Animal Production

Level II

Learning Guide # 44

Unit of Competence: Participate in forage development

Module Title: Participating in Forage Development

LG Code: AGR APR2 M14 0919 LO1- 44

TTLM Code: AGR APR2 TTLM 0919V1

LO1: Prepare site for forage development

Instruction Sheet	Learning Guide # 44

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- preparing materials, tools, equipment and machinery
- carrying out site selection and land preparation
- identifying and defining types of forages
- determining forage development options
- identifying risk factors
- confirming soil conditions for forage production

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to: –

- prepare materials, tools, equipment and machinery
- carry out site selection and land preparation
- identify and defining types of forages
- determine forage development options
- identify risk factors
- confirm soil conditions for forage production

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5 and Sheet 6.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3, Self-check 4, Self-check 5 and Self-check 6” **in page -7, 11, 15, 23, 25 and 28** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1” **in page -29.**
6. Do the “LAP test” **in page – 29** (if you are ready).

Information sheet – 1	Preparing materials, tools, equipment and machinery

1.1. General concepts to forage development

Livestock production is an integral part of the farming systems in Ethiopia and plays a vital role in the livelihood of the majority of the people. The sector contributes to national economy 15 to 17% of gross domestic product (GDP) and 35 to 49% of agricultural GDP and 37 to 87% of the household incomes and the share to total exports is about 16%. Livestock have multiple uses such as income generation, cash storage, draught and pack services, milk and meat for household consumption, and manure for fuel and fertilizer. Despite the large number of livestock resources the country own, its productivity is extremely low. The major constraint to such low productivity is shortage of livestock feeds in terms of quantity and quality, especially during the dry season. Even during years of good rainy season, forage is not sufficient to feed livestock for reasons associated with restricted grazing land and poor grazing management.

The role of natural pasture grazing as a source of livestock feed has begun to decline from time to time due to shrinking grazing land size as a result of increased areas of cultivation, increase in human and livestock population and changing patterns of land use. An adequate supply of livestock feed is crucial to the livelihoods of millions of people across the developing world, and not just for smallholders, but also for pastoralists and the large number of landless who depend mainly on common land for grazing. A basic shortcoming of the natural grasslands as a source of feed for ruminant livestock are low production of dry matter and nutritive value due to a combination of the negative effects of inadequate rainfall and soil nutrients.

Feed is the most important input in livestock production and its adequate supply throughout the year is an essential prerequisite for any substantial and sustained expansion in livestock production to support the livelihood of millions of smallholders, pastoralists, and others people across the developing world that depend on livestock rearing. However, the main feed resources for livestock in Ethiopia are natural pasture and crop residues, which are low in quantity and quality for sustainable animal production. The availability and nutritional quality of the available feed resources are among the most important factors that determine the productivity of livestock.

As a result providing a proper nutrition to animals, especially during the dry season when pasture and cereal residues are limiting both in nutritional quality and quantity remain to be the problem faced by livestock producers in the tropical countries. Low quality feeds are associated with a low voluntary intake, thus resulting in insufficient nutrient supply, low productivity and even weight loss and animals are not able to meet even maintenance requirements and lose substantial amount of weight. It is important to increase the pasture yield and nutritive value of the plant (CP content and digestibility), which can improve livestock production.

Shortage of feeds is exacerbated by the increase in human and livestock population and expansion of croplands, resulting in decrement of grazing lands. In such situation, improved forage options that address yield and nutritive value issues are needed to increase livestock productivity. This requires introduction of high quality cultivated forage with high yielding ability and adaptability to the biotic and abiotic environmental stresses. A number of important improved forage has been generated by the research systems over the last years in the country.

