamin supplements should be adequately provided.

(f) Good communication. Proper information should be given to the inseminator as to when the animal came on heat to enable him/her to carry out insemination at the right time.

(g) Proper Insemination technique by the AI technician is needed.

(h) Maintain high hygienic conditions at calving to avoid infection of the uterus.

(i) Accurate detection of heat. This requires that the farmer knows the signs of heat in the cow (Table 4.1.12). Check for signs of heat every morning and evening. You must record the dates of heat to enable you predict the next heat (18 –24 days later).
Table 4.1.13: Details of heat signs to look out for during the 18 hour heat period

<table>
<thead>
<tr>
<th>Mounting</th>
<th>Behaviour</th>
<th>External genitalia</th>
<th>Mucus</th>
<th>Bloody discharge</th>
<th>Ruffled head tail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Early or pre-heat period</strong>: At this stage an insemination is useless and can only cause harm. The period varies much, and is not present in all cows. It can last from a very short time to one day or more.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tries to mount other cows, animal does not stand when mounted by others</td>
<td>Sniffing of other animals, looks for the company of other cows, or of a bull, restless, extra attentive, moos</td>
<td>Vulvas is wet, red and slightly swollen</td>
<td>Very little</td>
<td>None</td>
<td>None, but may be on cows mounted by other animals coming in heat</td>
</tr>
<tr>
<td><strong>Middle or Standing heat period</strong>: Pre-heat changes into standing heat (the heat period). Heat length depends on breed and climate. Duration in tropical countries for the Friesian cow is about 10 –12 hours.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stands to be mounted, but will still mount others</td>
<td>Complacent, friendly, still trails other cows, very nervous, restless and mooping frequently, attentive, active ear play, banded backbone (bent upwards), less appetite, less milk production, slightly higher body temperature</td>
<td>Lips of vulva red and swollen,</td>
<td>Abundant and clear conspicuous in amount</td>
<td>Seldom</td>
<td>Muddy flanks and ruffled tail head</td>
</tr>
<tr>
<td><strong>Late or post head period</strong>: After the period of standing heat, some cows continue to show activity. This activity is mainly passive.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Will not stand to be mounted, but will mount others</td>
<td>All signs of nervousness, trailing and head butting disappearing</td>
<td>Swelling decreased &amp; rubbery in consistency</td>
<td>Decreased in amount and other signs have ceased</td>
<td></td>
<td>Dirty tail with dried mucous discharge</td>
</tr>
</tbody>
</table>
4.2 Approaches for Sustainable Improvement of Animal Genetic Resources

4.2.1 Introduction
Animal genetic resources for food and agriculture comprise an essential component of the biological basis for world food security. A majority of poor rural people keep livestock to provide multiple products and services. In harsh environments where crops will not flourish, livestock keeping is often the main source of livelihood. There are over 239 million cattle in Africa of which about 150 breeds are indigenous. The indigenous cattle breeds are diverse with unique genetic attributes such as adaptation to heat and drought, tolerance to diseases and utilization of low-quality forages. The majority of the indigenous cattle are local types with a low genetic potential for milk and meat production. However, there is an ever growing demand for livestock products in developing countries and a need for increased productivity. Inexistence of herd recording, lack of efficient breed improvement programmes and non-availability of proven superior quality breeding animals are among the factors that contribute to the slow progress in improving the genetic merit of local cattle populations (Rege and Wakhungu, 1992). This is largely due to lack of proper organization and management of breeding schemes.

4.2.2 Community based approaches and nucleus breeding schemes
Community participatory approaches have registered success stories in the implementing genetic improvement programmes involving farmers, breeding organizations and marketing
agents such as the Sahiwal crossbreeding programme in Pakistan and the Operation Flood programme (OFP) in India. In most of these, the key factor was the creation of organization that integrated different functions in the community chain and ensured participation of farmers at all levels of animal improvement and production. In order to ensure various key stakeholder involvement and sustainability of livestock breed improvement programmes, the two components are run concurrently. The proposed feasible approaches for sustainable cattle genetic improvement in developing countries through either pure breeding (selection within breed) or crossbreeding (improvement from different breed combinations) are the application of the centralized breeding station referred to as Central Nucleus Breeding System (CNBS) and the community based breeding approach or Group Nucleus Breeding Structure (GNBS). The two approaches are operated together by opening up the central station to the farming communities.

Other proposed farmer participatory approaches include the Open Nucleus Elite Breeder and Participatory Farmer flocks (ONEB-PF) system or the Open Nucleus Elite Breeder and Multiplier Flocks (ONEB-MF) system. In the ONEB-MF system, superior or elite animals are selected from farmers through screening techniques, reared and multiplied at a central station where by high selection pressures from accurate performance records are applied on dams, males and offspring. The resultant improved sires continuously produced at central station are then given back to farmers as high-grade animals. The key elements of the schemes are farmer participation, record keeping and farmer group organisations operating in
collaboration with a central breeding station.

4.2.3 Community based breeding schemes

In developing community-based breeding schemes, the following key issues should be considered:

(a) Need to understand and appreciate the social and cultural context for the intended innovation intervention, associations and existing partnerships within the community and breeding institutions, local perceptions of the new breed of animal to be introduce and its origin and local terminology and ethno-taxonomy

(b) Ecological and production context, identified breeding area, local soil types and classification, local farming systems, seasonal forage calendar and preferred grazing species

(c) Livelihood significance of the indigenous animals terms of types and products, range of products and uses and production and reproduction performance

(d) Management of the introduced and improved animals or gene pool, local preferences in reference to breeding goals, special characteristics and attributes, the proposed breeding mechanisms and techniques for identification and selection of superior animals or top breeders

(e) Population estimate and population trends of the farmers indigenous animals to be involved

(f) Chances for sustainable use and conservation, interest in revival and conservation of the indigenous animals by the local community and expected challenges, constraints and mitigation measures

(g) Baseline data to monitor special impacts such as benefits to the community and the number of people in terms of
families and individuals who are partly or totally dependent on the breed.

