PASTURE/FORAGE PRODUCTION AND MANAGEMENT[1]

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1.0 Introduction

The improvement of animal nutrition through controlling feed resources available is a major factor in increasing livestock productivity through increasing output per animal. Improved animal disease and parasite control, good breeding programmes and good livestock husbandry are important but, the farmers' emphasis should be placed on good proper feeding, which in turn will make the other things possible.

Pastures are the cheapest source of feed for ruminant animals which are particularly valuable because of their ability to convert all types of forages, roughages and crop by-products into products which are useful to man i.e. milk, meat, hides and skins etc.. Therefore, ruminant livestock production can be increased through increasing the productivity of already existing resources or through the introduction of new resources.

Animal feeding is of fundamental importance in livestock production. The basic requirements that are fulfilled when animals are fed are maintenance (growth), reproduction and production. The potential of the animal in meeting each of those objectives will depend on how well the animal is fed.

2.0 PASTURE DEVELOPMENT

Pastures are the cheapest source of feed for livestock. Pastures are mostly made up of grasses and legumes. Grasses form the dominant pasture component and are characterized by their ability to produce a lot of seeds and are able to propagate themselves vegetatively. Unfortunately, grasses mature very rapidly and loose quality as rapidly. Uganda has six dominant types of natural grasslands, which are adapted to the specific agro-ecological zones. This is mostly determined by amount of rainfall received and soil fertility condition. The management of the natural pasture is an integrated system involving management of the plants and soil on one hand and herd management on the other.

2.1 IMPROVEMENT OF NATURAL PASTURES

2.1.1 Fencing

Perimeter fencing using barbed wire or live hedges will exclude unwanted animals from grazing the pasture and will help control grazing. Paddocking is also recommended where possible as this makes rotational grazing for efficient pasture utilisation possible. *Euphorbia tirucalli* and *Erythina abysinnica* are trees mostly used for live hedges but any other appropriate trees can be used. The use of live hedges cuts down on the cost of purchasing fencing posts.

2.1.2 Bush Control

Dense tree canopies and bushes will reduce grass productivity through shading and competition. Trees should be thinned leaving only those for shade. Fire, weed killers, manual cutting and hoeing

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can be used to control bush. Frequent slashing of the re-growth shoots of most of those woody species will exhaust the food reserves in their root systems leading to death or stunted growth and will in turn increase the grass cover.

2.1.3 Weed Control

Bush clearing is often followed by annual or perennial weed growth which must be removed. Notorious weeds like *Cymbopogon afronadus, Imperata cylindirica, Sporobolus pyramidalis* and shrubs like *Solanum incanum and Lantana camara* must be removed as soon as they occur, preferably before setting seed. Possible methods to use would include manual hoeing and slashing.

2.1.4 Provision of watering points

Water supply is usually a hindrance to good pasture management during the dry season. Overgrazing occurs around watering points and this should be prevented as much as possible. This can be overcome through desilting of dams where they exist and livestock drinking points should be constructed so that livestock does not have to directly drink from the dam or borehole. Watering points should be evenly distributed on the farm.

2.1.5 Soil Conservation

Soil erosion could be a result of rain and wind in areas that have been overgrazed. To prevent further soil conservation measures should be taken. Planting of fodder trees and stoloniferous or rhizomatous grass species will improve soil structure allowing for better water infiltration and stabilise the soils. Where patchy grazing has occurred, cut tree branches could be used as mulch on the overgrazed sites, which allows vegetation to grow and cover the area.

2.1.6 Grazingland Management

Periodic rest during critical growth periods permits the accumulation of plant nutrient reserves and aid seed formation. A system of deferred-rotational or seasonal grazing will allow for seed development and formation; facilitate natural re-seeding of deteriorated grazing areas. Such areas should be protected or highly grazed during the time of seedling establishment of volunteer pastures. The basis of plant (grass) management is the provision of recovery periods between grazing cycles, which period allows the plant to build up reserves that will ensure continued plant growth vigour.

2.1.7 Oversowing /Re-seeding

The improvement of natural grasslands usually requires some means of bush eradication and overseeding with or without tillage. With minimum tillage, oversowing (introduction of improved forage species- grasses and legumes) is much cheaper than the elaborate seed-bed preparation. Oversowing is aimed at improving existing grass cover through the introduction of pasture legumes. The advantages of oversowing are:-

i. Less seed is needed
ii. Reduced cost of land preparation
iii. Reduced danger of soil erosion

Successful establishment of grasses and legumes sown into natural grazing lands lies in the choice of appropriate species; application of suitable techniques of land treatment, use of fertilisers especially phosphates and appropriate methods of sowing.

2.1.7.1 Time of Sowing

Weather conditions during establishment are of primary importance and the condition of the seed-bed may be of less consequence. Germination and growth of seedlings are dependent on subsequent rains rather than stored moisture, whether sown into cultivated, harrowed or raked seed-beds. It therefore follows that oversowing should be done at the beginning of rains.

Sowing shortly after the rains begin takes advantage of soil nitrogen made available by mineralisation. Sowing should be done early so as to take advantage of the moisture which will enable the shallow-rooted seedling do root suffer from water shortage especially in the first two months of growth.

2.1.7.2 Seed and Seed Rates

Generally, natural pastures in Uganda have a very low legume component. Oversowing with legumes especially *Stylosanthes guyanensis* has proved useful as indicated by increased body weight. Other legumes, which have succeeded by being oversown, are *Desmodium uncinatum D. intortum* and *Centrosema pubescens* in all grasses. For Stylosanthesis, the legume is then allowed to re-seed before grazing and in this way it is spread through animal droppings after scarification by the rumen enzymes.