1.2. Identifying and preparing tools, materials and equipment

There are different materials, tools and equipment used for forage development may include:-

- **Tools** are objects designed to do a specific kind of work such as cutting or chopping by directing manually applied force or by means of a motor.
- **Equipment** is necessary items such as the tools, clothing, or other items needed for a particular activity or purpose.
- **Materials** are something used in making items or things

The following tools & equipment are used for pasture establishment and preservation work:-

- Hoe
- Sickle
- Meter
- Tractor with its accessories
- Combine harvester
- Disk
- Barrel
- Weighing scale

- Graduated cylinder
- Watering can
- Silo
- Store
- Chopper 

- Watering plastic tube
- Spade 
- Wheel barrow
- Bailer

- Shovel
- Rack
- fork
- Water pump

- Axe
- Peg
- Hammer

Materials includes the following

- Rope
- Standing hay
- Hay
- Silage
- Urea/ fertilizer

- Molasses
- Salt
- Fuel
- Feeds
- Seed
- Seedling
- Grass cut
- Empty sack
- Plastic sheet

Self-Check-1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List tools and materials that used for forage development. (3 points)
2. Why natural pasture grazing as a source of livestock feed decline through time? (4 points)

Note: Satisfactory rating – 5 points unsatisfactory rating –below 5 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score: _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions:

1._____

2._____

Information sheet – 2	Carrying out site selection and land preparation

Preparation for pasture establishment needs to begin at least one full year before the seed is actually sown. Basically the establishment of forage crops begins with the proper soil environment. Soil test indicate whether the PH of the soil is suitable for maximum production. Under most situations, the optimum PH value should fall between 6.5 and 7.5. In addition to the PH value the availability of elements such as phosphorous, potassium, calcium, magnesium and other trace elements in the soil are needed for proper growth.

Pasture establishment procedures may include in developing a pasture establishment program requires evidence that a person can assess site factors, select suitable pasture species and cultivars, determine resources and equipment for planting and post-planting care, and prepare pasture establishment plans to meet livestock production plans and schedules.

A. Site selection- Forage seed production sites must be accessible and as much as possible located in lands suitable for cultivation, irrigation, and fertilizing. Other ecological requirements for a suitable site include:

- ✓ A climate and soil suitable to most elite forage species or at least the target species.
- ✓ Soil fertility: Improved forages can behave as food crops in soil-fertility requirements.
- ✓ The area must be free of noxious, weeds, pest and diseases.
- ✓ Adequate space to make isolation possible for multiplying cross-pollinated species.
- ✓ Adequate growing season with ample rainfall.
- ✓ Access to irrigation to make multiple harvests possible and guarantee against fluctuating rain distribution.
- ✓ Topography: Must be convenient for easy farm operation (cultivation, fertilizing, spraying, harvesting, etc.), and convenience for grazing animals (if grazed pasture).Free from frost: ensure the site is not located in a frost-pocket in the landscape.
- ✓ Sunny weather during flowering to initiate reproductive development, flower opening, pollination and facilitate seed harvesting.

When assessing a locations potential for pasture production, it is important to consider the following site selection characteristics:-

- ✓ **Annual precipitation;-** Available soil moisture is the limiting factor for plant growth and establishment .sites with less precipitation have limited productivity and may not provide

the site should adequate economic return. Therefore the site with adequate annual precipitation should be selected. Most dry land forage species require at least twelve inches of annual precipitation for adequate growth and long term survival.

- ✓ **Soil depth; -** To provide sufficient water holding capacity for productive plant growth, the soil depth must be at least eighty inches.
- ✓ **Soil texture; -** Soil texture and depth determine a soil's water holding capacity and therefore strongly influence a site's potential for forage production. Soil texture ranging from a sandy loam to silt or clay loam is most suitable for plant growth.
- ✓ **Drainage; -** Most forage species thrive in well-drained soils that have no shallow sub surface restrictive layers. The common types of restrictive layer are clay lenses and volcanic ash layers.
- ✓ **Salt accumulation; -** Salt affected soils present several problems for pasture establishment. The accumulation of salt in soils has negative influences on several soil properties, including soil structure, water infiltration and nutrient availability.
- ✓ **Freedom from rocks;-** The presence of large rocks in the soil rules out most cultivation and planting options and significantly reduces the potential for success in establishing pasture.
- ✓ **Slope; -** Slopes should be less than 15% in order to accommodate planting and soil preparation equipment and minimize the potential for erosion.
- ✓ **Freedom from over story vegetation; -** Dense over story vegetation should be removed or thinned both to decrease competition for moisture and light and to reduce the potential for soil erosion.