4.2.4 Breeding programmes
Selection and cross-breeding are the two main tools used to achieve genetic changes in livestock populations. Selection implies genetic improvement based on variation among individuals within the population (breed). This process is often referred to as straight-breeding. In contrast, cross-breeding involves making use of variation among populations (breeds). Straight-breeding and cross-breeding programmes may represent components within a broader breeding strategy; they are not mutually exclusive and are often used in combination. However, such combinations depend on first developing the capacity to operate each element in a sustainable manner. Among the many factors that must be considered in the development of a breeding programme are: the animal species involved; the types of traits considered; the availability, accessibility and affordability of different breeds; the production environment; the time frame for the planned genetic improvement (improvement through straight-breeding usually takes longer than through cross-breeding); and the infrastructure of the livestock sector and the resources allocated to the programme.

4.2.4.1 Pure breeding (straight breeding)
This is based on selection within a specific breed. Farmers and key stakeholders need to be involve to participate in determining suitable and agreed up on breeding goals and the associated goal trait values (measures of relative importance and economic value), identification of current breeding
practices and market structure and development of operating procedures for the breeding programme. The main objective of selection within breed is to develop a sustained straight-breeding programme by using the genetic variation within the breed being targeted. The breed may be that of cattle such as the Small east African Zebu, Nganda or Ankole.

In straight-breeding genetic progress is generally obtained after a long time since the estimation is based on the generation interval of a particular species or breed. Cattle have long generation intervals and thus progress per year or per generation is low. The selection of animals for the selected goal traits will be based on the assumptions these are from an infinitely large population of animals and thus distributed according to the standard normal distribution curve (Fig. 9.1). Conducting selection for superior performing individual animals as parents of the next generation on a continuous basis leads to genetic progress for a particular trait per year or generation.

![Fig. 9.1 Standard normal distribution](image)

The values for milk yield measured in each individual cow or dam in a population sample will be deviated from the overall population average or mean value ($\mu$) which is standardized ($\sigma$). Selection of the best animals will be those with standard ($\sigma$) values over $1\sigma$ on the right of the graph. Conducted this
way, the values can be used to estimate genetic progress where generation interval will play a key role being the denominator. Sometimes indirect traits can be used such if their correlations are high.

With accurate data and use of established heritabilities ($h^2$) and selection differential ($S$) or the average difference between the parent generation and the selected parents for the goal trait, the response to selection ($R$) or average difference between the parent generation and the next generation can be estimated from the formula $R = h^2 S$

### 4.2.4.2 Crossbreeding

Cross-breeding is the other alternative means of generating superior animals from genetic change in a population. It may be implemented in various forms including sustained cross-breeding where there is also a set of breeds contributing the cross are also maintained as straight-bred populations, sometimes the development of a new synthetic breed, or breed substitution carried out by recurrent crossing. In cross-breeding, progress is generally obtained within a shorter time period. Cross-breeding can be used for sustained crossing (i.e. producing cross-bred animals continuously), changing a local breed by upgrading or creating a new (synthetic) breed that combines desirable traits from two or more breeds. The basic objective of crossbreeding systems is to simultaneously optimize the use of heterosis and breed differences within a given production and marketing environment. The production environment includes feed resources as well as climatic conditions. The level of heterosis tends to be inversely proportional to heritability. In moderately to highly heritable traits, such as carcass characteristics, level of
heterosis is low while traits having low heritability, such as fertility and livability, heterosis is high.

Crossbreeding produces F1 crossbred that exhibit visible heterosis as it increases levels of production above what would be obtained through selection from mainly additive gene effects. Heterosis is mainly due to dominance effects and the joint effects of the loci from the parents will be the sum of their separate contributions (Falconer, 1989):

\[ HF = \sum dy^2 \]

In which \( d \) represents the dominant effect at the individual loci and \( y \) is the difference in gene frequency between the two parent stocks. In this way, the strong points of one or more breeds such as adaptation to tropical conditions say among indigenous cattle breeds or high producing ability of exotic cattle can be used to compensate for these weak points among indigenous cattle for milk or meat traits. Crossbreeding also introduces heterosis through combinations of non-additive gene effects i.e. both dominance deviations and epistatic effects between genes on different loci. Heterosis is the percent of superiority expressed in a trait by crossbred progeny over the average of the parent breeds involved in the cross (% Heterosis = \( x \times 100 \)). For example, two parents breeds in a cross with their average daily milk yield of 3.0 and 2.0 litres/day that are later mated and produce kid progeny with average daily milk yield of 2.75 kg would thus give the heterosis for their kid progeny of 10% \([(0.25/2.5) \times 100 = 10\%]\)
Well-controlled cross-breeding programmes with efficient monitoring systems can be useful for genetic improvement without negatively affecting the valuable genetic diversity that exists within and between local breeds. However, if adequate controls and checks are not put in place, indiscriminate crossing will take place and the genetic integrity of local breeds will be damaged. A genetic impact assessment of the introduction of exotic genetics must be made and measures taken to prevent indiscriminate crossing.

In undertaking breeding programme, the following have to be considered:

- Review the breeding goal and implementation process for the programme.
- Assess the state of current breeding practices, capacity and infrastructure.
- Prepare the plan for the start of the straight-breeding programme.
- Set up the financial and organizational structures such as communities and associations.
- Implement the straight-breeding programme.
- Pen the nucleus for generating superior genetic merit animals.
- Improve dissemination and distribution of animals of superior merit or performance.
- Improve recording and evaluation.
- Optimize the selection intensity and the generation interval.
- Ensure that the programme is delivering as expected.
4.2.4.3 Requirements needed for implementation of breeding programmes

- Effective infrastructure for accurate data collection, handling, management and analysis
- Good communication system for identification, measurements, recording and tracking of animals
- Training and supervision of field staff to ensure effective performance
- Setting clear targets that are measurable and achievable and challenging
- Establish an efficient and simple delivery system for the germplasm from the programme
- Consider using artificial insemination

