COURSE GUIDE

ANP 512
PASTURE AND RANGE MANAGEMENT

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INTRODUCTION

ANP 512: Pasture and Range management (2 Units) is a 2-Credit Unit course offered in the fifth year to students of the undergraduate degree programme in Animal Sciences. There are four study modules in this course. The course is a guide for distance learners enrolled in the B. Agric. programmes of the National Open University of Nigeria.

In this guide, you will find very useful information about this course: aims, objectives, what the course is about, what course materials you will be using; and information on practical sessions. It also offers you guideline on the amount of time you are likely to spend on each study unit and your tutor marked assignments.

I wish you all the best in your learning experience and successful completion of this course.

This course examines the chemistry of feed nutrients, their implication and application in animal production. The various definitions and terminologies used in animal nutrition were also defined. The classes of food and the nutritional value of the different feedstuff was considered. The feedstuff and ingredients available which could be used as livestock feed, such as cereals grains and by products, legumes, oilseeds and forages were listed. The course also describes the importance of storage and feed quality in livestock production.

COURSE AIMS AND OBJECTIVES

This course aims to introduce you to the knowledge of pastures available for animal production and their systems of management, their nutritive value and application in animal production.

There are objectives to be achieved in each module of the course on completion of this course. You should be able:

- explain the importance of pasture in animal nutrition
- explain the meaning of common terms used in pasture production and range management
- enumerate the nutritional value and characteristic of pasture forage
- explain the importance of forages and roughages in crops animal feeds.
- explain importance of legumes and shrubs in animal feed
- highlight nutritional quality of legumes
- mention examples of some legumes
- importance of and production of silage

WORKING THROUGH THE COURSE

To complete this course, you are advised to read through this course guide to familiarize yourself with the structure of the course. Read the study units and attend all tutorial sessions where available. You are also encouraged to practice all assignments contained in this material. The course guide also helps you to know how to go about your Tutor-Marked-Assignment which will form part of your overall assessment at the end of the course.

At the end of the course, there is a final examination. The course should take you not less than forty-two hours to complete. It is advised you draw up your own timetable and allocate time to read each study unit in order to complete the course successfully and on time. A great effort was put into this course thereby enriching it with a lot of useful information.

COURSE MATERIALS

You will be provided with the following materials course guide and study units. In addition, the course comes with a list of recommended textbooks and materials which though are not compulsory for you to acquire or indeed read, are necessary as supplements to the course material.

STUDY UNITS

There are eight study units in this course and they are:

1. Commonly used Terminologies in pasture and range management
2. Adaptation of forage plants
3. Plant introduction
4. Pasture establishment
5. Maintenance and pasture utilization
6. Forage yield determination
7. Forage conservation
8. Pasture nutritive value

MAIN COURSE

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MODULE 1 COMMONLY USED TERMINOLOGIES IN PASTURE AND RANGE MANAGEMENT

UNIT 1 COMMONLY USED TERMINOLOGIES

CONTENTS

1.0 INTRODUCTION

Sound forage establishment and management practices are critical to realizing a profit in hay and/or forage-based livestock production. It is critical for managers to understand that there are fundamental differences in managing introduced and native forages. In regions where precipitation levels are higher, introduced species dominate forage-based livestock production systems. Below 750 mm of annual precipitation, however, fewer introduced species are used due to the lack of moisture. Native plant communities, known as rangelands, dominate the more arid regions. While the use of introduced forages requires appropriate grazing management, fertilizer inputs, and more frequent use of herbicides, good grazing management and prescribed fire to suppress woody species encroachment generally represent the management strategies used on rangelands.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- define some terms in pasture and range management
- understand overgrazing
- morphology of plants

3.0 MAIN CONTENT

3.1 Commonly Used terminologies in pasture and range management

Range:- Rangelands, native and naturalized pasture, forest and wood lands and riparian areas that support an understory or periodic cover of herbaceous or shrubby vegetation useful for grazing or browsing by wild life and or livestock and that are amenable to range management principles or practices.

Rangeland:- Land on which the historic climax plant community is predominantly grasses, grass like plant, forbs, or shrubs. include land revegetated naturally or artificially when routine management of that vegetation is accomplished mainly through manipulation of grazing. Rangeland include natural grassland, savannas, shrub land, most desert, tundra, alpine communities, coastal marshes, and wet meadows.

Pasture:- 1) grazing lands comprised of introduced or domesticated native forage species that are used primarily for the production of livestock. the received periodic renovation and or cultural treatment such as tillage, fertilization, mowing, weed control and may be irrigated. They are not in rotation with crops. 2) grazing area enclosed and separated from other areas by fencing or other barriers the management unit for grazing land. 3) forage plant used as food for grazing animals. 4) Any area devoted to the production of forage, native or introduced, and harvested by grazing.

Graze;- 1 the consumption of standing forage by livestock or wildlife. 2;- to put livestock to feed on standing forage.

Grazing system;- A specialization of grazing management that defines systematically recurring period of grazing and deferment for 2 or more pastures or management units.

Grassland:- land on which the vegetation is dominated by grasses, grass like plant, and or forbs.

Forb;- Any broad leafed herbaceous plant other than those in gramineae, cyperaceae and juncacea families.

Forage;- all browse and herbage that is available and acceptable to grazing animals, or that may be harvested for feeding purposes. Act of consuming forage.

Hay:- the herbage of grasses, legumes, or comparatively fine stemmed forbs cut and cured (dried) to preserved forages for later used as livestock feed.

Herb:- any flowering plants except those developing persistent woody stems above ground.

Introduced species;- a species not a part of the original fauna or flora of the area in question.

Range conditions;- the present status of vegetation of a range site in relation to the historic climax or natural potential plant community for the site. Range condition is expressed as the percentage of the climax plant community presently occurring on the range site and grouped in to the following range condition classes

Range condition class	percentage of climax plant community present on the site
Excellent.	76-100
Good.	51-75
Fair	26-50
Poor	0-25

Range improvement: 1 any structure or excavation to facilitate management of rangeland or livestock. 2 any practice designed to improve range condition or facilitate more efficient utilization of the rangeland. 3 An increase in the grazing capacity of range land; I.e., improvement of rangeland condition.

Range management;- The art and science of manipulating, using, and conserving native grazing land resources to benefit society.

Shrub:- A plant that have persistent, woody stems, a relatively low growth habit,and generally produces several basal shoots instead of a single bole. It differs from a tree by its low stature and non-arborescent form. Maximum height is generally 4 meters.

Stocking Raye;- The number of specific kind and classes of animals grazing or utilizing a unit of land for a specific period of time. It may be expressed as animals per acre,hectare, or section, or the reciprocal (area of land/animal). When dual used is practiced (e.g cattle and sheep), stocking rate is often expressed as animals units per unit of land or the reciprocal.

Trend;- A rating of the direction of change occurring on an ecological site.

Carrying capacity;- The maximum stocking rate possible without inducing permanent or long term damage to vegetation or related resources. The rate may vary from year to year in the same area as a result of fluctuating forage production.

Paddock:- (1) one of the subdivision or sub units of the entire pasture unit. (2) A relatively small enclosure used as an exercise and saddling area for horses, generally adjacent to stalls or a stable.

3.2 Range Versus Pasture

Range and pasture lands are diverse types of land where the primary vegetation produced is herbaceous plants and shrubs. These lands provide forage for beef cattle, dairy cattle, sheep, goats, horses and other types of domestic livestock. Also many species of wildlife, ranging from big game such as elk to nesting song birds such as meadowlarks, depend on these lands for food and cover.

Primary economic outputs include livestock production, but wildlife values are also a major economic consideration for these lands, especially range lands. Environmental values of these lands are extensive and provide many essential ecosystem services, such as clean water, wildlife and fish habitat, and recreation opportunities. Scenic, cultural, and historic values of these lands provide not only economic benefits, but also quality of life values cherished by many.