B. Land preparation activities include **land clearing** and **seed bed preparation**:-

Preparation of a good seedbed (the smaller the seed the finer the seedbed), sown grasses and legumes require a finely granulated soil surface which is firm and free from weeds. Sowing shortly after the rains begin takes advantage of soil nitrogen made available by mineralization. However, it also coincides with the period of heavy downpours and strong weed competition. Excessive downpours may wash seeds away or cover them too deeply. Also the first rains may be intermittent and unreliable and resulting short drought periods may affect seedling survival. Tree or shrub removal is always one of the first steps. However trees should not be removed if

the trees are important as browse species or needed for shade, if the land is sloping and there is a danger of erosion and if they are protecting water courses.

- ✓ **Land clearing; -** It refers to the activities to remove all unwanted plant materials and other things from the land. It refers to avoiding or cutting all undesirable, trees, bush, grass and any other waste materials from the selected site.

  The land can be cleaned by hand cutting, by fire and by using land clearing machines like dozer.

  The main methods of **land clearance** include:

  - Mechanical movement of trees and shrubs - manually by knives and saws or by machine.
  - Chemical treatments (2,4,5-T or 2,4-D, mixtures of these, picloram, fenuron, arsenic, etc. can all be useful herbicides for killing tree stumps. Chemicals can be injected into the tree by using an axe with a cylinder attached which delivers herbicide to the axe blade. Aerial herbicide spraying is also possible.
  - A combination of mechanical and chemical or mechanical and burning
  - Regular burning (if allowed by law).

- ✓ **Seed-bed preparation; -** Pastures usually require a well- prepared seed –bed for good germination and establishment. Good seed-to-soil contact is essential to maintain adequate moisture near the seeds. This moisture is necessary for germination and for the small root systems of young grass seedlings. The type of seedbed preparation that is chosen will depend on the type of equipment available and whether a new pasture is being established (conventional tillage) or an existing pasture is being renovated (no-till drill). Two methods of seed –bed preparation are recommended.

  Soil tillage: consists in breaking the compact surface of the earth to the certain depth and to loosen the soil mass, so as to the roots of the crops to penetrate and spread in the soil. Tillage may be called the practice of modifying or mechanical manipulation of the status of soil to provide favourable condition for plant growth. Tillage operation is most labour consuming and difficult operation, as compared to all subsequent operations in the field.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List requirements in site selection for forage development (4 points)
2. Mention site selection characteristics for forage development (6 points)
3. List methods of land clearing for forage development (5 points)

Note: Satisfactory rating – 10 points unsatisfactory rating –below 10 points

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions:

1._____

2._____

3._____

Information sheet – 3	Identifying and defining types of forages

3.1. Classification of forages

Forages can be broadly classified in the two

Grasses

All grasses are members of the family Gramineae. They are monocotyledons (i.e. the embryo of a grass seed contains a single cotyledon or seed leaf). The basic design of a grass is simple.

It has:

- Roots anchoring the plant in the soil
- Cylindrical jointed stems consisting of nodes and internodes
- Alternately positioned leaves consisting of leaf sheaths and leaf blades with the sheath encircling the stem
- An inflorescence spike consisting of several flowers from which seeds develop.

Grasses can be annual or perennial. Annuals complete their life-cycles in one year while perennials survive for more than 2 growing seasons. Almost all grasses are herbaceous (non-woody) plants.

Examples: Annual: maize, sorghum, cumbu

Perennial: guinea grass B.N. hybrids

Growth habit of grasses

- **Tufted** - A cluster of single shoots arising from a single crown (*Panicum maximum*). The culms of tufted grass species may grow erect, in a decumbent fashion (curving upwards), semi-erect or semi-decumbent. The stems can even lie flat on the ground for some length.
- **Creeping** - Stems trail over or grow underneath the ground (e.g. *Cynodon* species).
- **Scrambling** - Most climbing plants are normally creepers but the stems will grow upward and over upright objects (e.g. *Pennisetum clandestinum*).

Legumes

Legumes are dicotyledons with their embryo's containing two seed leaves (cotyledons). The roots of many leguminous plants become infected by bacteria of the species Rhizobium.