4.2.5 Recording and performance evaluation

Accurate data on the performance of various genotypes is necessary for on-farm evaluation and comparisons of their performance enabling accurate identification and selection of suitable genotypes and superior performing individuals for continued breeding and genetic progress. Lack of information on the performance of individuals under various management environment conditions makes it difficult to compare performance between populations and individuals within breeds. This limits the identification and selection of superior individuals and suitable breeds for particular agro-ecologies. Accurate data on average population phenotypic values for performance traits is obtained for performance evaluation in order to obtain heritability and repeatability values for the estimation of breeding value and genetic progress. In considering data collection for effective performance
evaluation, the following need to be undertaken:

(a) Provide incentives to improve the uptake of the breeding services such as holding structures and shelters for livestock provide health care services (vaccinations) and provide incentives to encourage recording such as record books or charts.
(b) Provide identification tags or branding for cross-bred animals to identify semen used and animals
(c) Establish a performance recording system for production traits in all genotypes for comparison between the production performances of the two groups.
(d) Establish basic pedigree recording system involving identification and recording of the sire and dam. This would enable avoidance of mating between a sire and his female progeny, which would lead to inbreeding depression.
(e) Carry out an assessment of genetic impact on the integrity of local breeds

4.2.6 Formation of groups and community breeding associations
A group is a social unit of two or more individuals who have a common set of Interest, beliefs, values and always follow common norms. A group operates in a dynamic manner where flow of coherent activities which are envisaged will lead a group towards the establishment of its set goals. Group formation involves both identifying with some individuals and explicitly not identifying with others. Distinctiveness is necessary for group formation. Through interaction, individuals begin to develop group norms, roles and attitudes which define the
group and influence behavior. A lot of training of groups is required to build capacity.

4.2.7 Training of farmers
Establishing groups occurs once interested men and women have a better idea of what they want to do and how they can do. Four basic principles in group formation: Group should be small (8-15), Group should be homogeneous, Group should be formed around income-generating activity and Group should be voluntary and democratic. Members are listed with interest in forming a group and inform them of size (8 to 15 people is always a most effective group). Inform people that membership implies rights and benefits (share profits, etc.). A group must have obligations especially attend meetings, payment of membership fee, election of leadership, regular contributions to group savings, repayment of group loans and to help other members if in need. A group should address partnership matters especially; Women participation, Group name (Some names do not reflect good intent; so avoid such), When and how often to meet, Set specific objectives, Importance of attending meetings, Importance of good communication, Building blocks of a group.

The building blocks of a group include: Leadership (a group that is well led usually succeeds), Leaders and committee members must be chosen carefully, Contributions (Regular group savings are essential), Member’s contribution to their group activities help to build a sense of group ownership and solidarity, Group constitution (a written record of the purpose and rules for the group). Avoids a group to have internal conflicts and makes responsibilities of each member clear,
Record keeping (help the group remember what has been decided at meetings). They are very important in monitoring and evaluation. The form of these building blocks depends on the ideas and experiences of the members. The final form of the group must be agreed by the members themselves and adjusted to suit their needs and views.

4.2.8 Farmers associations
These are intergroup associations (formed from small groups). As groups develop, they face problems or challenges that a single group cannot solve alone. Linking up with other groups can help them to solve problems (bulk purchase of inputs, collective marketing, etc). Inter-group associations (IGAs) ideal is suggested to be of say (3-10 groups). This seem to work best that those with larger memberships. Also IGA with member groups within easy reach/ walking distance of each other do much better than IGAs whose groups are spread over a wide area. Large distances between groups make communication more difficult and discourages member participation. The associations can take the form of Societies, Co-operatives, Companies,

4.3 Record Keeping

4.3.1 Introduction
A record is an accounting of events or data which must be processed or summarized in order to provide information. Livestock owners often try to commit too much to memory yet very few individuals have total recall. However, decisions made with limited or inaccurate information can be very costly. In order to keep proper records, it is important to
identify animals by names, ear tags, branding neckbands or tatoos.

4.3.2 Importance of record keeping
(a) Information is required to make sound management decisions that lead to efficient running of the farm. Decisions are based on facts.
(b) Problems are identified before they become serious.
(c) With records, one can easily monitor whether the farm enterprise is profitable or not.
(d) Information from records can also be used to plan future actions
(e) Planers and policy makers use farm records to assess current national production levels.

Every good record system should have the following characteristics: easily updated, understood, easy to summarize, current and complete. Incomplete or incorrect records can be as useless as no records and often more frustrating. These characteristics are vital if the records are to provide useful information, that is, processing or summarization. Records on the farm broadly fall in the following categories: Breeding and Reproduction, Production (milk), Financial (input and output), Health and Feeding.

Each animal in the herd should have an individual permanent record that is initiated at birth or when purchased. This permanent record can be broken down into several basic parts. Formats of sections on the permanent record may vary from farm to farm, but the data recorded remains the same. For example, the Lifetime Record Cards which are available
from the National Animal Genetic Resources Centre and Databank in Entebbe have various sections which include, Identification, breeding and reproduction, milk production, prophylactic measures, health, and calves produced. This card contains a summary of all events about the animal which are got from separate detailed records of, e.g., daily milk production, artificial insemination service card, health record, calf record, etc. Below are some examples of record formats:

**Health record format**

<table>
<thead>
<tr>
<th>Cow ID</th>
<th>Date of Birth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Symptom, Injury or Test</td>
</tr>
</tbody>
</table>

**Breeding record format**

<table>
<thead>
<tr>
<th>Cow ID:</th>
<th>Dam (mother):</th>
<th>Sire (father):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactation No:</td>
<td>Date bred:</td>
<td>Service Sire:</td>
</tr>
<tr>
<td>Calving Date:</td>
<td></td>
<td>Postpartum Exam</td>
</tr>
<tr>
<td>Calf ID:</td>
<td>Sex:</td>
<td>Calf Weight:</td>
</tr>
</tbody>
</table>

Comments:
Daily milk production format

<table>
<thead>
<tr>
<th>Cow No.</th>
<th>Date of Birth</th>
<th>Lact No.</th>
<th>Last Calving Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MONTH</th>
<th>MILK YIELD litres</th>
<th>TOTAL Litres</th>
<th>MONTH</th>
<th>MILK YIELD litres</th>
<th>TOTAL litres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>DATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A.M.</td>
<td></td>
<td>A.M</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P.M.</td>
<td></td>
<td>P.M.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DATE</th>
<th>A.M.</th>
<th>P.M.</th>
<th>DATE</th>
<th>A.M</th>
<th>P.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 5:

ANIMAL HEALTH AND DISEASE MANAGEMENT

By
Halid Kirunda and Charles Ssekitto
5.1 Animal Health Management

5.1.1 Introduction
It is always important that an animal is kept free from disease. Signs of health and disease can be reviewed from the entire animal body, region(s) or system(s). It is easier to describe the signs on body system basis. Basic knowledge of the animal anatomy (structure) and physiology (function) is essential for a proper understanding of the health and disease status.