In oversowing, grasses and legumes are sown alone or in mixtures. Grasses have been used for oversowing natural grasslands and re-seeding degraded areas caused by overgrazing, wind and water erosion. *Chloris gayana, Cenchrus ciliaris* are some of the species that have shown a good potential for improvement of grazing lands in low rainfall areas. Placement of cut branches on the soil surface favoures seedling development.

The quality and viability of the seed will determine the seed rate whereby smaller seeded species are sown at lower rates than larger seeded species. The most suitable seed rate recommended for oversowing of most forage legumes under Uganda's conditions is 2-4 kg/ha. The reason for this high seed rate is mostly poor seed quality and poor seed-bed preparation. Seed quality can be improved by ensuring that a start is made with certified seed. If certified seeds are used, the following are the recommended seed rates:-

Recommended Legume Types	**Seed Rate**
Stylosanthes spp. (Stylo)	1-1.5 kg/ha
Centrocema pubescens (Centro)	1.5-2 kg/ha
Glycine wightii (Glycine)	1.5-2 kg/ha
Desmodium Spp.	1-1.5 kg/ha

2.1.7.3 Seed treatment

(i) Scarification: Pasture legume seeds are highly impermeable to water imbition because of hard seed coats; and so scarification improves germination by breaking hard seededness. This can be done mechanically by hand rubbing with sand paper. Species which can be mechanically scarified include: *Centrosema pubescens, Macroptilium atropurpureum and Desmodium spp.* Scalification can also be achieved by hot water treatment. The seeds are soaked in heated water to about 80^0C for about 5 minutes, rapid cooling and then dried. Another method is to boil the water remove from the source of heat, place in the seeds and leave them in the water overnight and then plant the following day.

(ii) Inoculation Seed inoculation with the appropriate *Rhizobium* bacteria is necessary for nodulation and this will ensured good legume establishment. Most tropical legume species introduced in Uganda nodulate naturally from the native cowpea *Rhizobium*. For those legumes requiring specific *Rhizobium*, the inoculant can be obtained from the Dept. of Soil Science, Makerere University. Instructions for use of inoculants are supplied with the seed and are quite easily followed.

2.1.7.4 Planting methods

The seed may be sown in cultivated strips; patches or after rough harrowing, burning or after closer grazing. A little disturbance of the soil will improve establishment. Seedlings do not tolerate heavy shade therefore cutting of trees/shrubs and dense grass provides higher initial stands and more dense populations than sowing into regularly grazed rangeland. The commonest methods are:-

i. **Direct overseeding:** The simplest approach is direct sowing of seed into natural or native grasslands after rough harrowing, burning or after closer grazing by broadcasting. A little disturbance to the soil will improve establishment.

   The seeds are spread by hand, taking care to assure uniform distribution. The area should be divided into equal parts the seeds divided into similar equal parts. Then each portion of seed should be broadcasted into one area. Wind is a factor to be considered especially with light seeds which may be blown over some distance. Mixing the seeds with materials such as sawdust, sand and fertilisers helps to distribute the seeds more evenly.

   Broadcasting gives satisfactory stands when conditions are favourable for rapid seed germination and seedling growth. However, the method has the disadvantage of difficulty in weed control. It is difficult to differentiate between the sown seedlings and the weeds especially at the early establishment stage.

ii. **Strip planting**: This involves the plating or sowing of forage seeds in narrow belts or strips in active grazing lands as a means of improving the pasture and providing supplemental feed for grazing animals. Strip planting into natural grasslands using forage legumes e.g. Stylo, Desmodium, Centrocema and Siratro into a natural grazing land dominated by grass increases the herbage available for grazing, as well as the stocking capacity, and facilitated the spread of the legumes into non-seeded areas by passing seeds through the grazing cattle. This is achieved by sowing the legumes into cultivated strips 1-2 ft (30-60 cm) wide and 4 m apart. Strip planting reduces the cost of cultivation and facilitates weeding and cultivation especially during the early stage of establishment.

iii. **Spot sowing**: Both grass and legumes can be successfully seeded in heavily grazed native pasture by spot sowing. Low density planting in fertilised spots is effective and cheap.

The success of improving the natural pastures using of the oversowing techniques will depend on the low cost of SSP or TSP fertilisers, the availability of improved forage grass and legume seeds. Legumes supplied with phosphate fertilisers nodulate properly and are able to supply the associated grass with nitrogen.

2.1.7.5 Fertilisers in Establishment

For the development of a legume-grass pasture, it is imperative that phosphate in the form of SSP or TSP (Single Super phosphate or Triple Super phosphate respectively) be applied before or at the time of sowing. The quantity needed is generally in the range of 125-250 kg/ha of super phosphate. Generally phosphatic fertilisers at the rate of 200 kg/ha are recommended for successful oversowing of legumes into natural pastures of Uganda. The best fertilizer recommended for pasture

improvement in Uganda is N.P.K (Nitrogen, Phosphorous and Potassium) applied at the rate of 250 kg/ha/year. However, considering the high costs of NPK, it is advisable that the fertilizers are used on sown pastures where quick responses can be observed.