These bacteria grow and multiply forming growths within the roots called nodules. The nodules differ in size, shape and arrangement on the roots. This relationship between the host plant and the rhizobium is a symbiotic relationship which benefits both the plant and the bacterium. The rhizobium takes up atmospheric nitrogen and fixes it, transforming it into a form which can easily be taken up by the host plant. In return the legume provides nutrients and energy to the bacteria. It is this relationship that gives legumes such a great advantage over other species, enabling it to grow in highly infertile soils which could support few other plant species. These species can grow in the absence of rhizobia but their growth is stunted and weak.

Some of the fixed nitrogen finds its way into the soil and from there to associated plants and succeeding crops or may be ingested by animals. When a legume is incorporated into a pasture mixture, provided it is nodulated by an effective strain of rhizobium and is growing vigourously, it is a valuable source of protein in animal diets and also useful for soil fertility building. It is a cheap and useful source of nitrogen.

In summary, it can be said that the 3 main functions of legumes are:

- To provide a nitrogen rich component to animal diets;
- To improve soil fertility;
- To stimulate growth of associated species (i,e, in multi or inter-cropping systems).

Examples: Annual: cowpea, cluster bean, desmodium

Perennial: lucerne, desmanthes

Growth habit of legumes

1. Bush type

The bush type is typified by a central stalk with side branches appearing along the main stem. Axillary branches also develop. Examples include Cajanus cajan (pigeon pea) and Desmodium tortuosum.

2. Bunch type

A typical bunch type plant consists of a single crown from which several stems and new tillers arise. It is difficult to identify the main stem. Stems can be erect or decumbent. Examples are Stylosanthes guianensis and Medicago sativa.

3. Creeping

Creeping stems of the creeping type trail over the ground surface. Some examples include Calopogonium mucunoides, Macroptilium atropurpureum and some Vigna species.

4. Scrambling

The scrambling type is typified by creeping plants, climbing and growing over upright objects. Examples are *Centrosema pubescens* and *Pueraria phaseoloides.*

5. Rosette

The **rosette** is a vegetative form of some perennials developed after flowering or with the onset of cool weather. Examples include Medicago sativa and Trifolium pratense. Because of the wide range of altitudes, soils, rainfall, existing management systems, etc. a wide range of pasture and forage species are found within Ethiopia and a wide range of exotic forage species are potentially very suitable for introduction to Ethiopia.

3.2. Seedling stage and young plant growth

Grasses when sowing conditions are optimal the emergence of grasses takes place 5 or 6 days after sowing. The time will increase (i.e. 10 - 14 days) if conditions are not optimal. The endospermic reserves feed the young plant for the first 7 to 10 days of its growth. As soon as light touches the coleoptile photosynthesis begins. The leaves appear at a linear rate with time and tillering. After 2 or 3 weeks stolon’s and rhizomes start to develop but this timing is species specific.

Legumes under optimal conditions legumes emerge 3 to 5 days after planting. When the conditions are not optimal the time between planting and emergence may be 15 days or more. When developed cotyledons are green they play a role in the first photosynthetic activities of the new plant. The first 3 leaves usually appear in 10 to 12 days with lateral branches appearing about 2 weeks later

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are growth habits of grasses? (3 points)
2. List growth habit of legumes (4 points)
3. List some advantages of legumes over that of grasses. (3 points)

Note: Satisfactory rating – 7 points unsatisfactory rating –below 7 points

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions:

1._____

2._____

3._____

Information sheet – 4	Determining Forage development options

4.1. Improved Forage Production Strategies

Forage development strategies enable farmers increase the supply of animal feeds both in quantity and quality. Apart from increasing animal feed supply, these strategies enable to reinforce the traditional linkage between livestock and crop production (for example, inter-cropping). They promote sound soil and water conservation in denuded and bare grazing lands. However, this does not mean that all forage development strategies can have these benefits equally nor does it mean that they can be promoted under any circumstances. Each of these strategies has its own area of application. This is indicated in the following diagram showing the existing feed situation and possible forage development strategies.

The strategies developed and successfully implemented by the FLDP in Ethiopia evolved from experiences in other countries and an understanding of the importance of matching forage systems to AEZs. The strategies are farmer centered and were developed with farmers to maximize sustainable income generation and food production at the household level. The key forage production strategies are conservation based and promote the use of legumes as improved forage. The key strategies are divided into **two** categories:

On Farm Strategies	Common Land Strategies
• Backyard Forage Production • Under sowing and Inter planting • Countour Forage Strips • Agroforestry	• Over sowing Common Grazing Areas • Stock Exclusion Areas/Forage Banks • Permanent Pastures

4.1.1. Backyard Forage Production

Backyard forage production is based on small plots and hedges of productive forage and browse planted within house compounds and around their boundaries. This is the most important initial strategy since it is developed in the farmer's household, and is very convenient for intensive feeding of dairy animals or fattening of meat animals.