Other Grazing Lands
Most grazing lands are considered either range or pasture, but grazing lands also include grazed forest lands, grazed croplands, haylands, and native/naturalized pasture.

3.3 Morphology of Grasses

The study of the physical features (external structure) of plants is referred to as morphology. Morphology of grass plants is not just a biological pursuit but can aid in many everyday decisions for the forage manager. Grasses, whether annual or perennial, are mostly herbaceous (not woody), monocotyledon plants with jointed stems and sheathed leaves. They are usually upright, cylindrical, with alternating leaves, anchored to the soil by roots. Grasses have leaves (blades that narrow into a sheath), a stem (culm), a collar region (where leaves attach to the stem), roots, tillers, and during the reproductive stage an inflorescence or seedhead develops. Grasses may have rhizomes or stolons and the collar regions have differing variations of ligules, auricles, and blades (laminas). Inflorescences of grasses also vary widely so during vegetative stages, the collar and leaves help in proper identification and during reproductive stages the inflorescence is very helpful.

Inflorescences are an arrangement of many spikelets composed of individual florets. Grasses have three main inflorescence (seedhead) types: panicle, spike, and raceme.

From a seed, primary (seminal) roots develop to nourish and anchor the seedling. Eventually fibrous or adventitious roots develop from lower stem nodes. Some grasses have underground stems called rhizomes which grow horizontally before pushing above ground to a new shoot. Some grasses have stolons which are above ground, trailing stems that produce leaves, roots, and flowering shoots from the nodes. Some grasses have both while some have neither.

Stems or culms are really a series of sections called internodes which are separated by nodes. This is why grasses are referred to as jointed or as "joints" (during the proliferation of marijuana). The internodes or sections are very close together near the stem and but lengthen or stretch out as the plant matures. The internodes are most often hollow but a few grasses have internodes of white pith, such as sorghum. The branching of leaves always occurs at the nodes and develops from a bud that is between the leaf-sheath and the stem. When branching results from nodes at the base of the plant it is called tillering (suckering, stooling).

All grasses have a distinctive collar region. Proper identification requires a look at this area where the leaf blade wraps around the stem. If the leaf blade is pulled back, the collar region reveals a unique combination of ligule, auricle, and meristemat tissue. Barnyardgrass has no ligule or auricles. But other grasses will have a ligule (hairy or membraneous growth at the blade-sheath junction). Ligules vary in size, shape, and type. Many grasses will also have distinctive auricles (appendages that wrap the blade around the stem). The meristematic tissue will appear whitish and is the area of leaf blade growth and expansion.

When learning about grasses, it is helpful to learn how certain physical characteristics can affect other features. For example: meadow foxtail can be described as a cool-season, pasture grass. But its physical trait of having few leaves means it would not make a great hay and even as pasture, protein content may be a concern. Corn is a common warm-season grass but it is too tall for a pasture. How high a grass can grow or other unpalatable features will enter into forage-livestock decisions.

Whether a grass is an annual or perennial will determine many forage-related decisions. Annual species usually have inflorescences on more stems. Annual species typically require annual re-establishment costs and labor. This also may lead to erosion hazards. Most annuals grow during the spring and summer but some grasses are winter annuals and when used carefully can add flexibility to a grazing system. Wheat, annual ryegrass, and barley can extend the grazing seasons and reduce winter feed costs. Perennials have inflorescences on some stems but also produce vegetative tufts which will wait for two years or more to produce an inflorescence. Perennials reduce the yearly cost and labor or reseeding but must be managed to thrive or may not be as productive.

Each grass has its own list of environmental characteristics as well. The following traits should be considered by forage managers: winter hardiness, drought tolerance, salinity tolerance, soil pH tolerance, production potential, and livestock suitability.

Different grasses have different palatability, digestibility, and sometimes harmful effects on certain livestock. Livestock do have preferences and will be choosy, so careful management is necessary to ensure the best animal nutrition and pasture longevity and yield.

Understanding grass formation and structure can help managers wisely use the vast variety of grasses available.

3.4 Legumes and Shrubs

Legumes are plant species of the family Leguminosae. They have seed pods that, when ripe, split along both sides. Legumes are a significant source of protein, dietary fiber, carbohydrates and dietary minerals; manganese. Like other plant-based foods, contains no cholesterol and little fat or sodium. Legumes are also an excellent source of resistant starch which is broken down by bacteria in the large intestine to produce short-chain fatty acids (such as butyrate) used by intestinal cells for food energy. The legume family is probably the third largest of the vascular plants. Orchid and grass families are larger. However, economically, legumes are second only to grasses in importance because of their extensive use as forages. While only about 40 legumes are significant in forage production, there are 12,000-18,000 species. Forage legumes, such as alfalfa, clovers, and trefoils are generally of high quality, and their digestibility declines less rapidly as the plant matures than that of many perennial grasses. Legumes have a longer window for best utilization, so they fit well into a feed calendar. Legumes also generally have higher levels of protein than grasses. But legumes require more management than grasses because they are more sensitive to fertility and edaphic (soil) factors. Legumes and grasses can be mixed together to take advantage of their strengths but since they have different characteristics mixtures must be more carefully managed.

Forage managers must learn to utilize grasses and legumes for maximum quality and yield.

The banning of meat and bone meal in animal diets has led to increased interest in vegetable protein sources. Soybean meal is the predominant protein source for animal diets worldwide, but the increased use of genetically-modified (GMO) soybeans has resulted in an interest in alternative sources of vegetable protein, especially among organic poultry producers. Some other legumes can be used as alternative feed ingredients.

Legumes are noted for their ability to use nitrogen from the air. This ability is the result of a symbiotic relationship between the plants and bacteria (rhizobia) found in root nodules. This ability to use atmospheric nitrogen reduces fertilization costs and allows legumes to be used in crop rotation to replenish soil that has been depleted of nitrogen. Legumes break the annual cycle of cereals, reducing the buildup of cereal weeds and pests.

3.4.1 Types of legumes

1. Grain legumes refer to those crops cultivated for immature or mature grain.
2. Forage legumes refer to legumes consumed as forage. Forage legumes can also be used as a source of biomass and green manure.

Nutritional quality of legumes

Legumes have been mostly used as feeds for ruminants, although there are some reports of their inclusion in the diets of non-ruminants (pigs and poultry). The leaves, stems and fruits may be used either as a complete feed or as a supplement to other feeds.Legume seeds have twice as much protein as grains. Crude protein content of legume grains ranges from 27% in peas and faba beans to almost 50% in soybeans. The proteins are digested in the rumen to provide ammonia and amino acids for microbial cells in protein synthesis. Legume grains are also high in iron and B vitamins.

Limitations

One of the factors limiting the use of grain legumes as feed is the presence of antinutritional factors in legumes that decrease the nutritive value of the grain and, if consumed in large amounts, cause health problems for animals. These antinutritional factors include protease inhibitors, lectins, oligosaccharides, phytate, antivitamins, L-canavanine, tannins, and isoflavones.