5.1.2 Signs of health and sickness

<table>
<thead>
<tr>
<th>Feature</th>
<th>Healthy animals</th>
<th>Sick animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body condition</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Facial expression</td>
<td>Bright, alert, calm</td>
<td>Dull or excited</td>
</tr>
<tr>
<td>Coat</td>
<td>Clean, shiny</td>
<td>Staring or hair loss</td>
</tr>
<tr>
<td>Posture</td>
<td>Balanced and steady</td>
<td>Not balanced</td>
</tr>
</tbody>
</table>

5.1.2 Digestive system

<table>
<thead>
<tr>
<th>Feature</th>
<th>Healthy animals</th>
<th>Sick animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdomen</td>
<td>Normal size</td>
<td>Distended or reduced</td>
</tr>
<tr>
<td>Appetite</td>
<td>Normal</td>
<td>Little or none</td>
</tr>
<tr>
<td>Drinking</td>
<td>Normal</td>
<td>Little or none</td>
</tr>
<tr>
<td>Faeces</td>
<td>Soft well formed</td>
<td>Watery, bloody or hard</td>
</tr>
<tr>
<td>Defecation</td>
<td>Normal</td>
<td>Diarrhoea or constipation</td>
</tr>
</tbody>
</table>
5.1.3 Nutritional diseases of dairy cattle
(a) Acidosis
When the animals eat too little fibrous feeds (fodder) and too much feeds rich in soluble carbohydrates (like grain, maize and maize-bran, brewers grain) the acidity in the rumen becomes too high and the pH drops. After 8-12 hours the animals show signs.

Key clinical signs
- Shock and sudden death.
- Listlessness.
- Lethargy (general body weakness).
- Loose appetite.
- Indigestion and irritability.
- Little rumen movement.
- Pass loose and watery faeces (dung) with an offensive smell.
- Reduced milk production.
- But body temperature remains normal.

Treatment
- Injecting with Thiamine is most commonly recommended.
- Drenching with baking powder may help.
- Best to call a veterinarian.
Prevention

- Avoid feed too much fermentative carbohydrate meals (e.g. grains, bran, tubers, etc).
- Gradually increase amounts of grain so the rumen can adjust.
- Always have high levels (>70%) roughage in the diet.
- Always have feed available for animals to eat so they don’t suddenly over eat.
- Preventing acidosis is easy and a worthwhile process to do. If acidosis ends up getting to bad, then you will end up with sick cattle and death if not treated right away.

(b) Ketosis (Acetonaemia)
The disease commonly occurs in high producing cows or cows on poor diet. It is mainly seen before calving, but occurs mainly in the first month after calving and occasionally in the second month. It might be found when the animal has received a ration which was too rich in energy during the period she was dry.

Clinical signs

- Decline in appetite for 2-5 days.
- Eating any object.
- Decline in milk production.
- Staggering or un-steady movement.
- Head carried low to the ground.
- Breath has a sweet ‘sickly’ smell.
- May show apparent blindness.
- May wander aimlessly.
- May strange movement of tongue.
Temperature remains fairly normal.

Treatment
• Intravenous administration with a dextrose solution by a veterinarian.
• Drenching with propylene or glycerine (has a longer effect).
• May give an injecting of long-acting corticosteroids.

Prevention
• Proper feeding and management practices.

(c) Milk fever (Hypocalcaemia)
Milk fever occurs mostly in high-yielding dairy cows soon after calving, usually within 72 hours. Caused when feed has been deficient in calcium during pregnancy, the cow uses her body reserves for the development of the foetus. When she starts to produce colostrum, which is also rich in Ca, a calcium deficiency occurs in her body.

Clinical signs
• Initial excitement or agitation
• Tremor in muscles of the head and limbs
• Staggering
• Go down to a “sitting” position, often with a ‘kink’ in the neck, and finally lie flat on their side before circulatory collapse, coma and death.
• A dry muzzle
• Staring eyes
• Cold legs and ears
• Constipation
• Drowsiness are seen after going down
• Weaker and faster heart beat.
• Poor appetite

_Treatment_
• Intravenous injection with calcium borogluconate by a veterinarian. The cow will respond immediately and will stand.
• To prevent further problems DCP (Di-Calcium Phosphate) should be introduced in the ration.

_Prevention_
• Proper feeding and management practices

(d) **Bloat (Ruminal tympany)**
Bloat is an excessive accumulation of gas in the rumen of the cow. The reason is that the animal is unable to belch and to release the produced gas. It is usually caused by an excessive intake of a single type of green, fresh leguminous fodders, like lucerne, lablab, cowpea, velvet bean. It is recognized by a swollen rumen and a drum like sound when patting on it. The condition is usually seasonal. It can be frothy of gas-free bloat. Caused by excessive accumulation of gas or froth in the rumen.

_Clinical signs_
• Stops grazing.
• Reluctance to move.
• Distended left abdomen.
• Appear distressed - vocalise, eyes bulging.
• Strain to urinate and defaecate.
• Has rapid breathing - mouth may be open with tongue protruding.
• Staggering movement.

Treatment
• If it is gas-free bloat, remove gas from the stomach. Puncturing the rumen with the standard trocar and cannula is much less traumatic than means. It would better be done by a veterinarian.