The higher fertility levels typically found in and around house compounds also help with the successful establishment of backyard forage. This strategy has a major impact in exposing

farmers to the management and productivity of new species and also provides a seed bank to help establish new plantings for other forage strategies. Woody leguminous browse species are particularly suited to this strategy because of their multipurpose benefits and rapid growth rates. Tall growing tropical grasses are also suited to backyard forage development. Tree legume hedges have been the most widely adopted backyard forage strategy and need to be used as an incentive for broad-scale forage development based on contour forage strip and under sowing strategies. This strategy introduces farmers to the concept of supplementing crop by-products and poor quality roughages with high quality forage in a location, which facilitates close attention to management.

Backyard forage provides significant quantities of both forage and fuel wood where they can be conveniently used. Other benefits perceived by farmers include shelter, increased privacy, wood products construction and implements, and bee products. The multipurpose benefits of backyard forages provide a range of incentives for farmers to adopt this strategy. Backyard forage can be cut and carried to tethered or housed animals, or cut and conserved for dry season use in mixes with crop residues and natural pasture hay or roughages. The backyard forage strategy provides an opportunity to reach large numbers of farmers very quickly and can therefore have a great impact nationally, even in the short term. Demonstrations of about 100 browse legume.

4.1.2. Under sowing and Inter planting

Under sowing and inter planting is the establishment of forage species in an annual crop or perennial plantation. This strategy provides the most convenient approach to rapidly increasing on-farm forage supplies over a large number of farmers and should have a major impact in the short to medium term. The use of legumes in this system will contribute to the improved fertility and structure of cropping soils. Farmers seeing on-farm trials of under sowing and inter planting accept the strategy readily and understand the benefits and techniques very quickly. This is normally the second strategy to promote after backyard forage has been adopted by farmers. Under sowing and intercropping are probably the most important of the forage development strategies. Under sowing works best with sprawling, low growing annual legumes but can also work well with climbing legumes. The strategy is particularly suited to the production of tall

growing cereals such as maize, sorghum or millet but also works with other cropping systems. Under sowing with legumes produces large quantities of high quality forage for utilization by either postharvest grazing or cut and carry systems. The under sown forage protects the soil from erosive rains, can contribute nitrogen for the food crop, and balances the forage value of crop residues such as Stover and straw to increase its intake and utilization. The strategy works well with sprawling and climbing legumes but is also effective with other forage legumes and dual purpose legumes such as cow pea.

4.1.3. Contour Forage Strips

Forage strips are broad based mixtures of herbaceous and tree legumes, and grasses planted on contour bunds or in narrow strips along the contour without any physical structures. This is a multipurpose strategy providing forage, shelter, soil stabilization, and fuel wood. Forage strips planted along the contour contribute to soil conservation by directing ploughing along the contour and by reducing run-off down the slope. This increases infiltration and reduces soil erosion, especially where a thick sward of grass or herbaceous legumes is included in the forage strip. Contour forage strips are particularly successful when perennial, thick rooted grasses are mixed with woody leguminous species. Because this strategy integrates forage production in cropping areas, potentially weedy species such as stoloniferous grasses should not be used for forage strip plantings.

4.1.4. Agroforestry

Agroforestry involves a close association of trees or shrubs with crops, animals and/or pasture. Specifically, it is the deliberate combination of trees with crop plantation or pastures, or both, in an effort to optimize the use of accessible resources to satisfy the objectives of the producer in a sustainable way. Agroforestry is the combination of trees and agriculture in an integrated and sustainable farming system. Many of the forage production strategies can be developed as agroforestry systems. In particular contour forage banks and under sowing of tree crops or forest plantations can be designed as agroforestry systems where leguminous browse species provide an upper story in a forage system or under sown legumes and grasses provide an under story in a forestry or horticultural system. Agroforestry maximizes the use of land by adding a third dimension to the above and below ground areas of utilization. This aspect is particularly important for farmers with limited land resources. Because many agroforestry strategies include

leguminous species, they are also attractive to farmers facing problems of declining soil productivity.