Antinutritional factors and species where they are found

Anti-nutritional substances		**Species**
1.	Non-protein Amino acids	
	Mimosine	*Leucaena leucocephala*
	Indospecine	*Indigofera spicta*
2.	Glycosides	
	(A) Cyanogens	*Acacia giraffae* *A. cunninghamii* *A. sieberiana* *Bambusa bambos* *Barteria fistulosa* *Manihot esculenta*
	(B) Saponins	*Albizia stipulata* *Bassia latifolia* *Sesbania sesban*
3.	Phytohemagglutinins	
		Bauhinia purpurea
	Ricin	*Ricinus communis*
	Robin	*Robinia pseudoacacia*
4.	Polyphenolic compounds	
	(A) Tannins	All vascular plants
	(B) Lignins	All vascular plants
5.	Alkaloids	
	N-methyl-B-phen	
	Ethylamine	*Acacia berlandieri*
	Sesbanine	*Sesbania vesicaria*
		S. drummondii
		S. punicea
6.	Triterpenes	
	Azadirachtin	*Azadirachta indica*

	Limonin	*Azadirachta indica*
7.	Oxalate	*Acacia aneura*

Examples of some legumes

Soybeans
Globally, soybeans (Glycine max) are the most important feed grain legume. Soyabean is an oilseed containing about 20 percent oil. The extraxtion of oil results in a high protein cake. One of these products is soyabean meal which is one of the main protein source in animal diets. Soybean, meal is about 44 percent crude protein, while the concentrate Contains about 70% CP. Soyabean leaves and stem can be grazed, ensiled or dried to make hay. The foliage is very palatable, has a high nutritive value and highly digestible. Raw soyabeans seeds contains trypsin but leaves and stem does not.

Chick Peas
Chickpeas (Cicer arietinum) are one of the world's most important grain legumes. Like other legumes, chickpeas contain such antinutritional factors as protease and amylase inhibitors, lectins, tannins, and oligosaccharides. These antinutritional factors interfere with nutrient absorption from the digestive tract. Most of the antinutritional factors in chickpeas can be deactivated by heat treatment.

Cowpeas
Cowpeas (Vigna unguiculata), also called black-eyed peas, are an important grain legume in tropical and subtropical regions. Cowpeas are heat- and drought-tolerant crops. Cowpeas have an amino acid profile that is similar to that of soybeans. cowpea is a legume that is extensively grown, particularly throughout sub-Saharan Africa. It is a subsistence crop, often intercropped with sorghum, maize and pearl millet. The peas provide valuable protein, the leaves are used as a nutritious vegetable and the rest of the plant serves for animal feed. The plants are drought tolerant and grow well on relatively poor soils. The peas can be consumed fresh or removed from the pods and dried.

Faba Beans
Faba beans (Vicia faba) are grown in several countries, especially in the Mediterranean area. The nutrient content of faba beans makes them look like a suitable substitute for soybean meal, but the presence of antinutritional factors has limited their use in poultry diets.

Field Peas
Field peas (Pisum sativum) are grown in several countries. Field peas have been referred to as "feed peas" in Canada and as "protein peas" in Europe. The relatively low levels of antinutritional factors in pea grains

eliminates the need for heat treatment of field peas prior to inclusion in poultry diets.

Lupins

Australia is the dominant world producer of lupins, accounting for around 85% of world production. Lupins are also produced in the United Kingdom and western Canada. The high price of organic feed has been hampering the development of organic poultry production. This has resulted in an increased interest in lupins, which have the advantage of not requiring roasting prior to feeding. There are two classifications lupins (Lupinus species): bitter and sweet. Bitter types are high in alkaloids, compounds that have been bred out of the sweet varieties.

Lentils

Lentils (Lens culinaris) are grown primarily for human consumption, but lentils that fail to meet food-grade standards are available for use in livestock feeds. Lentils have a relatively high protein content and few digestive inhibitors.

Vetch

Common Vetch

Common vetch (Vicia sativa) is an annual climbing legume. Common vetch originated in southern Europe but is now grown all over the world. Common vetch has many valuable agronomic characteristics: It is resistant to drought and adapted well to semiarid regions. It can also grow in poor soils. The presence of cyanoalanine toxins has limited the use of common vetch seed in poultry diets.

Other Types of Vetch

Bitter vetch (Vicia ervilia) is an old grain legume that originated in the Mediterranean and is now grown around the world. It has high yields and is resistant to droughts and insects. It is a good source of energy, and its amino acid profile is similar to that of soybeans. The seeds have been used in animal diets, but the presence of canavanine has limited the use of bitter vetch in poultry diets.

Shrubs

Shrub, any woody plant that has several stems, none dominant, and is usually less than 3 m (10 feet) tall. When much-branched and dense, it may be called a bush. Intermediate between shrubs and trees are arborescences, or treelike shrubs, from 3 to 6 m tall. Trees are generally defined as woody plants more than 6 m tall, having a dominant stem, or trunk, and a definite crown shape. These distinctions are not reliable, however, for there are some shrubs, such as lilacs and honeysuckles, that, under especially favourable environmental conditions, grow to the size of an arborescence or even a small tree. Some specimens of a plant species may take a tree form, whereas others, under different conditions, may assume a shrub or arborescent form—*e.g.*, sumacs, willows, and spruces.

Shrubs are very similar to trees in that both have woody branches that remain alive throughout the year. Shrubs differ by virtue of branches that grow near or below ground level, while trees typically have a single trunk and branches that begin higher above ground level. This means that some shrubs, like the lilac, can actually tower over a smaller tree. Shrub plants differ according to height as well as a number of other characteristics. They come in either deciduous or evergreen varieties.

Examples of Shrubs

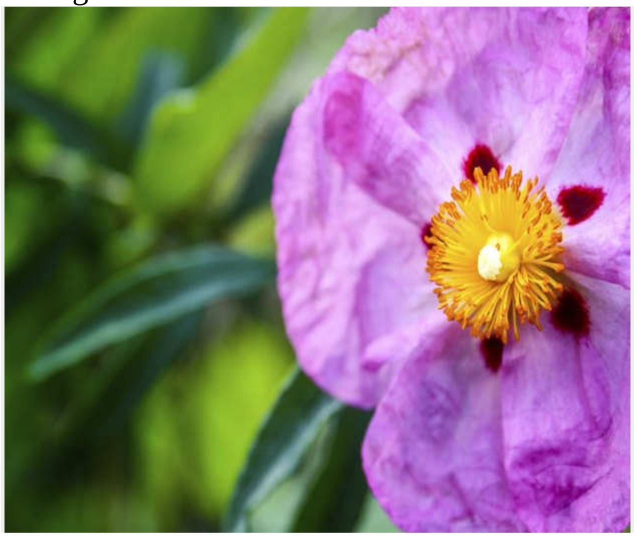
Shrubs, along with trees, help to form the "bones" of the garden. Whether used for winter interest, as a screen to diminish an unsightly view, or grown for showy flowers, there is a shrub for every situation.

Shrubs for Screen or Hedge

Myrtle (*Myrtus communis)*. Perennial in U.S. Department of Agriculture hardiness zones 8 through 10. Height and width 4 to 6 feet. Easily grown in well-drained soils, in sun or part shade, myrtle has dense, fragrant foliage that can be sheared for formal hedges. Evergreen.

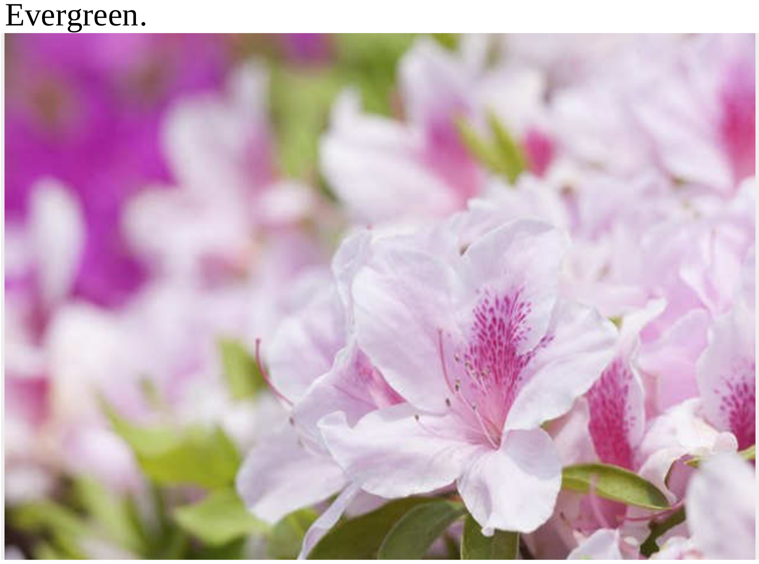
(*Ligustrum japonicum* 'Texanum'). Grows up to 10 feet high and 6 feet wide. Glossy foliage looks handsome year round, with white blooms appearing in spring. Waxleaf privet requires regular water, grows well in sun or part shade, and tolerates pruning to shape. Evergreen.