2.1.7.6 Weed Control

In oversown grass-legume pasture under optimum conditions, germination of the legumes takes about three to four weeks. Alongside the grass/legume seedlings, weeds will also germinate. With a dense stand of grass-legume-weed mixture, slashing or hand-pulling should be applied. It is hard to completely get rid of weeds during the establishment phase. Light grazing might be useful as long as it does not lead to loss of the legume due to trampling and uprooting. Hand -slashing can be employed where labour availability is possible. Weeding should be done as early as the weeds appear (if they can be differentiated from sown pastures).

2.1.7.7 Management after Sowing

Grazing or cutting should be avoided until plants are large enough (30 cm high) to withstand defoliation; and this occurs 4-8 weeks after sowing. However, light grazing or cutting helps in the control or weeds and stimulates further pasture growth and reduces the shading effect created by the grass for the legumes.

2.2 ESTABLISHMENT OF PASTURES ON A PREPARED SEED-BED

Sown pastures are improved grazing lands comprising introduced grasses and /or legumes for temporary or permanent grazing. It is important to note that seed of most pasture species is very small and it becomes necessary to prepare a fine seed-bed, free from weeds and with adequate fertilisers and soil moisture for successful establishment.

2.2.1 Seed-bed Preparation

In preparing a seed-bed, two basic requirements must be borne in mind; whether a tractor or a hoe or ox-plough are being used and these are:-

i. A seed-bed that will provide conditions for rapid seed germination and seedling emergence
ii. Elimination/ reduction of competition from unwanted plants.

The aim should be to produce a fine but firm seed-bed. If a tractor is being used, the initial depth ensures that only top soil which contains more organic mater and retains moisture better is used in the preparation of the seed-bed. On many soils, however, there is a risk that the fine seed-bed may be broken down heavy rain and form a hard crust through which the seedling cannot penetrate. This should be avoided by timing the seed-bed operation to commence before the heavy rains.

2.2.2 Time of Sowing

Sowing shortly after the rains begin takes advantage of soil nitrogen made available by mineralisation, but coincides with the period of severe rainstorms and strong weed competition. With heavy downpours excessive run-off of water occur and either washes seeds out of position or covers them too deeply. In such areas, sowing should be done early so as to take advantage of the moisture which will enable the shallow-rooted seedlings take advantage of the rains especially in the first two months of growth.

2.2.3 Methods of Sowing

Grasses and legumes are sown alone or in mixtures. Sowing should coincide with periods when seed-bed moisture is adequate or when rainfall reliability is highest. The commonest methods are:-

(i) Broadcasting

The seeds are spread by hand, taking care to assure uniform distribution. The area should be divided into equal parts and the seeds divided into similar equal parts. Then each portion of seed is broadcasted into one area. Wind is a factor to be considered especially with light seeds which may be blown over some distance. Mixing the seeds with materials such as sawdust, sand and fertilisers helps to distribute the seeds more evenly. All grasses and small seeded legumes are planted at a depth of 1.2-1.5 cm. Light cover can be achieved by going over the planted area with a bushy branch or a garden rake. Broadcasting gives satisfactory stands when conditions are favourable for rapid seed germination and seedling growth.

(ii) Rows

Sowing in rows facilitates weeding and cultivation especially during the early stage of establishment. With grass-legume mixtures, they can be planted in same row or in alternate rows; depending on the species, species, seedling vigour and habit of growth. Spacing should be 30-60 cm for good ground cover and optimum production of herbage.

2.2.4 Seed Rates

The quality and viability of the seed will determine the seed rate and the method of sowing to be used. Smaller seeded species are sown at lower rates than larger seeded species and the seed rate is even lower when a species forms part of a mixture. The grass seed rate recommended for Uganda is 10-15 kg/ha while legume seed rate is 4-5 kg/ha.

2.2.5. Seed treatment

(i) Scarification

Pasture legume seeds are highly impermeable to water imbition because of hard seed coats; and so scarification improves germination by breaking hard seededness.

(a) Mechanical

Hard rubbing with sand paper may be necessary. Pricking the seed coat with a pin or sharp-pointed knife is effective but time consuming especially with small seeds. Species which can be mechanically scarified include: *Centrosema pubescens, Macroptilium atropurpureum and Desmodium spp.*

(b) Hot Water

Soaking the seeds in heated to about 80^0C for about 5 minutes, rapid cooling and drying improves germination. Another method is to boil the water remove from the source of heat, place in the seeds and leave them in the water overnight.

(ii) Inoculation.

Seed inoculation with the appropriate *Rhizobium* ensures that the necessary bacteria for nodulation and this ensure good legume establishment. Most tropical legume species introduced in Uganda nodulate naturally from the native cowpea *Rhizobium*. For those legumes requiring specific

Rhizobium, the inoculant can be obtained from the Dept. of Soil Science, Makerere University. Instructions for use of inoculants are supplied with the seed and are quite easily followed.

2.2.6 Fertilisers in Establishment

Soils in the tropics are low in phosphorus content and this is a principal limitation to the successful establishment of legume. For the development of a legume-grass pasture, it is imperative that phosphate in the form of SSP or TSP (Single Super phosphate or Triple Super phosphate respectively) be applied before or at the time of sowing. The quantity needed is generally in the range of 125-250 kg./ha of super phosphate. SSP has the advantage of containing the element sulphur (S) essential for proper growth, especially the protein formation. Phosphorus increases N (nitrogen) fixation of the legume plant, hereby improving herbage yield and nutritive value.