4.1.5. Over sowing common grazing areas

Over sowing is the simplest of the forage development strategies and can be undertaken at very low cost depending on the seeding rates used. It involves broadcasting or sowing improved forage species into common grazing lands, native pastures and degraded areas without any cultivation or other inputs. Typically there is no attempt to modify grazing management but existing stocking rates should not be increased after over sowing. The strategy includes sowing roadsides from vehicles and is suited to aerial seeding where very large areas are to be developed. Aerial seeding is also another way of establishing improved extensive grazing areas using over sowing techniques. This strategy is most suited to pioneer legume species, which grow quickly and seed prolifically. Because of the low input nature of this strategy, incremental forage yields are not large but pioneer species with good grazing tolerance and natural seeding ability gradually colonize common areas and improve the overall species composition available for grazing. Natural spread of seed with water movement, grazing animals and wind action can be rapid, enabling very large areas of land to be developed so long as grazing management is possible to enable plants to become established and set seed.

4.1.6. Stock Exclusion Areas/Forage Banks

Stock exclusion areas are an important means of protecting degraded areas, key watersheds, and common land. They also provide an opportunity to develop forage banks for use during droughts or periods of seasonal forage shortage. Stock exclusion areas are particularly important for the conservation of highlands but are only accepted by farmers where they see sufficient benefits to organize grazing management groups or pastoral associations to control stock exclusion areas and voluntarily keep stock out. The introduction of browse species, productive legumes and improved grasses can rapidly increase the productivity of exclusion areas. The strategy is suitable for aerial seeding techniques which enable very large areas of land to be sown to forage quickly. Rehabilitation of degraded areas using forage species normally provides a good incentive for farmers and pastoralists to organise grazing management groups or pastoral associations. Because degraded land has low value as a

common grazing resource farmers are usually willing to voluntarily exclude livestock from these areas. Rehabilitation of degraded areas with forage species provides an incentive for these initiatives, especially when farmers understand the benefits of forage development. Without farmer initiated grazing management groups or pastoral associations to control grazing, stock exclusion areas and forage banks are unsustainable. The extension effort therefore needs to focus on the benefits of collaborative management of common lands and initially focus on degraded areas where benefits will be maximized and the likelihood of farmer resistance will be minimal. Cultivation is not necessary to establish forage banks or rehabilitate stock exclusion areas, especially on very bare sites, but broadcast sowing should take place after commencement of the main rains to ensure that there is enough soil moisture to sustain germination. Direct seeding with chisel tyned cultivators may be necessary in degraded areas with scalded or hardpan surfaces. Leguminous browse and tall grass species should always be included in stock exclusion areas to maximize the production potential and drought resistance of the species mix. Woody species can be planted by direct seeding but generally develop more successfully where they are planted as bare rooted seedlings early in the main rainy season.

4.1.7. Permanent Pastures

Permanent pastures comprise a broad range of annual and perennial legumes and perennial grasses. Productive mixed pastures can be readily established, particularly in the low and medium altitudes with warmer growing conditions. Grazing management is a significant problem for sustainable pasture productions in some regions, which is best overcome with cut and carry systems. Permanent pastures are most useful for dairy farmers who rely on optimal productivity of their livestock investment for their livelihood. Permanent dairy pastures should include a mix of legumes and grass species with high palatability and productivity.

4.1.8. Roadside Sowing

Roadside sowing is a successful means of implementing the oversowing strategy. It is quick and effective and provides an impressive visual impact which can be used to excite farmer interest and provide an incentive for the formation of grazing management groups or pastoral associations. This strategy can be highly cost-effective, particularly when using species with the ability to spread under grazing. Sowing a broad grid of suitable roads provides a convenient

mechanism for introducing improved forage species to a large area since the rate of spread from a very long narrow transects is high. 10 km of roadside sowing equates to about one hectare of over sown grazing land. Seeding rates are typically 0.5 to 1.0 kg per kilometer of roadside. Mixed seed should be emptied from sacks or buckets from the back of a reasonably fast moving vehicle. In this way the vortex currents carry seed onto the roadside verge. Roadside sowing is most suitable for quickly establishing and prolific seeding species, which tolerate grazing. The stylos are the most successful species used in roadside sowing in Ethiopia.