If it is frothy bloat, immediately drench with 300 to 500 millilitres of a vegetable oil such as dioctyl sodium sulfosuccinate. Any non-toxic oil, especially a mineral oil that persists in the rumen, is an effective bloat treatment. This treatment can be repeated several times within a few hours if necessary.
• You may drench with rumen contents, separately or with oil.
• Feeding of the animal with legumes should stop immediately.

Prevention
• To prevent problems, allow the legumes to wilt some time after cutting and before feeding. Never let the animal graze on a pure legume stand and balance the ration with other roughages.

(e) Constipation
This is one of the most common ailments that cattle suffer from. Constipation is due to paralysis of the bowels. In this case the bowels require a laxative and tonic. It is dangerous to give a cow salts or oil. Caused by feeding of very dry feed together with insufficient drinking of water, feeding moldy hay, insufficient exercise, and intestinal and liver diseases.

Clinical signs
• The animal produces solid dry faeces, which is brittle and covered with mucus.
• The animal has pain and is straining during defecation.
• Lack of appetite.

Treatment
• Give plenty of drinking water, bran mashes and laxotonic.
• Administer quarts of warm water once or twice daily per rectum by the use of a flushing outfit.
• Subject the animal to a reasonable amount of exercise.  
  OR  
• Provide green, succulent, laxative diet and plenty of water.

**Prevention**
• Always provide animal with feed and plenty of drinking water.  
• Avoid feeding animals with moldy hay.  
• Animal should be allowed sufficient exercise.

(f) **Urea poisoning**
Urea poisoning is one of the more commonly suspected toxicities of cattle where urea is used as a source of non-protein nitrogen (NPN) in feed supplements. It is an acute and fatal disease caused by a too high or accidental consumption of urea.

**Cause**
• Excess consumption of urea.  
• Sudden introduction to high quantities of urea.  
• Irregular consumption of urea.  
• Wet supplement containing urea.  
• Urea separating out from the supplement after transport; re-mix prior to feeding.

**Clinical signs**
• Signs of poisoning can include twitching of ears and facial muscles, grinding of the teeth  
• Frothy salivation
- Bloat
- Abdominal pain
- Frequent urination
- Forced rapid breathing
- General weakness
- Staggering
- Violent struggling
- Bellowing, and terminal spasms.
- Often, animals are found dead near the source of the urea supplement.

_Treatment_
- Treatment is rarely effective.
- But, if cattle can be handled, a stomach tube can be passed to relieve the bloat and then used to drench the animal with a large volume of cold water: 45 litres for an adult cow is suggested, followed by 2-6 L of 5% acetic acid or vinegar.
- Treatment repeated within 24 hours, as relapses can occur.

### 5.1.4 Tick and other vector-borne protozoan diseases
#### (a) East Coast Fever (ECF/Theileriosis)
East Coast fever (ECF) is a serious tick-borne disease, often fatal, disease of cattle that causes major economic losses in Uganda. It is a common disease in the country. Caused by Protozoan parasites (_Theileria parva_) transmitted by the brown ear tick (_Phipicephalus appendiculatus_)

_Clinical signs_
- Dullness.
• Loss of appetite.
• Increased body temperature from a normal of 39°C to about 41.5°C (107°F).
• Swollen lymph nodes especially those below the ears, in front of the knee joints of the shoulders.
• Haemorrhages on oral and vulva mucosae.
• Constipation at the beginning but later diarrhoea.
• Coughing and profuse clear nasal discharge.
• Weakness.
• Corneal opacity.
• Froth appears from the nostrils when it dies.
• Difficulty in breathing.

**Diagnosis**
• Make a diagnosis from the clinical signs and take a blood smear for the laboratory examination to confirm the diagnosis.

**Treatment**
• Curative drugs, such as pervaquone (clexon) and bupervaquone (butalex) can be used. But they are very expensive.
• As there might be mixed infection, you could also use oxytetracycline.
• Supportive drugs including vitamins and iron sulphate are also necessary.

**Prevention**
• Tick control through spraying with an acaricide is the most important preventive method.
(b) **Anaplasmosis**
Anaplasmosis is a tick-borne infectious blood disease of cattle. It is caused by a rickettsia organism (*Anaplasma marginale* and *Anaplasma centrale*) transmitted by a blue tick of the *Boophilus decoloratus*.

**Clinical signs**
- High temperature 40 °C.
- Loss of appetite.
- Constipation.
- Pale mucous membrane (anaemic) which then become yellow.
- Urine dark yellow.
- Body weakness.
- Respiratory distress.
- Rapid loss of condition.

**Diagnosis**
- Use history and clinical signs. Take a blood smear for the laboratory examination to confirm the diagnosis.

**Treatment**
- Imizol (imidocarb dipropionate).
- Oxytetracycline (given early).

**Control**
- Tick control through spraying with an acaricide is the most important preventive method.

(c) **Babesiosis**
Bovine babesiosis is a tick-borne, parasitic disease that causes
significant morbidity and mortality in cattle. Caused by Protozoan parasites (Babesia species) transmitted by blue tick (Boophilus species)

**Clinical signs**
- Increased body temperature to 41 °C.
- Loss of appetite
- Staring coat
- Pale mucous membranes (anaemic), which may become yellow (jaundice).
- Red urine (may only be seen in the morning).
- Body weakness

**Diagnosis**
- Make a diagnosis from the clinical signs and take a blood smear for the laboratory examination to confirm the diagnosis.

**Treatment**
Many drugs, if used early, will cure babesiosis. These include:
- Diminazene acetate (Berenil, Veriben, Diminasan)
- Imidocarb dipropionate (Imizol, Imidox)

**Control**
- Tick control through spraying with an acaricide is the most important preventive method.

(d) **Heartwater (Cowdriosis)**
Heartwater is an infectious, non-contagious, rickettsial disease of ruminants in areas infested by ticks of the
genus *Amblyomma*. Caused by Protozoan organism (*Cowdria ruminantium*), transmitted by a tick called *Amblyomma variegatum*.