Drought-Tolerant Shrubs



Purple rockrose *(Cistus* x *purpurea)*. Requires well-drained soil and full sun. Grows 4 feet high and 4 to 6 feet wide. Pretty spring blooms attract butterflies and belie the purple rockrose's ability to withstand dry conditions. Evergreen.

Creosote bush *(Larrea tridentata)*, USDA zones 8 through 10. Typically reaches 3 to 8 feet in height and width. With fine foliage that smells like desert rains, creosote bush produces small yellow flowers in the spring. Evergreen.



Shrubs for Spring Flowers

Azaleas (spp.) grow in USDA zones that vary with cultivar, and there are many. Evergreen azalea flowers come in all shades of pinks and whites, while deciduous azaleas have blooms that range in color from white and pink to yellow, orange and red.

All azaleas thrive in moist, acidic soil in an area of the garden that receives afternoon shade.

Forsythia (*Forsythia* x *intermedia* 'Beatrix Farrand') grows 6 to 8 feet high and wide in USDA zones 5 through 8. Cheery yellow flowers cover the bare branches in spring. Thrives in full sun and well-drained soil. Deciduous.

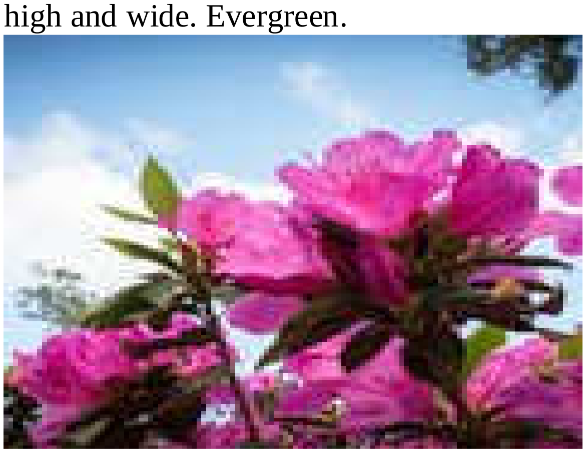
Shrubs for Fall Color

aAmerican cranberry bush or highbush cranberry (_Viburnum trillium) t_hrives in sun to part shade in USDA zones 2 through 8. Large deciduous shrub that reaches 8 to 15 feet high and 8 to 10 feet wide. Produces white lacecap flowers in the spring and has edible fruit in summer purple-red foliage in fall. Highbush cranberry tolerates average soil provided it is well-drained.

Oak leaf hydrangea (*Hydrangea quercifolia)*. USDA zones 5 through 9. Reaches 6 to 8 feet high with similar spread. Grown in moist soil in part shade, this shrub rewards the gardener with white flowers in early summer followed by a show of crimson leaves in the fall. Deciduous.

(*S__yringa)* sp. USDA zones 3 through 7, although some species are hardy only to zone 4. They can vary in height from 4 feet to 20 feet. What lilacs have in common are showy, fragrant flowers in the spring and a preference for sunny sites with well-drained soil. Deciduous.

(*Gardenia jasminoides),* hardy in SDA zones 8 through 11. Well-known for its perfumed white blossoms from mid-spring to early summer, gardenias like rich, acidic soil and shady conditions. Grows up to 6 feet high and wide. Evergreen.



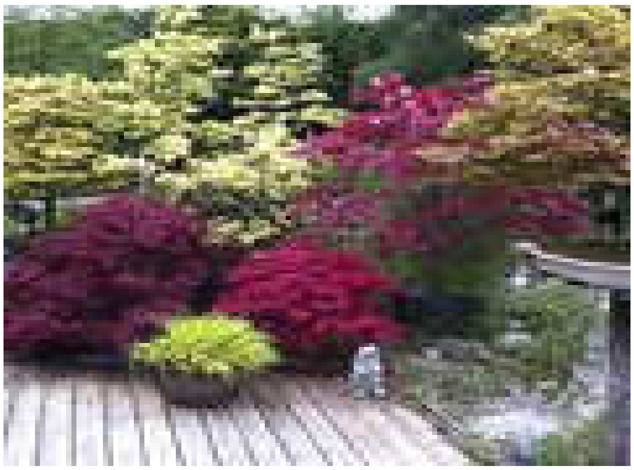
List of Flowering Evergreen Shrubs

List of Prickly Shrubs

The Best Shrubs for a Tall Screen Quickly

Pink Flowering Tree Identification

What Trees Have Red Berries in the Summer?



Tall Plants for a Privacy Fence

4.0 CONCLUSION

Pastures are important because of their extensive use as forages in ruminant nutrition. Different terms used in range management, morphology of grasses. You also learn in this unit legumes and shrubs.

5.0 SUMMARY

In this unit we have learnt about range, pasture, legumes and shrubs and their nutritional quality, management and methods of improving the nutritional quality. You also learnt about range management.

6.0 TUTOR-MARKED ASSIGNMENT

1. What are pasture legumes?
2. How do you establish pasture?
3. Explain livestock management on rangelands.

7.0 REFERENCES/FURTHER READING

National Range and Pasture Handbook - Provides procedures in support of NRCS policy for the inventory, analysis, treatment, and management of grazing land resources.

Prescribed Grazing - NRCS National Conservation Practice Standard - Describes the national standard used to best manage range and pasture lands. Find out more about NRCS National Conservation Practice Standards.

- Conservation Effects Assessment Project (CEAP) - Grazing Lands - is an effort designed to quantify the environmental effects of conservation practices on non-federal grazing lands in the United States.
- NRCS Grazing Lands Personnel Directory - Contact local, state, and national NRCS personnel for range, pasture information and expertise.

Legumes are important because of their extensive use as forages in ruminant nutrition. Forage legumes, such as alfalfa, clovers, and trefoils high quality protein.

Shelton, H.M and Brewbaker J.L. (1998). The Role of Forage Tree Legumes in Cropping and Grazing Systems. In: Forage Tree Legumes in Tropical Agriculture (Eds) Gutteridge, R.C. and Shelton, H.M. Published by the tropical grass land society of Australia INC.

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MODULE 2 PLANT ADAPTATION

UNIT 1 ADAPTATION OF FORAGE PLANTS AND VEGETATION

CONTENTS

1.0 INTRODUCTION

The adaptation potential for most natural ecosystems is regarded as low, whilst that of many managed land-use systems is relatively high. Forage species are generally adapted to specific climatic regions and, at the centre of their adaptive zone, may regularly survive extremes of temperature and moisture as well as stress of lax management. Both genotypic and phenotypic plasticity influence adaptation, the former depends upon survival of genotypes making up the population and the latter results from interaction between the genotype and the environment. Alfalfa (Medicago sativa L.) is an example of a forage species with high genotypic and phenotypic plasticity enabling its adaptation to many Eco regions.

Nigeria is a large country with varying vegetation belts. The variations are found from North to South with the belts running from East to West. Climatic factors such as rainfall, temperature, and relative humidity account for these variations, other factors include topography and human activities on land. The type of agricultural activities to be engaged in a particular area depends on the environment.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- classify the vegetation zones in Nigeria
- understand the principle of adaptation by plants.