2.2.7 Weed Control

A well prepared seed bed is the starting point of controlling or suppressing weed and will boost the growth of sown pastures. Light harrowing or digging after about three weeks prior to sowing will destroy many weed seedlings, creating a "stale" (weed free) seed bed.

Weed population can also be reduced by growing a cash or food crop before the pastures. Selective herbicides, if affordable can be applied pre-or post-emergence. It is hard to completely get rid of weeds during the establishment phase. Light grazing might be useful as long as it does not lead to loss of pasture species due to trampling and uprooting. Hand -slashing can be employed where labour availability is possible. Weeding should be done as early as the weeds appear (if they can be differentiated from sown pastures) preferable before flowering.

2.2.8 Management after Sowing

If a grass-legume is pasture sown under optimum conditions, germination of the grass should be by end of two weeks; the legumes take a bit longer but should appear in the third to fourth week. Alongside the grass/legume seedlings, weeds will also germinate. With a dense stand of grass-legume-weed mixture, slashing or hand-pulling should be applied.

Grazing or cutting should be avoided until plants are large enough (30 cm high) to withstand defoliation; and this occurs 4-8 weeks after sowing. However, early but light grazing or cutting helps in the control or weeds and stimulates further pasture growth and reduces the shading effect created by the grass for the legumes.

2.3 OTHER ESTABLISHMENT METHODS

2.3.1 Vegetative Propagation

Pasture establishment is faster when starting from seeds but vegetative propagation (common in fodder crops) can be used where there is no regularly available pasture seeds. Species that can be vegetatively propagated include *Brachiaria spp, Chloris gayana, Desmodium uncinatum and Stlyosanthes sp.* A fine seed-bed is not necessary. Rooted splits of the chosen species should be planted into cultivated land and firmed. If unrooted stolons are being used, these should have at least three active bud sites each. The disadvantages of this methods of pasture establishment is that it is labour intensive; the pasture takes longer to establish i.e. forming a complete soil cover. Susceptibility of seedlings to pests and diseased is higher with vegetative establishment; and hazards of soil erosion are overcome by not preparing a fine seedbed.

2.3.2 Undersowing

This is sowing of grasses and legumes into crops such as maize, sorghum and millet (also known as nurse/companion crops). Undersowing *C. gayana* into maize has been successful in Uganda. Successful establishment of *Chloris gayana* under a sorghum silage crop in Uganda has also been reported. This would be a very useful method especially since many farmers are unwilling to clear land for pasture establishment but will clear land for crops. The cost of pasture establishment will mainly be absorbed in the cost of land preparation for crops. Sowing pastures and crops has the advantage of suppressing weeds in the inter row spaces and reducing soil erosion. Shade-tolerant and trailing legumes like siratro, centrosema and silver-leaf desmodium establish well when sown after first weeding. Stoloniferous grasses like *Chloris gayana* and *Brachiaria spp*. also establish well.

2.4 MANAGEMENT OF GRASS-LEGUME MIXTURE PASTURES

A perennial grass companion species is a desirable feature of a leguminous pasture for the following reasons:-

i. To increase total herbage production.
ii. To ensure stability of production. The growth patterns of both grass and legume species varies; and their rhythmic development may be different because of availability of nutrients and moisture. Grasses usually begin growth more quickly after early rains following the dry season and thus encourage earlier grazing.
iii. To increase the energy value of the pasture. The grasses are generally lower in crude protein content than legumes and provide the bulk of the energy ration.

2.4.1 First Season Management

The success of pasture development whether the pasture is an improved natural pasture or a sown pasture will depend on management in the first season after establishment. Protection from grazing after seedling emergence or re-generation of growth in the case of vegetatively propagated species and until plants attain well-formed root systems is necessary to ensure good stands of sown grasses and legumes. Grazing should begin about 8 weeks after planting or when plants are about 40-60 cm high. Light grazing, preferably using calves, could then be practiced. Light grazing protects the legume component of the pasture and promotes tillering of the grass component.

2.4.2 Subsequent Management.

The main objectives of good pasture management are to:-

i. obtain higher and better production from both the pasture and the animal;
ii. allow plants to persist for a longer time;
iii. maintain a favourable balance between grasses and legume. The fully established pasture should be grazed by rotation which encourages proper growth of the pasture; and
iv. suppress the invasion of weeds. Under proper grazing management, the perennial grasses maintain more dense sward and help to reduce growth of annual grasses and broad-leaved weeds.

On the other hand, legumes in a pasture have the following attributes:-

i. Increasing the amount of crude protein available for the grazing animals. This is more important as grasses mature and become more lignified during the dry season.

ii. Extending the grazing period into the dry season. Legumes remain green through much of the dry season; but even when legumes mature and become brown, their nutritive value is maintained at a higher value than for grasses. With judicious management of grazing lands and grazing animals, it is possible to maintain a year round feed supply of pasturage if correct grass-legume pasture combinations can be used.

iii. Provide N (nitrogen) for companion grasses. The N fixed by legumes is not directly available/transferable to the associated grass. Nitrogen becomes available after the nodules drop off the roots. Legumes fix 30-300 kg/ha N on annual basis; and this fixation depends on the type of legume used.

If the pasture mixture is allowed to seed, re-generation from soil seed reserves is possible and cows grazing such a mixture will disperse the seeds in their droppings in other paddocks.