**Clinical signs**
- Sudden onset of fever.
- Excessive watering from the eyes.
- Convulsions.
- Loss of appetite.
- Chewing constantly.
- Licking of lips.
- Flicking of eyelids while circling with a high-stepping movement.
- Standing with legs straddled and head lowered.
- Animal lies on sternum and then on sides and die during convulsion.
- Diarrhoea is sometimes seen.

**Diagnosis**
- Make a diagnosis from the clinical signs and take a blood smear for the laboratory examination to confirm the diagnosis.

**Treatment**
- Use oxytetracycline or doxycycline preferably the long-acting oxytetracycline formulation.

**Prevention**
- Tick control through spraying with an acaricide is the most important preventive method.
(e) Trypanosomiasis (Nagana)

Animal trypanosomiasis is a parasitic disease that causes loss of condition and anaemia. Many untreated cases are fatal. The disease is found where its biological vector, the tsetse fly, exists. Caused by Protozoan organism (trypanosome) transmitted by a tsetse fly.

Clinical signs
- Intermittent fever
- Anaemia
- Oedema
- Lacrimation
- Enlarged lymph nodes
- Abortion
- Decreased fertility
- Loss of appetite, body condition and productivity
- Early death in acute forms
- Emaciation and eventual death in chronic forms often after digestive and/or nervous signs
- Drop in milk production
- Starry coat

Diagnosis
- Use history and clinical signs. To confirm, take blood and lymph node smears for laboratory examination.

Treatment
- Drugs for treatment include diminazene aceturate, homidium chloride and homidium bromide.
- Prophylactic drugs for cattle include homidium chloride, homidium bromide and isometamidium.
Control

- Control the Tsetse fly.
- Use prophylactic drugs e.g. samorin dosage and duration will depend on the tsetse fly challenge

5.1.5 Bacterial diseases

(a) Mastitis

‘Mastitis’ is a disease of the udder commonly caused by bacteria. It is a common and major problem in the dairy cattle causing economical loss to the farmers. There are increased chances of occurrence of mastitis due to physical damage to the udder or teats by improper milking practice and mechanical injuries to the udder. The disease usually common in cattle living under poor sanitation conditions such as unclean floorings, bedding, and poor milking surroundings.

Cause

- A range of bacteria usually due to poor milking techniques and poor hygiene.

Clinical signs

- Swelling of the udder and teat; asymmetrical swollen udder
- Redness and pain of the udder
- Milk gets curdled and becomes watery with blood streaks in some cases
- Fever
- Listlessness
- Loss of appetite
- Reduced milk production
- In chronic and sub clinical cases, the teat canal gets thickened.
Treatment

- Drain the affected quarter of all milk.
- Administer an intra-mammary infusion of antibiotic in tubes per affected quarter.

In these tubes are a combination of antibiotics including ampicillin, oxytetracycline, sulphonamides, dihydrostreptomycin, cefuroxime, clavulanic, cloxacillin, cephalonium, oleandomycin, neomycin, novobiocin, penethamate etc. Providing an injection with the same
antibiotics is often recommended. The choice of antibiotic and the treatment are better done by a veterinarian.

_Prevent_
- Identification of sub clinical form of mastitis and treating them is a good practice to prevent mastitis spread
- Teat dipping and dry animal treatment is also a good practice to prevent mastitis
- Good milking technique and strict adherence to hygiene

_(b) Contagious Bovine Pleuropneumonia (CBPP)_

It is an infectious and highly contagious bacterial disease in cattle and water buffalo. CBPP is sometimes referred to as lung sickness. Caused by *Mycoplasma mycoides* subspecies *mycoides*.

**Clinical signs**
- Loss of appetite.
- Fever.
- Difficult breathing.
- Cough.
- Nasal discharges.
- Animal may stand with head lowered and fore legs spread apart.
- Animal is unable to tolerate exercise.

**Diagnosis**
- Clinical signs, post mortem lesions and bacterial culture in the laboratory.
Prevention

- Conduct regular vaccination using the CBPP vaccine.

(c) Bovine Tuberculosis

Tuberculosis (TB) is a contagious disease of both animals and humans. The disease is usually chronic that often doesn’t show signs until it has reached an advanced stage. Caused by a bacterium, *Mycobacterium bovis*. Bovine TB can be transmitted from livestock to humans and other animals.

Clinical signs

- Emaciation
- Lethargy
- Body weakness
- Low-grade fever
- Pneumonia with a chronic, moist cough.
- Lymph node enlargement, which may be present.

Diagnosis

- TB is difficult to diagnose with clinical signs alone. In the early stages of TB, clinical signs are not visible.
- The standard method for detection of TB is the tuberculin test. Definitive diagnosis is made at the laboratory.

Prevention and control

- The standard control measure applied to TB is test and slaughter.
- Systematic individual testing of cattle and removal of infected
- Animal movement controls
- Post mortem meat inspection of animals. Detecting these
infected animals prevents unsafe meat from entering the food chain and allows veterinary services to trace-back to the herd of origin of the infected animal.

(d) Anthrax
Anthrax is a highly infectious and fatal disease of animals and humans. Most forms of the disease are lethal. The predominant sign in cattle with anthrax is a progression from a normal appearance to dead in a matter of hours. Most animals are simply found dead. The disease is caused by the bacterium *Bacillus anthracis*.

**Clinical signs**
Once an outbreak begins in the herd the following signs may progressively be observed;
- Weakness.
- Fever.
- Excitement.
- Depression.
- Difficulty breathing.
- Uncoordinated movements.
- Convulsions.
- Bloody discharges from the natural body openings.
- Sometimes fluids accumulation in different parts of the body.
- After death, the animal’s body rapidly decomposes.
Diagnosis

- If signs of that kind are observed, just call a veterinarian. Do not touch a suddenly dead animal.

Treatment

- Try penicillin or tetracyclines in very early stages of the disease.

Prevention and control

- Vaccination is very effective.