3.0 MAIN CONTENT

3.1 Regional Adaptation of Forage Plants

Scores of annual, biennial and perennial species are used as forages in Nigeria. Some species are native, but most are introduced, and many of those introduced have become naturalized because of their long-term use. Our assessments are also affected by regions due to increases in precipitation from the west, near the 100th meridian, eastward to the Atlantic Ocean, and to increases in average temperature and length of the growing season going from the Canadian border to the Gulf of Mexico. These climatic variations form a matrix of temperature and precipitation that affect the forage species grown. The number of times it is harvested, and the dominant livestock enterprises of the region that use the forage. Pest, pathogen, and wildlife populations also differ among regions to give an array of variables that affect adaptation of each forage species and its optimum harvest management for economic return and conservation. Species differ in morphology and forage quality that help define their management use for growing or milking livestock in defined geographic areas of adaptation. Nearly all State Agricultural Experiment Stations conduct extensive applied research to determine the major species and mixtures that are best adapted to the specific climate and meet yield, quality, and persistence needs for major livestock enterprises of the state. Yield, quality, and stand longevity are emphasized to determine the optimal harvest management regimes for economic return. These recommendations may include more specific management systems when the primary goal is yield, quality, or stand persistence. Cultivars within a species differ in maturity, seasonality of growth, yield potential, and quality of forage produced, thereby allowing some fine-tuning of management on a within-species basis for specific sites. Fortunately, most states define optimum harvest times of forage crops according to growth stages based on flowering of a monoculture or flowering of the most desired species in a mixture. This allows neighboring states to share performance data based on plant development such that recommendations for harvest management tend to have some similarity and transferability within geographic regions. Unfortunately, there is little research on minor use species or the latest “hot introduction,” which can lead to management decisions based on unreliable information, often based on promotional hype and testimonials. Eventually these factors are evaluated scientifically and documented in the literature, but by then there may be another generation of “wonder grasses” that needs scientific evaluation.

3.2 Nigerian Vegetation Zones

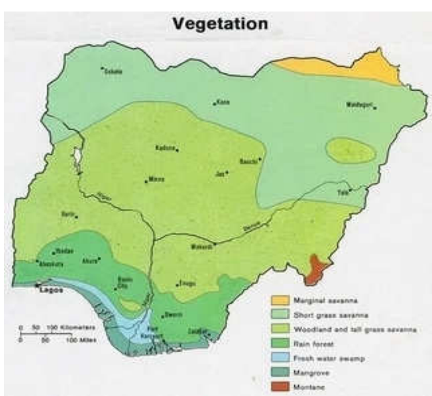
Vegetation usually depends on the vegetation zones of the country. Vegetation belts of the country reflect the tight link between the vegetation and the country’s climate. These include;

- Rainforest
- Fresh water swamp
- Sahel savanna
- Short grass savanna
- Guinea savanna
- Woodland savanna
- Marginal savanna
- Mangrove
- Sudan savanna

Below there is a map of Nigeria showing the vegetation belts (zones).

Types of Vegetation in Nigeria

Nigeria is a state of forests and savannas. Once, a significant part of the territory was covered with dense tropical rainforests. Constant cutting and burning out of crop plots led to a drastic reduction in the area of forests that now occupy about one-third of the territory.



3.2.1 Rainforest

High-mountainous multi-tiered tropical forest have been preserved mainly along the right bank of the lower reaches of the River Niger and in the valley of River Cross. Trees with heights of 40-45 m from the first upper tier. Such giants with powerful tree shaped roots, diverging from the base of the trunk, are not are not afraid of the elemental forces of nature.

The trees of the second and third tiers are especially densely strewn with epiphytes, intertwined with lianas that rush towards the sun. The rays of the sun almost do not penetrate through the dense canopy formed by woody crowns.

In the north of the forest zone the annual amount of precipitation does not exceed 1600 mm, the conditions for forest growth are deteriorating. Relative humidity is lower here, and soils are drier. Some trees shade their leaves in the dry season. These are the so-called dry tropical forests. They are also multi-tiered, but less dense, the under bush is difficult to access. Still, further to the north, the forests are becoming sparser, and at last the expanses of the savanna open.

3.2.2 Guinea Savanna

Almost half of the territory of Nigeria is occupied by a moist, so-called Guinea high grass savanna. Precipitation per year hear is 1000-1400 mm on the average. The plots of this savannas alternate with the park savannas and border the banks of the rivers with gallery forests. The grasses reaches a great height, in which not only a man, but also a large animal can hide. Among the savanna vegetation in Nigeria, various types of elephant grass are predominant.

Groups of trees rise above the grassy sea: drought resistant Kaya, Isoberlinia, Mitragina. Some of them have trunks twisted from annual fires. In the first half of dry season the savanna looks lifeless, the trees stand bare. In the middle of this season, a smoke screen rises over the savanna the dry grass burns, that is, it is burned from year to year with the purpose of preparing the land for crops. With the first rains appearance juicy shoots of young grass and green leaves. Nigerian savanna awakens.

3.2.3 Sudan Savanna

North of the zone of the Guinea savanna the amount of precipitation decreases to 500-1000 mm and the dry period lasts more than six-seven months and a zone of Sudanese savanna with a dense but low grass cover is located. A distinctive appearance of the landscape is given by different types of Acacia with an umbellate crown and thorny bushes. Camels willingly eat young shoots of these bushes, while leaves are used in folk medicine. It is difficult to imagine the Sudanese savanna without Baobabs. Next to them you can meet the palms and doom, the whale, the whitish acacia, which shades the leaves in the wet season and during the drought is covered with fresh leaves serving as food for animals. Generally, natural conditions of this zone is favorable for the progress of agriculture and animal Farming. Herds of sheep, cattle, and goats graze on vast pastures. Relative to the dryness of the climate, there is no tsetse fly here.

3.2.4 Sahel Savanna

The main characteristic of sahel savanna is the desert vegetation. The annual precipitation is poor and the wet season last for three to four months, so the vegetation of this zone is rare and the presence of grasses is extremely short. In this vegetation zone such plants as Ngibbi, Acacia raddiana, leptadenia, and African Myrrh are growing.

3.2.5 Montane

The montane is situated at high-mountain areas. Montane vegetation in Nigeria (mountains and plateaus) is not developed due to low average temperatures and the significant impact of animals and man, the Jos Plateau is one of the highest points in Nigeria. This zone is potentially perfect for growing of rich crops of different vegetables and small grain crops and just a good place for pasture.

3.2.6 Mangrove Zone

Mangrove vegetation depends on the coastal location of the zone, constant influence of saltish sea water. The soil in the mangrove zone is extremely poor and contains salt. The places, which were stabilized for growing of rice.

4.0 CONCLUSION

Pastures are important because of their extensive use as forages in ruminant nutrition. You also learn in this unit unit the different ways of improving the nutritive value of pasture and different methods pasture conservation.

5.0 SUMMARY

In this unit we have learnt about the different vegetation zone in Nigeria and how forage adapt to their environment.

6.0 TUTOR-MARKED ASSIGNMENT

1. Classify the different vegetation zone in Nigeria.
2. How vegetation zone can you find in the Northern part of Nigeria.

7.0 REFERENCES/FURTHER READING

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UNIT 2 PLANT INTRODUCTION

CONTENTS

1.0 INTRODUCTIOON

Transference of a genotype or a group of genotype of crop plants from the place of their cultivation in to a new area where they were not being grown previously. Movement of crop varieties from one environment into another within a country is also known as introduction. Some examples of within the country introduction are popularization of Grapes cultivation in Haryana, Wheat in West Bengal, and Rice in Punjab etc. any country cannot be self-sufficient in its needs for plant genetics resources. An average crop genetics resource dependency among various region of the world is more than 50%, and some region it may be as high 100% for the most important crops.