2.5.2.1 Grazing management

Grazing pressure or intensity is the number of animals per unit of available pasture. The intensity at which the pasture is grazed will affect both animal and pasture production. The grazing method used will therefore be important. Under extensive conditions with indigenous pastures, continuos grazing is recommended. If, however, efforts are put into pasture improvement, then the integration of herd management and land use will require some form of rotational grazing. Rotational grazing involves a good deal of subdivisions (paddocks) and costly fencing. Rotational grazing has the following advantages:-

i. parasite control; and
ii. maintenance of botanical composition of the pasture.

The recommended rotational grazing in Uganda is two weeks grazing and four weeks rest.

Generally, improved pasture species need a rest period to produce new tillers and new leaf. The response to defoliation varies with species; the more prostrate stoloniferous species and those with buried crowns will stand closer grazing than the upright tussock types.

2.4.2.2 Stocking Rates

Stocking rate is the most important management factor influencing the output of animal production from the pasture; the stability and persistence of the pasture components and the financial returns that the farmer gets.

Proper stocking rates are based on knowledge of the estimated dry matter yield of the herbage in a season; the type and number of stock and the animals' daily intake. Below is a guideline on which to bases stocking rates:-

1 Cow	300-400 kg	1 Livestock Units (LU)
1 Bull	300-400 kg	1 Livestock Unit
1 Heifer	2 –3 years	¾ LU
1 Heifer	1-2 years	½ LU
1 Calf	up to 1 year	¼ LU

The recommended stocking rate for improved pastures in Uganda should be 1 LU/ha but because most cattle in Uganda are kept on unimproved pastures averaging less than 800kg DM/ha, a higher stocking rates of 2.5 – 4 ha/LU are recommended.

2.5 PROVISION OF WATER

Water is very important as a nutrient to livestock and failure of livestock to get sufficient water may cause rapid death. Water is needed for all the body processes. A milking cow requires about 40 litres per day plus about 3-5 lts of water for every litre of milk produced. A Cow will take in more water if it is given twice daily than when given once and will take in even more if water is available all the time. Cows will produce more milk when they have continuous availability of water. Therefore, fresh water should be available to dairy cattle at all times. In cases where a farmer has only one watering point on the farm, the animals should be taken for water at least three times a day (morning, afternoon and evening).

2.6 CONCLUSION

Pasture development is a must if livestock production is to serve its purposes to the highest possible level. It does not, however, only improve livestock production but improves environment as well; by providing ground cover hence preventing soil erosion; improving the soil structure hence allowing water infiltration.

3.0 FORAGE PRODUCTION FOR ZERO GRAZING/STALL/FEEDLOT FEEDING

3.1 INTRODUCTION

Zero grazing is a system of animal husbandry where cattle are housed indoors all the time and feedstuffs both grass/legume and concentrates are brought in and fed to the cattle. Under this system the cattle do not graze but are confined in a shed or yard. The system is highly productive, but rather labour intensive, since the forage must be cut in the fields and brought to the cattle.

The main feed used on smallholdings for zero-grazing is Napier grass and to some extent green maize. By- products such as sweet potato vines, sweet potato tubers, banana stems and garden waste are also fed to cattle. In addition, a mineral lick should be provided.

By feeding good fodder a dairy cow can produce up to 8kg of milk per day. For a higher yielding cow, the fodder must be supplemented with concentrates. The main a advantage of zero-grazing over pasture grazing is that production per unit land is 3-4 times higher. One ha of good grazing will support one cow whilst under Napier grass in the zero grazing system, the same land can support up to 3-4 cows.

3.2. FEEDING

Feeding of an animal is a very important part of management, to ensure health and production. The feeding of an animal on a zero grazing unit involves the bringing of all the feed to the animal without the animal feeding by itself. The major feedstuffs include both grass/legume and concentrates. Pasture yields are higher than when cattle are permitted to graze it in the open paddocks and this is attributed to:

(a) The herbage is efficiently utilised partly because it is harvested at optimum growth with regard to nutritive values.
(b) Both soil and sward are spared the trampling by the grazing animal.
(c) Pastures in distant and/or covering difficult topography are brought into the cycle of forage utilisation.
(d) The injurious effects of the environment particularly solar radiation/high temperatures are eliminated and feed intake can be leveled throughout the day.

(e) The period of green fodder production per hectare is prolonged. This is particularly true in the case of elephant grass and Guatemala grass since these two types of fodder and susceptible to trampling.
(f) The system obviates extensive fencing into paddocks and water reticulation. However, perimeter fencing is necessary to protect the pastures from communal grazers who often harbour various cattle disease particularly the deadly East Coast fever.

There are, however, disadvantages in the system of stall feeding namely that the high cost of labour of cutting and carrying fodder to the cattle favours small units of 3-5 milking cows. It is estimated that an adult dairy cow requires 60-100 kg of fresh green fodder per day depending on body size and physiological status of the cow. Conversely the system can be economical with a large herd of good milking qualities when expensive cutting and carting machinery can be utilised.

3.3 FEEDS

These include:

i. **Grass fodder -** which are necessary for providing bulk, energy and other nutrients.

ii. **Legumes -** which provide protein necessary for growth and production of milk.

iii. **Fodder trees -** which also provide protein necessary for growth and milk production. Fodder trees can be fed fresh or after preservation as hay or silage.

iv. **Minerals –** which are necessary component for body maintenance fertility and production.

v. **Water -** for all body fluids and milk production.

vi. **Concentrates -** for increased growth and production.

vii. **Farm byproducts -** such as banana peels, maize stover, groundnut tops, potato vines, etc. for roughage and proteins.