4.1.9. Aerial Sowing

Aerial sowing enables very large areas to be overs own with improved forage seeds. The success of establishment depends largely on the selection of suitable sites. The most suitable sites have rough often gravelly surfaces. Sites with compacted or hardpan surfaces do not enable good establishment of aerial sown or broadcast seed. *Stylosanthes* are particularly successful for aerial over sowing – being extremely resilient to grazing and a successful pioneer species. Aerial sowing is particularly suited to the rehabilitation of large catchments, which include relatively inaccessible areas. Where grazing is restricted or there are protected niches because of thorn bushes or rocks, leguminous browse species should also be included in aerial sowing mixes. *Leucaena* is especially appropriate for this purpose. Seed is best dispersed from fixed wing aircraft, which travel at sufficient speed to create air currents for seed dispersal. If helicopters are used, spinners are normally required for efficient seed distribution. Flag bearers on the ground or the use of prominent landmarks are necessary to plan and manage aerial seeding operations.

4.1.10. Cereal/forage crop rotation

This system involves introducing annual forage legumes into the traditional cropping pattern. In the central highlands, to which the system is more applicable, the cropping sequence is cereal-cereal pulse. In between any two cereal crop phases, annual fodder crops like clovers, medics or lablab may be sown, harvested and conserved as hay for strategic feeding during the dry season. The advantages of this system are primarily to provide high-quality fodder and maintain soil fertility. Interspersing a legume in the crop rotation enhances soil fertility, prolongs the

cropping period and reduces the normal fallow time traditionally used to replenish soil fertility. Legume crops also reduce the use of high amounts of chemical fertilizers. Thus, the method minimizes expenses for commercial fertilizers, especially nitrogen, which is fixed from atmospheric sources through Rhizobial fixation.

4.1.11. Sequential cropping

Sequential cropping is practiced when two crops (forage and pulse) are grown during a season, one after the other. The essential feature of this system, known as sequential or double cropping, is that the two crops do not overlap, the second being sown only after the first crop is harvested. This cropping is incorporated between any two cereal crop phases according to the traditional crop rotation.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention on farm strategies in forage development strategies (5 points)
2. List advantages of backyard forage production in forage development strategies (3 point)

Note: Satisfactory rating – 5 points unsatisfactory rating –below 5 points

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions:

1._____

2._____

Information sheet – 5	Identifying risk factors

Risk factors that consider during forage development may include fire, vermin/pests, flood, over matured of pasture, overgrazing, weed, shattering, leaching, bleaching, moulds, etc. A mixture of species should be selected for each agro-ecological zone to ensure biodiversity and thus minimize the risks from pests and climatic extremes. Utilization of developed foraged at optimum time and stage is one of the crucial ways to reduce risks associated with forage development. Also balancing between nutrient content and yield of forage one of the considerations to reduce risk related less nutrient content of forage types. Start from site selection, soil sampling and land preparation requires especial attention to keep balance between quality and yield of pasture as well as animals become better productive.

According to forage development enterprise every activities starting from site selection until supply to animals as feed requires professional attendant. Types of forage and ways of utilization of developed forage (grass only, grass-legume mix, legume only, legume-fodder trees, etc.) are one of the methods to be used as animal productivity improvement. Harvesting at optimum time and using different feeding or grazing methods or otherwise storing in clean and dry places reduce risks. Harvesting forages at early stage leads in to an increment of yield but reduces in nutrient contents and similarly harvesting at late stage causes reduces nutrient content but increase in quantity.

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention risks that associated in forage development (4 points)
2. List ways of reducing risks associated with forage development (6 points.)