2.0 OBJECTIVES

In this unit, you will learn about:

- Plant Introduction
- Specie evaluation
- Methods of plant breeding

3.0 MAIN CONTENT

3.1 Types of Plant Introduction

3.1.1 Based on adaptation

1) **Primary Introduction** - Variety is well adapted to the new environment, released for commercial cultivation without any alteration in the original genotype. Sonora 64, Lerma Roja in wheat and TN-1, IR-8 and IR-36 in rice.

2) **Secondary Introduction** - Introduced variety may be subjected to selection & hybridization to isolate a superior variety. Kalyan Sona and Sonalika wheat varieties selected from material introduced from CIMMYT, Mexico.

3.1.2 Based on utilization

1) Direct Introduction - New variety takes no time for establishment.
2) Indirect Introduction - New variety takes some time for establishment.

Objectives of Plant Introduction

- To introduce new plant species there by creating ways to build up new industries. e.g. Oil palm
- To introduce high yielding varieties to increase food production. e.g. Rice and wheat.
- To enrich the germplasm collection. e.g. Sorghum, Groundnut.
- To get new sources of resistance against both biotic and abiotic stresses.

Activities of NBPGR (National Bureau of Plant Genetic Resources)

- Introduce & supplement of required germplasm from other agencies in other countries.
- Exploration & collection of valuable germplasm.
- Inspection & quarantine.
- Testing, multiplication & maintenance of germplasm.
- Publishing its exchange & collection list.
- Setting up natural gene sanctuaries.
- Maintenance of record of introduced plants.
- To supply on request germplasm of various scientists or institution.
- Improvement of medicinal and aromatic plants.

Sources of Plant Introduction

- Centre of diversity
- Gene bank

- Gene sanctuaries
- Seed companies
- Farmers' field

Procedure of Plant Introduction

- Procurement of germplasm - Any individual or institution can introduce germplasm in India. But all the introductions must be routed through the NBPGR, New Delhi. There are two routes for plant introduction. In first route the individual or the institution makes a direct request to an individual or institution abroad. In second procedure the individual or institute submits his germplasm requirements to the NBPGR with a request for their import.

- Quarantine - Quarantine means to keep materials in isolation to prevent the spread of diseases, weed etc. all the introduced is materials thoroughly inspected for contamination with weeds, diseases and insect pests. The materials is fumigated or treated to avoid the contamination. If necessary, the materials are grown in isolation for observation of diseases, insect pests and weeds.

- Cataloguing - Accession number is given to a new introduced material. Information regarding name of species & variety, place of origin, adaptation & its various features are also recorded. Cataloguing of germplasm collections is published by gene bank. The introduced materials are of 3 types & given a prefix- EC - Exotic Collection; IC - Indigenous Collection; IW -Indigenous Wild.

- Germplasm Evaluation - The introduced material is evaluated to assess the potential of new introduction and their performance. These materials are evaluated at different substation. The material resistance to disease and pest is evaluated under favourable environment conditions, and the promising one is either released as such as a variety or subjected to selection or hybridization.

- Multiplication & Distribution - Promising introductions or selections from the introductions may be increased and released as varieties after the necessary trials. Most of the introductions, however, are characterized for desirable traits and are maintained for future use. Such materials are used in crossing programmes and are readily supplied by the bureau on request.

Acclimatization

The process that leads to the adaptation of a variety to a new environment is known as acclimatization. Generally, the introduced varieties perform poorly because they are often not adapted to the new environment.

Sometimes, the performance of a variety in the new environment improves with the number of generations grown. Acclimatization is brought about by a faster multiplication of those genotypes (present in the original population) that are better adapted to the new environment. Thus acclimatization is essentially natural selection.

The extent of acclimatization is determined by
(1) The mode of pollination,
(2) The range of genetic variability present in the original population,
(3) The duration of life cycle of the crop and
(4) Mutation.

Cross-pollination leads to far greater gene recombination than self-pollination. As a result, cross - pollination is much more helpful in acclimatization than self-pollination.

Purpose of Plant introduction

The main purpose of plant introduction is to improve the plant wealth of the country. The chief objectives of plant introduction may be grouped as follows.

1. Entirely New Crop - Plant introductions may provide an entirely new crop species. Many of our important crops, e.g., Maize, potato, tomato, Tobacco, etc., are introductions. Some recently introduced crops are Soybean, sarson, oil palm etc.

2. New Varieties - Sometimes introductions are directly released as superior commercial varieties. The Maxican semi-dwarf wheat varieties Sonora 64 and Lerma Rojo, semi drawf rice varieties TN 1, IR- 8 and IR - 36 are more recent examples of this type.

3. Utilization in Crop Improvement programme - Often the introduced material is used for hybridization with local varieties to develop improved varieties. Pusa Ruby tomato was derived from a cross between Meeruty and Sioux, an introduction from U.S.A.

4. Save the Crop from Diseases and Pests - Sometimes a crop is introduced into a new area to protect it from diseases and pests. Coffee was introduced in South America from Africa to prevent losses from leaf rust.

5. Utilization in Scientific Studies - Collections of plants have been used for studies on biosystematics, evolution and origin of plant species. Vavilov developed the concept of centers of origin and that of homologous series in variation from the study of a vast collection of plant types.

6. Used for Aesthetic Value - Ornamentals, shrubs and lawn grasses are introduced to satisfy the finer sensibilities of man. These plants are used for decoration and are of great value in social life.

Important Achievements

- Crops are cultivated extensively after their introduction as new crop species.
- Introductions have been directly released as variety.
- Varieties selected from introduction
- Introduction helps to develop varieties through hybridization.

Merits of Plant Introduction

- Entirely new crop plant is derived.
- It provide new crop varieties.
- Quick & economical method of crop improvement.
- Protection of crops from damage by introducing them in to disease free areas.
- Development of superior varieties through selection & hybridization by using introductions.

Limitation of Plant Introduction

- Introduction of weeds along with introduced materials.
- Introduction of diseases along with introduced materials.
- Introduction of insect pest along with introduced materials.
- Some plants introduced as ornamental species became noxious weeds.
- Some introduced plants are threat to the ecological balance.

3.2 Specie Evaluation

The appraisal of the value of plants so that the breeder can decide which individuals should be discarded and which allowed to produce the next generation is a much more difficult task with some traits than with others.

3.2.1 Qualitative characters

The easiest characters, or traits, to deal with are those involving discontinuous, or qualitative, differences that are governed by one or a few major genes. Many such inherited differences exist, and they frequently have profound effects on plant value and utilization. Examples are starchy versus sugary kernels (characteristic of field and sweet corn, respectively) and determinant versus indeterminant habit of growth in green beans (determinant varieties are adapted to mechanical harvesting). Such differences can be seen easily and evaluated quickly, and the expression of the traits remains the same regardless of the environment in which the plant grows. Traits of this type are termed highly heritable.

Quantitative characters are much more difficult for the breeder to control, for three main reasons:

(1) the sheer numbers of the genes involved make hereditary change slow and difficult to assess;
(2) the variations of the traits involved are generally detectable only through measurement and exacting statistical analyses; and
(3) most of the variations are due to the environment rather than to genetic endowment; for example, the heritability of certain traits is less than 5 percent, meaning that 5 percent of the observed variation is caused by genes and 95 percent is caused by environmental influences.

It follows that carefully designed experiments are required to distinguish plants that are superior because they carry desirable genes from those that are superior because they happen to grow in a favourable site.

3.3 Methods of Plant Breeding

Several breeding methods are available to plant breeders for germplasm improvement, such as the pedigree method, bulk method, single seed descent, backcross method, and recurrent selection. The North Dakota breeding program primarily uses a modified pedigree program and, to a lesser degree, backcross, single seed descent, recurrent selection and doubled haploid breeding methodologies.