3.3.1 PASTURE

There are many grasses, legumes and trees in Uganda that grow well and can be used for fodder in a cut, collect and carry system. Some types grow better in one area of climate than in other areas. For purposes of this manual, the emphasis will be placed on fodder species that are most suitable for the zero grazing system in Uganda.

(i) Fodder grasses.

There are three important fodder grasses that are utilized by zero grazers in Uganda. These include elephant/napier grass (the most important), Guatemala grass and giant setaria

(a) Elephant/Napier grass ***(Pennisetum purpureum).***

This is the most widely grown fodder grass in Uganda. Napier grows year after year without need to replant. It grows well with several pasture legumes such as silver leaf desmodium, Green leaf desmodium, centrosema and siratro. These legumes will increase the total fodder yield. They help add nitrogen to the soil and they make the feed more nutritious as they contain more proteins than elephant grass.

(b) Guatemalla grass *(Tripscacum laxum)*

Guatemala grass grows tall and does not need to be replanted. It grows bunched with broad leaves. Cows do not like it as much as elephant grass, but it is a good grass to grow as a dry season feed. It is grown from cane-cuttings and does well on drained swamps.

(c) Giant setaria *(Setaria splendida)*

Giant setaria is still new to most farmers and extension staff. It produces plenty of good fodder and tolerates frequent cutting. It is planted from root-slips because of poor seeding qualities. Giant setaria grows well in many places and combines well with desmodiums, siratro and centrosema. It can be used for hay making.

(ii) Fodder legumes (multipurpose trees/shrubs, MPTs)

(a) ***Leucaena leucocephala*** for lowlands**,** ***Leucaena gradifora*** for high lands

Leucaena is a tree with many uses. It is also a legume. It is used as fodder, fuelwood, mulch or green manure. Leucaena has a well developed tap rot system for tapping nutrients from deep in the soil. The tree may reach a height of 20 meters if not cut. It can recover from repeated loss of leaves and grows from 10—20 years or more. Also it is good seeder. Cow and goats like leucaena leaves (fodder). It is nutritious because of it high protein concents. The major problems with leaucaena are:

- it contains a chemical called mimosine which may cause problems if there is too much leucaena in the diet. Leucaena should not be more that 30% of the total fodder.

- the Pysllid insect which has eaten and killed large areas of leucaena in a number of countries.

(b) Gliricidia (*Gliricidia sepium*)

Gliricidia, like leucaena is not native to Uganda. Evaluation studies so far have shown that it is good for fodder, whether grown alone or mixed with grasses. It can grow up to 15 m. if not cut. It is a good seeder although it is also grown from cuttings. It does well in many soils except acid soils. Some farmers have these trees on their farms as shade for vanilla.

(c) Other fodder legumes

- **Sesbania (***Sesbania sesban***)**

- **Pegeon pea (***Cajanus cajan***)**

- **Calliandra (***Calliandra colothyrsus***)**

(iii) Pasture legumes

The pasture legumes in this section should be fed or grown with the fodder grasses (elephant grass, Guatemala and Giant setaria) to increase fodder yield and nutritive value of the mixture. The legumes are high in crude protein, grow longer in a green form and can improve the soil fertility through nitrogen fixation.

(a) Green leaf desmodium (*Desmodium intortum*)

(b) Silver leaf desmodium (*Desmodium uncinatum*)

These are hardy plant with a spreading root system which forms a dense mat of leafy stolons. The stolons rot at nodes. They are also grown from seed. These legumes grow will under wet conditions and on fertile soils. They combine very well with napier grass, Guatemala grass and setaria. These legumes produce a lot of palatable and nutritious fodder.

(c) Siratro (*Macroptilium atropurpurerium***)**

Siratro is a creeping plant and often roots at nodes. It grows well under a wide range of soils and rainfall. It produces a lot of green fodder which cows like. It forms a dense mat of green grass thus, protecting the soils. It nodulates well. It persists very well when cut or grazed.

(d) Other pasture legumes.

- **Centrosema (***Centrosema pubescens*)
- **Lablab (***Lablab purpureus*)

3.3.2 FARM BYPRODUCTS

There are several other forages that are being utilized by zero grazing farmers. These are basically crop residues like bean hulls, potato vines, groundnut tops, soya bean hulls, pineapple peels, banana peels and jackfruit. The crop residues are highly palatable and nutritious.

3.3.3 WATER (see section 2.5 above)

3.3.4 CONCENTRATES AND MINERALS (Discussed in Feeds and Nutrition of beef cattle)

3.4 ESTABLISHMENT OF IMPORTANT PASTURE AND FODDER SPECIES

3.4.1 Fodder Grass

(i) Elephant/Napier grass

(a) Seedbed preparation

Seedbed preparation for elephant grass is not as elaborate as for other pasture species established from seed. A weed-free seedbed is most suitable. Planting materials used are whole canes, cane-cuttings or rooted shoots. Diseases-free cuttings should be used. Planting is normally done during the rainy season. The most productive variety of napier grass is KW_{16}, that was developed at Kawanda Research Station in the late 1960s and the newly introduced hybrids from International Livestock Research Institute (ILRI) formally ILCA.

(b) Spacing

The canes (3-4 nodes) are spaced at abut 3 feet between rows and at 2 feet within rows. Close spacing is encouraged as this leads to high productivity.

(c) Intercropping

Herbaceous forage legumes (green leaf desmodium, centrosema and siratro) are good for intercropping with elephant grass. The legumes are sown into the rows at a rate of 1–2 kg/hectare.