Note: Satisfactory rating – 7 points unsatisfactory rating –below 7 points

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions:

1._____

2._____

Information sheet – 6	Confirming soil conditions for forage production

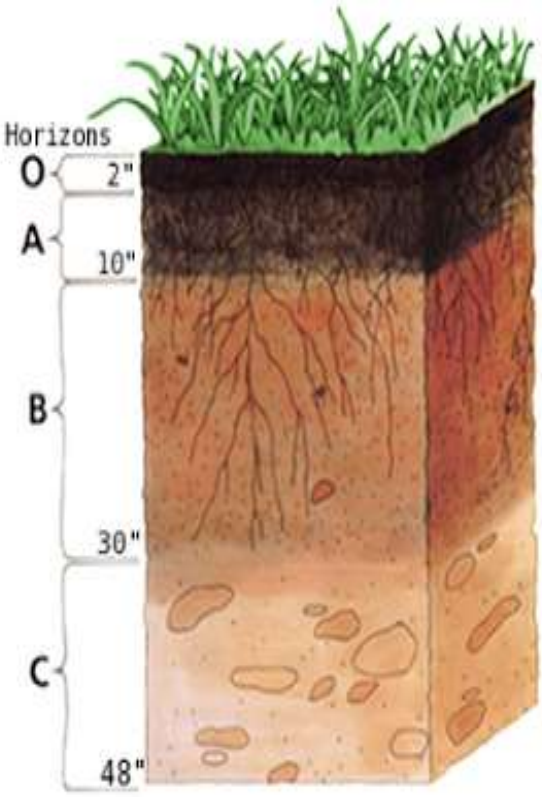
Soil fertility affects forage yield much more than it does quality. While it is possible to produce high quality forage on poor, unproductive soils, it is generally very difficult to produce high yields of high quality forage with an unproductive soil resource. Proper soil phosphorus (P) and potassium (K) levels help to keep desirable legumes in a mixed seeding and also reduce weed problems. It is necessary to balance soil fertility to avoid mineral imbalances in ruminants. Low soil fertility, as well as very high fertility, has resulted in reduced forage quality.

Soil is an unconsolidated, or loose, combination of inorganic and organic materials. The inorganic components of soil are principally the products of rocks and minerals that have been gradually broken down by weather, chemical action, and other natural processes. The organic materials are composed of debris from plants and from the decomposition of the many tiny life forms that inhabit the soil. Soil actually constitutes a living system, combining with air, water, and sunlight to sustain plant life. The essential process of photosynthesis, in which plants convert sunlight into energy, depends on exchanges that take place within the soil. Without soil there would be no vegetation—no crops for food, no forests, flowers, or grasslands.

Composition of soils

- Soils comprise a mixture of inorganic and organic components: minerals, air, water, and plant and animal material.
- Mineral and organic particles generally compose roughly 50% of a soil's volume.
- The other 50% consists of pores-open areas of various shapes and sizes.
- Function of soil pore-open:-
    - ☞ hold water within the soil
    - ☞ provide a means of water transport
    - ☞ move oxygen and other gases easily
    - ☞ serve as passageways for small animals
    - ☞ provide room for the growth of plant root

Soil Profile



Most soils have three major horizons --
the surface horizon (A)
the subsoil (B),
and the substratum (C)

Some soils have an organic horizon (O)
on the surface, but this horizon can also be buried.

The master horizon, E, is used for horizons that have a significant loss of minerals (eluviation).

Hard bedrock, which is not soil, uses the letter R.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the nutrient contents of soil? (4 points)
2. List types of soil composition (3 point)
3. Mention function of soil pore-open (5 points)

Note: Satisfactory rating – 8 points unsatisfactory rating –below 8 points

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions:

1._____

2._____

3._____

Operation sheet -1	Procedures in carrying out site selection and land preparation

Techniques to select and prepare land for forage development as follows:-

Step 1: Select site / area

Step 2: Clean & prepare land for pasture establishment

Step 3: select & prepare certified seed for forage establishment

Step 4: Sow

Step 5: Weeding & harvest on time depending on forage species

Step 6: Conserve as hay & silage

Step 7: Feed to livestock depending animal body condition

LAP Test	Practical Demonstration

Task. Select site and prepare land for forage development

REFERENCE

Duguma Gemeda. 2010. Participatory definition of breeding objectives and implementation of community based sheep breeding programs in Ethiopia. PhD Thesis, University of Natural Resources and Life Sciences, Vienna, Austria.

Muhammad, R. 2016. Elephant grass as forage for ruminant animals. Department of Forage Crops and Grassland Management, Faculty of Animal Science, Hasanuddin University, Indonesia.