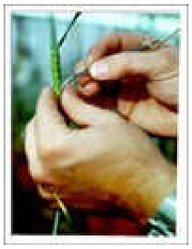
Mating systems

Plant mating systems devolve about the type of pollination, or transferal of pollen from flower to flower (see the article pollination). A flower is self-pollinated (a “selfer”) if pollen is transferred to it from any flower of the same plant and cross-pollinated (an “outcrosser” or “outbreeder”) if the pollen comes from a flower on a different plant. About half of the more important cultivated plants are naturally cross-pollinated, and their reproductive systems include various devices that encourage cross-pollination; e.g., protandry (pollen shed before the ovules are mature, as in the carrot and walnut), dioecy (stamens and pistils borne on different plants, as in the date palm, asparagus, and hops), and genetically determined self-incompatibility (inability of pollen to grow on the stigma of the same plant, as in white clover, cabbage, and many other species).

Modified Pedigree Method

A modified pedigree breeding method is used to evaluate ~225 to 275 segregating populations each year. The modified pedigree breeding method involves the evaluation and selection of parents and hybridization to provide useful gene recombinations.

Approximately 75% of the crosses made are single crosses involving only elite adapted parents. The remaining crosses involve one parent that may be considered "exotic," but possesses desirable genes. In this case, three-way crosses are used where the exotic parent's genetic contribution is one-third and the other two parents are elite adapted lines or cultivars. All crossing blocks and F_1 generation materials are grown in the greenhouse in Fargo, ND. Individual plants are selected for agronomic traits, glume color (associated with gluten strength), and disease resistance from space-planted F_2 populations grown in the field at Fargo and Langdon, ND. These selected plants are further tested for advance and possible variety release. From the initial cross to variety release (10 to 12 years) the experimental lines are extensively evaluated for their agronomic, disease resistance, milling, and end-use quality traits.



Planting yield trials

Planting short rows at Langdon, ND, using indexe

Durum wheat yield trials

Using a combine as stationary thrasher

Two row Suzue binder

Double Haploid Breeding

On average, 10 to 12 years are required to develop durum cultivars using the modified pedigree method. The use of doubled haploids in a breeding program is important in genetic studies and when rapid cultivar development is required. Completely homozygous and homogenous inbred lines can be developed in a single generation using the doubled haploid system. On average, we produce 300 to 400 doubled haploids every year using maize (*Zea mays* L.) as the pollen donor. Most of the doubled haploid populations are generated for genetic studies of various agronomic and end-use quality traits and to develop parents or cultivars resistant to Fusarium head blight.






Marker-assisted Breeding

Interest in applying molecular markers to various crop breeding endeavors has gained popularity. Three potential uses of molecular markers to assist crop breeding: 1) to assess the amount of genetic variation in a breeding gene pool, 2) to select lines based on presence of markers, and 3) to reduce undesirable linkage drag when introgressing genes from unadapted germplasm. The genetic variability in the breeding program was estimated using molecular markers. Marker-assisted selection for traits such as grain protein concentration and disease resistance is being used in the breeding program to enhance cultivar development. Marker-assisted selection also helps to reduce the linkage drag when using the unadapted germplasm such *T. dicoccoides* and the Fusarium head blight resistant source Sumai 3.

4.0 CONCLUSION

In this unit you learnt how the different methods of breeding plant introduction are being used. You also learn specie evaluation plant.

5.0 SUMMARY

In this unit, you have learnt what is plant introduction, specie evaluation and methods of plant breeding.

6.0 TUTOR-MARKED ASSIGNMENT

1. List and explain two types of plant introduction
2. Discuss the different types of breeding methods you know
3. State the merit and demerit of plant introduction

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MODULE 3 PASTURE ESTABLISHMENT AND MANAGEMENT

UNIT 1 PASTURE ESTABLISHMENT

CONTENTS

1.0 INTRODUCTION

It is important to consider whether the forage will be used for grazing or hay, what forage species are best suited for the area, and what resources are available in terms of equipment, money, and time. The decision of whether or not to renovate a pasture should be based on existing percentages of the desirable species present in the pasture. The following criteria could be used in such a decision:

- If the pasture contains 75 percent or more desirable species, consider not renovating and instead concentrating on management.
- If the pasture contains 40 to 75 percent desirable species, consider overseeding and concentrating on management.
- If the pasture contains less than 40 percent desirable species, consider reestablishing.

Establishing a new pasture or renovating an existing pasture usually requires some management to get the forage growing quickly and vigorously. Here are some of the steps involved in establishing or renovating a pasture:

1. Soil testing and correcting soil nutrient deficiency,
2. Selecting species adapted to the specific area,
3. Implementing the correct seeding method rate,
4. Implementing a weed control program, and
5. Using proper management to maintain a productive stand.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- state the factors to be considered when establishing a pasture.
- know the condition of seeds and soil.

3.0 MAIN CONTENT

3.1 Pasture Establishment

3.1.1 Soil Fertility

Planning for a successful pasture establishment or renovation should begin well in advance, often 6 to 12 months before the actual pasture establishment or renovation. If possible, adjust soil fertility before seedling. With today's higher fertilizer price, you cannot afford to guess how much fertilizer to apply. The first step is to obtain an accurate soil sample. Using soil test recommendations incorporate necessary fertilizer during seedbed preparation. Avoid applying fertilizer to drought-stressed seedlings, as the application could cause burning Injury to Young seedlings already under stress.

3.1.2 Seedbed Preparation

Good seed-to-soil contact is essentially to maintain adequate moisture near the seeds. This moisture is necessary for germination and for the small root systems of young grass seedlings. The best type of seedbed preparation depends 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).

3.1.3 Conventional Tillage

A properly prepared seedbed is a key step in pasture establishment. Conventional tillage should be used when a uniform seedbed is needed. Large soil clods and excess sod impact seed germination. For conventional seeding, prepare a fine and firm seedbed by disking. Roll the field with a cultipacker after the final diskimg. A firm seedbed will allow capillary action to draw water to the soil surface, where moisture helps to germinate seeds and sustain small seedlings during period of dry weather. A firm seedbed may help ensure that seed is not planted too deeply which usually result in poor seedlings emergence and weak pasture establishment. A general rule is that if you walk across the seedbed and you sink past the sole of your shoe more than 1/4 inch, the seedbed is too soft and should be culti packed.

3.1.4 No-Till Seedbed

No tillage involves using herbicides to kill existing vegetation and then seeding directlyin to the residue. Surface residue must be reduced in no-till seedbed by hard grazing or hay removal. No tillage seedbed require fewer passes over the field,reduced the possibility of soil erosion, and conserve moisture. on the other hand, seedlings in no-till seedbed emerge more slowly and less uniformly.

3.1.5 Species Selection

Selecting the right species or species mixture is extremely important. When establishing or renovating a pasture, its important to match forage species to the site,soil type,and type of operations (grazing or hay,animal species and class).

3.1.6 Seeding Methods

The ideal seeding method depends on the type of equipment available and whether you plant on a no-till or a conventional seedbed.to ensure good soil-to-seed contact, seed germination, and timely emergence, different seeding method are available. Some of this methods include drilling, cultipacking, and broadcasting.

Drilling cuts a thin furrow in the soil, deposits the seed, then covers it and firms the soil with press wheels. A good rule is to plant the seed 3to4 times as deep as diameter of the seed.

With a cultipack planter the seed is dropped from a Hopper on to the soil, where the toothed rollers press the seed below the surfaces when using a cultipacker be careful not to bury the seed too deeply, as it decreasing germination.

Broadcast seeding with a fertilizer spreader can result in an uneven seed distribution if the overlap is too wide. Less seed is distributed on the outer third so adjust your spacing to provide double coverage. Make sure the spreader is calibrated for the appropriate seeding rate. when broadcasting, increase recommended seeding rate by 20%. roll with a cultipacker to established a good soil-to-seed contact.