(d) Fertilizer application

Elephant grass responds very well when fertilized with farm yard manure. A manure and urine slurry is applied in a systematic way to the pasture grasses and worked well into the soil to avoid losses of nutrients. Fertilised grass will be dark green.

(e) Diseases

There are two major diseases that attached elephant grass, namely, stunting disease (viral) and white spot (fungal). The stunting disease causes stunted growth resulting into poor production. The fungal disease causes white spots on the leaves. Planting of disease-free canes is important to avoid this disease.

(f) Harvesting

Plants should be allowed to establish well by attaining a height of about –4-6 feet. They should be cut at a height of about 2–3 inches from the ground. They should be cut at intervals of 8–12 weeks. The first cut should be done 10-16 weeks after planting.

(g) Productivity and stocking rate.

In Uganda, one acre feeds 1 cow and 1 calf.

(ii) **Guatemala grass** and **Giant setaria** are alternative fodder to elephant grass. They are grown in a similar way to elephant grass but mainly using root splits.

3.4.2 Fodder legumes

(i) Leucaena and Calliandra

(a) Establishment

Leucaena and Calliandra can be grown on a well prepared seedbed or in cultivated strips in existing natural pasture. They can be established from direct seeding or from transplants from nursery beds.

Leucaena/Calliandra seeds should be scarified by soaking them in hot water for 1–2 minutes then soaking them in cold water over night. Sandpaper can also be used to scarify the seeds.

(b) Seeding rates.

A seed rate of 4–5 kg/hectare is recommended. The seeds should be planted in rows of 1.5–2 m wide and 50 cm within rows. The depth of sowing the seeds (2/hole) should be about 6 cm. A close spacing is recommended for the cut and carry system and for controlling soil erosion. A similar spacing is used for establishing leucaena/calliandra from seedlings.

(c) Inoculation

It is always advisable to inoculate leucaena/calliandra seeds to improve nodulation for nitrogen fixation. The inoculum is available at Makerere University in Kampala.

(d) Fertilizer requirements

The recommended fertilizer is farm yard manure of compost to enhance seedling establishment. Apply in bands along the rows but not in contact with the seeds. On acid soils, liming is necessary.

(e) Weed control

Weeds must be removed by hand at the seedling phase since leucaena/calliandra seedlings grow slowly initially. When the seedlings are over I meter, slashing between rows in recommended.

(f) Cultivars

There are many varieties of leucaena. It is best to plant the giant types. Leucaena does not do well at high altitudes. Calliandra does well both at low and high altitudes.

(g) Pests and diseases

Currently, there are no pests and disease problems for leucaena in Uganda. However, leucaena pyyllid pest has destroyed leucaena trees in other countries. It is always best to plant a mixture of crops, including fodder trees to lessen the problem of pests and diseases.

(h) Harvesting

Harvesting of leucaena should be done when the plants are about 1.5m high. A cutting height of knee length is recommended. The trees can be cut every 8-12 weeks. For calliandra a cutting height of 75 cm is recommended.

(i) Productivity and animal production

Leucaena/calliandra fodder production potential in Uganda is very good. Crude protein in the leaves is about 20%. There is increased milk production and growth for cows receiving elephant grass supplemented with leucaena.

(ii) Other fodder legumes.

Gliricidia, and sesbania are grown in a similar way as leucaena or calliandra. These fodder species produce high quantities of fodder of high nutritive value and are palatable to livestock. However, gliricidia and some sesbanias are still new in Uganda. Soon we hope there will be many fodder banks established in Uganda, using these species.

4.0 FORAGE/FODDER CONSERVATION.

Forage and fodder conservation is the keeping of forage/fodder when it is in excess for feeding to animals in dry season. Herbage production is highest during the wet season. Conservation of forage, should therefore be an important activity for zero grazing farmers. Feeds can be conserved as silage or hay.

4.1 HAY AND HAY MAKING

Good hay provides the cheapest from of feed nutrients during the non-grazing season. Good hay is weed-free forage, dried without loss of leaves from handling or deterioration, high in dry matter and nutrients, but with its natural colour and sweetness.

4.1.1. Type of forage/fodder used

Hay is made from young, green grasses and legumes cut before the heads mature. The hay is then dried quickly, gathered and stacked to retain its food value with as much green colour as possible. Legumes make hay of higher feeding value than grain plants or non-legume plants. The reason for this is almost entirely the difference in proportions of leaf to stem. Legumes have more leaves per given amount of dry plant than grasses.

Others include farm byproducts like bean hull, groundnut tops, and maize stover.

4.1.2 Cutting

Cut the forage on a sunny day after the dew has evaporated.

4.1.3 Curing (drying) of hay

To make good hay, it is absolutely necessary that the grass is dried quickly and not excessively exposed to the sun

(i) Drying in the field.

The cut grass should be left on the ground piled in small heaps of about 1 foot high for 2 to 3 days and turned several times to speed drying in the field. Alternatively, the small heaps can be tried and hung on a fence and left to sun-dry outside. When the initial noisture has evaporated, the material can then be placed under the roof and allowed to dry completely away from the sun. This will conserve the colour and the nutritive value of the hay.

(ii) Drying under shade

If the weather is humid or rainy, the cut material is built into small heaps and left to dry in the sun for about 4 – 6 hours. Then the cut material is transferred into a dying shed with open front or sides. The material can be placed off the ground on home-made hay tripods.