5.1.6 Viral diseases

(a) Foot and Mouth disease (FMD)

FMD is a viral disease of cloven-hoofed (two-toed) animals. FMD causes painful sores and blisters on the feet, mouth and teats of animals. Foot-and-mouth disease is a high consequence livestock disease due to its potential for rapid spread, severe trade restrictions and the subsequent economic impacts that would result.
Clinical signs

- Fever, shivering, dullness, blowing lightly
- Wounds (vesicles) in the mouth
- Tender and sore feet, blisters on feet, lameness
- Loss of appetite
- Drop in milk production and sore teats in milking stock
- Abortion
- Loss of body condition
- Slobbering and smacking lips, slavering
- Animal is “tucked up” with a staring coat.
- Copious frothy saliva around the lips that drips to the ground at intervals.

Sore on the gum and tongue
Sores/blisters on foot

Diagnosis

- From clinical signs, confirmation is by collecting samples of the vesicular fluid and sending them to a well-equipped laboratory.

Treatment

- There is no curative treatment. However, you should treat with antibiotics against secondary bacterial infection, selective feeding and foot bath.
Prevention

- Vaccination every 6 months and control of livestock movement. FMD is a notifiable disease.

(b) Bovine Ephemeral Fever (BEF)
This is a three day sickness manifesting with stiffness. It is also known as Bovine Epizootic Fever. Caused by a virus transmitted by insects and occurs at the beginning of the rainy seasons.

Clinical signs

- Fever
- Loss of appetite
- Nasal discharge
- Drop in milk production
- Stiffness and lameness
- Lying down
- Recovery after a few days

Diagnosis

- From the history and clinical signs

Treatment

- No specific treatment available. Antibiotics and anti-inflammatory steroids could be used.
- Good nursing care (tender loving care) is necessary for relief.

(c) Lumpy skin disease (LSD, Pseudourticaria)
Lumpy skin disease is an economically important disease of cattle and can produce a chronic debility in infected cattle.
LSD is an acute infectious disease of cattle of all ages. Caused by a virus that affects the skin of an animal.

**Clinical signs**

- Fever of 40 to 41.5 °C,
- Tears on the eyes (lachrymation)
- Loss of appetite (anorexia) is possible
- Some depression
- Reluctance to move
- Skin swellings (lumps) that may cover the whole body or be restricted to the head, mouth, neck, perineum, udder, genitalia or limbs.
- Lesions first appear as round areas of erect hair, measuring 5 to 50 mm in diameter.
- Swellings are firm and slightly raised above the surrounding normal skin separated by a narrow ring of blood.
- Swellings are of full skin thickness.
- Enlarged regional superficial lymph nodes.
- Increased nasal and oropharyngeal secretions.
- Severely infected animals lose weight.
- Persisting for 3 – 6 months
- Abortion often follows or calves are born with extensive skin lesions.

**Diagnosis**

- Use the characteristic signs of skin nodules, fever and enlarged superficial lymph nodes, but with low mortality rate. Scrapings of skin lesions taken to the laboratory for confirmation.
Treatment and control

- There is no specific antiviral treatment available for LSD infected cattle.
- Sick animals may be removed from the herd and given supportive treatment consisting of local wound dressing to discourage fly worry and prevent secondary infections.
- Systemic antibiotics and sulfonamides against secondary bacterial infection may be given but the response is usually poor.
- Food and water should be made readily available.
- Vaccination

(d) Rabies

A viral disease, when symptoms of rabies appear, the disease is certain to be fatal for whatever warm-blooded animal is infected. Animals with rabies suffer deterioration of the brain and tend to behave bizarrely and often aggressively, increasing the chances that they will bite another animal or a person and transmit the disease.

Clinical signs

The clinical signs of rabies in domestic warm-blood animals are highly variable, but similar is most species. Rabies should always be suspected if there is a sudden change in behaviour, unexplained progressive paralysis and increased, decreased, or normal spinal reflexes.

- Animal tends to become aggressive and physically dangerous.
- Excessive drooling of saliva that tend to be thick and foamy in appearance.
• Very sensitive, reacting violently or extremely to the slightest sounds or movement.
• Throat paralysis, resulting in inability to swallow.
• Animal is depressed and unwilling to socialize with the rest of the herd.
• Lack of Appetite.
• Excessive Sleeping.
• Have fear for water.
• Eating of inanimate objects such as sticks, stones etc.
• Fever may also be present.

**Diagnosis**

• Use clinical signs. Call a veterinarian to collect samples for laboratory confirmation.

**Treatment**

• No treatment

**Prevention and control**

• Keep all pets on farm or at your household vaccinated against rabies.
• Prevent strange animal including stray dogs and cats from accessing your cattle.

5.1.7 **Calf diseases**

Common calf diseases include scours, pneumonia, helminthosis and tick borne diseases

(a) **Helminthosis**

This is an infection caused by a heavy worm infestation. Worms cause this condition and the calf can pick them up from the mother.
Clinical Signs

- Progressive loss of weight
- Ruffled/dull coat
- Diarrhoea in some animals
- Sagging abdomen (pot belly especially young stock)
- Reduced vigour
- Changes in circulatory system - pale mucosa, and inter-mandibular oedema
- Slow growth
- Diarrhoea
- Poor hair coat

Diagnosis

- From the clinical signs and a regular fresh faecal sample taken to laboratory for examination of worm ova.

Treatment

- Administer dewormers (antihelmintics), as appropriate, at the age of two months and then repeat every 1-3 months.

Prevention and control

- Good hygiene and regular deworming include regular removal of manure and maintenance of unsoiled troughs. Most problems in calves are caused by faulty nutrition and poor hygiene.

(b) Rickets/osteomalacia/night blindness

- Rickets is found mostly in young growing animals.
- The development of the skeleton is hampered and bones might be deformed.
• Rickets occurs due to Ca deficiency, what might have been caused by feeding a calf too little mother’s milk.
• Osteomalacia is the corresponding disease in adult animals.
• Night blindness can be found due to Vitamin A deficiency in calves.