The grass is stacked around the tripod, building upwards from the cross-arms. In this way, the grass is kept off the ground. A hollow cone in the centre of tripod allows the air to circulate freely and hasten the drying process.

4.1.4 Hay storage

(i) **Stacking:** Once the forage is dry, it can be tied tightly in bundles and made into a stack which should be well thatched to protect it from rain and over-drying.

(ii) **Baling**: A method of h y making using an inexpensive hand baling box made of wood has been developed in Kenya for small scale dairy farms and can be adopted for use in Uganda. The method requires two or three people to cut and load the baler. It is possible to make 10 bales of hay of 15 kg each per day. The bales made should be protected from rainfall to avoid deterioration by storing them in a roofed shed.

(iii) How to minimize storage losses.

- Remove the bales from the field to reduce spoilage and to prevent moisture accumulation on the bottom of the bale.

- ♦ Store bales on a well-drained site to prevent moisture concentration in the lower portion of the bale.
- ♦ Select a site near the feeding area to reduce labour.
- ♦ Avoid the danger of mould by storing properly cured hay and allowing dry air to keep circulating in the stored hay.
- ♦ Keep the hay away from fire. Store hay in sheds with open side or use hay tripods.

4.1.5 Hay grading

Factors that determine the grade or quality of hay include:-

(i) **Colour:** It is generally assumed that greenness indicates high feeding value of hay.
(ii) **Leafiness**: This is an important factor in all classes of hays because it reflects the protein content of the hay.
(iii) **Maturity at cutting:** Leafiness is dependent on the stage of maturity of the plant when it is harvested.
(iv) **Mechanical losses** in curing (drying)

4.1.6 Feeding hay

Hay should be fed in a manner that avoids wastage**.**

4.2 SILAGE AND SILAGE MAKING

Silage is any green material that is preserved in moist from by fermentation in a silo. A silo is a place or container where silage is stored. The process of making silage is called ensiling. Well made silage contains nearly all the nutritive value present in the crop material that is ensiled. The quality of the silage is determined by the amount of sugar in the ensiled materials.

4.2.1 Types of crops ensiled.

Silage can be made from a variety of crops: maize, sorghum, sugar came tops, elephant (napier) grass, Guatemala grass, banana peelings, soyabean residues and many other legumes. The quality is determined by the nature of the crop, the stage of growth at which it is cut and the changes that take place during the ensiling process. It is important that young crops are harvested when making high quality silage.

4.2.2 How to make good silage

(i) **Harvesting time:** Harvest at the proper sage of maturity. Grasses should be cut at the flowering stage and legumes during pod ripening phase.

(ii) **Chopping:** Chopping is very important because it provides increased surface area for fermentation (bacterial action) in the silage pit.

4.2.3 Additives to silage

(i) **Use of molasses:** Forage that is low in sugars like grass or sorghum, if cut at early stages of growth, should have molasses added to it during ensiling. Molasses should be applied at a rate of 50 kg molasses per tonne of ensiled material. Molasses should be mixed with water at

the ratio of 1 part molasses to 2 parts water. Ten litres of this mixture should be used for each cubic meter of grass. Maize silage does not normally require the addition of molasses if harvested at the milk stage of the cobs and the cobs included in the stage.

(ii) If you do not have molasses, you can use one half kg of powdered cassava, sprinkled over each layer of 10 kg of chopped grass and legumes.

4.2.4 Air control

Air (oxygen) should not be allowed to enter the silo as it will cause oxidation of sugars in the forage.

4.2.5 Moisture content control

Materials with excessive or to little moisture make poor silage. Moisture content can be minimized by:

- Wilting
- Adding dry hay or straw.
- Adding a dry preservative.

Where the material is too dry, moisture can be increased by sprinkling with water.

4.2.6 Protection from water

The silo should be located on a well drained site and plastic lining placed before putting the material in the silo.

4.2.7 Ensiling methods: The Gunny-bag ensiling technique

This is the simplest technique for a small-scale farmer. The chopped material is packed tightly into synthetic gunny bags. Common bags hold approximately 40 kg of silage. A bag of 40 kg receives about 2 kg of molasses. Each bag is then tightly knotted (tied) and arranged horizontally in rows in a pre-dug trench silo. A polythene sheeting is then overlaid on top of the bags of silage to be ensiled.

Points to note:

- Make sure water does not enter the silo. Therefore do not fill the silo when it is raining.
- Locate the silo ear the shed to minimise labour.

4.2.8 Testing for good silage

Good silage has a green to light brownish colour and a well pickled appearance. Good silage is sweet smelling without any foul odour which is associated with rotting.

4.2.9 Feeding

After 45 days, silage is ready for feeding. If needed, open the silo and remove the feed for that day. Cover quickly and properly to avoid entry of air and water. If you find a spoiled layer, remove it, and

feed the good one. It may be necessary to feed only a little silage at first to adjust the animals to the new feed.

4.3 ENSILING STRAW/STOVER.

Straw/stover is feed material made of overgrown grass species and crop residues e.g. of maize, millet, sorghum stalks etc. This material is treated with urea and ensiled. After one week, it is ready for feeding.

4.3.1 Cutting: May not be as short as the material for silage, but it should be chopped for easy compaction.

4.3.2 Method: One half kg of urea is dissolved in 10 litres of water, sprinkled over 10 kg of straw cut at a length of 10 cm. It is then ensiled like silage. After a week, it is ready for feeding.