(c) Calf scours
Most causes are related to bad management practices. These may be unhygienic housing, contaminated utensils, feeding cold milk, feeding too much milk, or if inadequate colostrum was fed.

Signs
• Diarrhoea and whitish coloured faeces
• Strong smell of faeces
• Soiled anus and tail
• Dullness
• Loss of appetite
• Later as dehydration sets in, sunken eyes

Treatment
Not feeding milk for one or two feedings is helpful in most cases. Instead, give boiled water that has been cooled. If scouring persists, the following electrolyte solution can be mixed and fed to the calf instead of 3-6 milk feedings.
• Salt (4 teaspoons)
• Baking soda (3 teaspoons)
• Dextrose or Glucose or sugar (20 teaspoons)
• Water (Warm 5 litres)
Oral antibiotics may be added to the electrolyte solution or given separately.
**Prevention and control**
- Improve calf management

**(d) Pneumonia**
- Though bacteria and viruses may be involved several external factors, like poor ventilation dampness of chilling of the calf pen, increase the risk of the calf getting pneumonia

**Clinical signs**
- Coughing accompanied by running nose and eyes
- High temperature 40-41.5°C
- Difficult breathing
- Loss of appetite

**Treatment**
- Broad spectrum antibiotics

**Prevention and control**
- Keep the calf in a dry, well ventilated pen

**(e) Other conditions of the gastro-intestinal tract**
These include “Hardware” disease, Displacement of Abomasum, torsion and dilation of the Caecum, Ingestion of non-metallic objects leading to obstruction and impaction of the rumen.

**(f) Diseases associated with foot problems**
These include: Foot rot, Solar ulcers, white line diseases, heat erosions etc.
5.1.8 Notifiable diseases
Certain cow diseases are called “Notifiable Diseases.” Because they spread very fast, become difficult to control and hence cause big economic loss, they are governed by each country’s laws. According to the Animal Disease Act, cases or suspected cases must be reported to the nearest Veterinary Office without delay. Failure to do so makes the owner of the animals liable to prosecution.

Notifiable diseases in cattle in Uganda currently include:
- Contagious Bovine Pleuropneumonia
- Foot and Mouth disease
- Lumpy Skin Disease
- Rabies

5.2 Use of Indigenous Technical Knowledge in the Management of Diseases Among Small Scale Farmers

5.2.1 Introduction
Small scale livestock farmers form a big percentage of the total livestock population and play an important role in the provision food and income to their owners. Some of the farmers feed their animals by tethering, or communally graze them as communities. Many have got improved stock which are housed in zero grazing units.

These farmers face many challenges which include poor breeds, poor nutrition, poor growth rates and diseases. The nutrition component is currently being vigorously addressed. However, the disease problem still poses a big challenge. Many smallholder dairy farmers can spend over 60% of the
animal health budget on treatment of ticks and tick-borne diseases, and yet there are other diseases too like mastitis, lumpy skin disease etc which consume their income. Research is endeavoring to help these farmers by instituting health control measures that are cheap, simple to use, environmentally friendly and are effective.

Indigenous Technical Knowledge (ITK) is an age old phenomenon which farmers of long ago used to solve livestock problems. For example, in Uganda acaricides were first used in the 1930’s when colonialists wanted to bring in cattle from Europe. Before then, farmers had their own ways of treating the diseases and the parasites.

5.2.2 Documentation of ITK
Today ITK is used synonymously with ethno-veterinary medicine. This is the exploitation of plants to treat diseases, parasites and conditions in livestock. In NARO, we embarked on a drive to document this Indigenous Knowledge, and we have in our data base over 40 plants from different parts of Uganda which the farmers use to treat different diseases, parasites and conditions. We have tested some of these plants together with the farmers the way they use them. We have validated in the laboratory some of the plants, and we are studying further the most promising ones for purposes of improving the formulation and application method. Example of a few of the plants is given in Table 13.
Table 5.2.2: Some plants used in Indigenous Technical Knowledge

<table>
<thead>
<tr>
<th>Disease</th>
<th>Scientific name</th>
<th>Common name</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticks</td>
<td>Tephrosia vogelli</td>
<td>Muluku</td>
<td>Validated in the lab and controlled up to 77% of the ticks</td>
</tr>
<tr>
<td></td>
<td><em>Jatropha curcas</em></td>
<td>Ekroowa</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Gynandropsis (Cleome) gynandra</em></td>
<td>Ejjobyo</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Ocimum suave</em></td>
<td>Kawunyira</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Melinus minutiflora</em></td>
<td></td>
<td>Grass with hairs and can be eaten by animals. The hairs trap and kill the ticks</td>
</tr>
<tr>
<td></td>
<td><em>Stylosanthes spp</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Euphorbia tirukali</em></td>
<td>Orukoni</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Euphorbia candelabrum</em></td>
<td>Enkulukuku</td>
<td></td>
</tr>
<tr>
<td>Tick-borne diseases</td>
<td><em>Dombeye dawei</em></td>
<td>Emikohwa</td>
<td>(Runyoro)</td>
</tr>
<tr>
<td></td>
<td><em>Vernonia amygdalina</em></td>
<td>Mululuza</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Phytolaca dodecandra</em></td>
<td>Oluwoko,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Omuhoko</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Cannibus sativa</em></td>
<td>Enjaga</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(mariajuana)</td>
<td></td>
</tr>
<tr>
<td>Nagana</td>
<td><em>Basella alba</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Venomia amygdalina</em></td>
<td>Mululuza</td>
<td></td>
</tr>
<tr>
<td>Eye diseases</td>
<td><em>Phytolaca dodecandra</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retained placenta</td>
<td><em>Kigelia africana</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Acacia sieberiana</em></td>
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</tr>
</tbody>
</table>
5.2.3 Research in ITK
Currently tests and validation are going at NaLIRRI on *Tephrosia vogelli* which has been claimed to have effect on several parasites. We have tested the plant against ticks, and currently we are trying to improve the formulation and method of application.

ITK and Ectoparasites control

- Use Tephrosia to control ticks on cattle

*Tephrosia vogelli*

Ticks in cattle
REFERENCES