3.1.7 Seeding Time

Seeding on the correct date is also very important. Seeding too early in the rainy season can lead to failed establishment because young seedlings can die back if there is a prolonged dry period as is usually observed at the beginning of the rains. seeding should only be done well the season is established. Late planting will suffer some setbacks due to heavy down pourse and erosion leading to seeds being washed away or buried deep by moving soils.

3.1.8 Seeding rate

Properly seeding rate depends on forage species and seeding method to obtain a good establishment, used seed that's is pure, has a high germination rate, and has not been stored for a long period of time. High quality, certified seed is recommended. Seed cost could be a major portion of the total establishment cost, but buying less expensive seed does not always translate in to savings. If the seed is of poor quality, it must be applied at higher rate to obtain a desirable stand, making the used of cheap seed with low quality neither agronomically nor economically sound.

3.1.9 Weed control

A weed management plan will help ensure success in forage establishment. Its important to control weeds during establishment because newly emerged forages seedlings are extremely susceptible to weed competition. Weed compete for water, nutrient and sun lights. Broad leaf weed control is possible but may require multiple applications or applications at different times of the year. Application at different times during the year will better control weeds that germinates during different season.

3.1.10 Management

Do not allowed animals to grazes new stand too early or too frequently. Allow plant to become well established for heavy grazing or set stocking.

Mow or lightly graze pastures when plants are 8-to12 inch's tall. Most forages crops should not be grazed shorter than 3 to 4 inch’s. Maintaining proper grazing height will help trigga new plant to tiller or producer runners. Allows plant to grow to 8 to 12 inch's before grazing or mowing again. A rotational grazing approach could be beneficial in ensuring successful establishment.

4.0 CONCLUSION

In this unit, you have learnt the various factors to be considered when establishing pasture.

5.0 SUMMARY

In this unit, you should be able to know the different factors to be considered when establishing pasture. you also learn learn fertilization and pasture management and how to determine pasture yield. You also learn methods of forage conservation: silage production and making haylage.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the steps involve in forage yield determination.
2. Discuss the different methods of feed silage making.
3. Differentiate between silage and haylage.

7.0 REFERENCES/FURTHER READING

A. T. SEMPLE, associate animal hushandmariy Bureau of Animal Industry; H. N. ViNALL, senior agronomist^ and C. R. ENLOW, associate agronomist^ Bureau of Plant Industry; and T. E. WOODWARD, senior dairy husbaudman^ Bureau of Dairy Industry

UNIT 2 PASTURE MAINTENANCE, FERTILIZATION AND PASTURE UTILIZATION

CONTENTS

1.0 INTRODUCTION

The resources of a livestock production unit include land, livestock, water and capital. Livestock producers are resource managers, and as such are faced with the challenge of producing the maximum amount of saleable product annually without destroying the long-term production potential of the farm or ranch unit. A good sound pasture management program is essential to meet the challenge.

Unlike fertilization of most field crops, where the decision as to the amount and type of fertilizer to apply is largely driven by trying to achieve optimum production, pasture fertilization should be more controlled by careful consideration of the individual goals for the pasture. Factors to consider include: 1) production needed for the animals; 2) time of forage needs; 3) species present; and 4) expected methods of management.

Whether or not to apply fertilizers to pastures to increase production raises questions that graziers need to ask. Some of these questions are 1) what are the production needs for the animals grazed; 2) when are the forages needed in the grazing season; 3) what species are present; and 4) what are the expected methods of management? The answers to these questions will help determine if you use fertilizer/manure and the amount used.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- explain the pasture maintenance tips
- fertilizer in pasture production
- describe the types of processing method

3.0 MAIN CONTENT

3.1 Pasture-maintenance tips

Pasture maintenance during the growing season is critical to long-term productivity. Iowa State University Agronomist and Extension Forage Specialist Steve Barnhart provides the following tips to consider for the months of June and July.

JUNE

- Clip seed heads to prevent formation on fescue and control weeds as necessary.
- Monitor and record pasture rotations for proper graze and rest periods.
- Prepare a pasture risk management strategy based on the availability alternative pasture or hay meadows, and the price and availability of hay, grain, and grain by Products.
- Consider high intensity early season grazing of warm? season perennial grass pasture by stockers for a few weeks in early to mid-June
- Apply needed top dress phosphorus and potassium to alfalfa and other hay meadows, if not completed in early spring.
- Monitor alfalfa fields for potato leafhopper
- Consider cutting oats for hay or silage at early head emergence to provide higher quality cereal forage. Delaying to the "soft dough" grain development stage will add 15 to 20 percent yield, but at the sacrifice of forage nutritive value. Removing cereal grain cover crop shade competition early aids in more rapid development of under seeded forage seedlings.

JULY

- Avoid grazing warm season annual or perennial grasses below an average 5’6 inch stubble height.
- Incorporate alfalfa fields or paddocks into grazing system to compensate for poor growth of cool season grasses, if needed.
- Monitor and record pasture forage productivity and regrowth rates. Consider rainfall patterns, and implement drought management options if needed.

- Monitor alfalfa fields for potato leafhopper.

3.2 Pasture utilization

Using more of the green pasture grown throughout the year is often the most cost effective way to lift the productivity of a grazing enterprise. Grazing managers should aim to convert the largest amount of pasture energy and nutrients into saleable product while leaving pasture residue in the best condition for rapid regrowth.

This is achieved by identifying the stocking rate and density that an enterprise can sustain to maximise green pasture utilisation. The number of animals will depend on the nature of the enterprise (breeding and/or trading), but should be sufficient to ensure high utilisation of the pasture grown while maintaining the long-term sustainability of the pasture and the grazing system.

To achieve an increase in pasture use, a plant-based grazing management approach that considers seasonal plant growth patterns should be adopted. This approach should be underpinned by a grazing plan that determines the stocking densities and grazing durations for the pastures within an enterprise.

Developing a grazing plan

The key principles in developing a grazing plan are to:

- Match feed supply with animal demand.
- Identify the stock numbers (stocking density or head/ha) that the enterprise will sustain when green pasture utilisation is increased.
- Identify and monitor pasture quality, quantity and ground cover to time the start of grazing.
- Identify and monitor the pasture quality, quantity and ground cover to identify when to stop grazing to prevent pasture composition and ground cover from being adversely affected.
- Use routine field measurements (pasture growth stage, mass and height) to estimate both the number of days rest required before the next graze and the amount of pasture mass available. Use a fodder budget template to calculate how long stock can graze a paddock while ensuring production is maintained.
- Manage grazing pressure to ensure that planned and efficient use of available pasture mass and energy content is achieved before regrowth is grazed. This may mean spelling a paddock to allow regrowth.
- Plan the best balance of animal performance and pasture regrowth by grouping and allocating livestock according to their nutritional requirements.

- Set pasture and animal targets and manage the grazing of all pasture zones to achieve production targets, maintain pastures and prevent soil and environmental degradation.

3.3 Fertilizer in pasture production

Soil Testing

Since a regular nutrient management program has been an often-neglected practice for grazing, soil tests should be used to accurately determine phosphorus, potassium, and lime needs. Soil testing helps you apply fertilizers where they are needed, and avoids areas where they are not needed. Also, soil testing helps to prevent developing excessive levels of phosphorus and potassium. Phosphorus can runoff into streams and lakes, fueling algae blooms. Excessive levels of potassium can contribute to grass tetany or milk fever in grazing cattle.

For field crops, sampling the soil once every 3 to 4 years or once in a rotation is sufficient. Fields where high value specialty crops are grown and those that are more susceptible to changes in nutrient levels, such as those with sandy soils, should be sampled more frequently. Take soil samples at any convenient time. Studies examining that effect of sampling time on soil test results suggest that test values for pH, phosphorus (P), and potassium (K) are typically slightly higher in early spring samples than in fall samples. To receive your recommendations early enough to enable you to apply the lime and fertilizer needed, it may be best to sample in the fall. Another benefit of fall testing is that fertilizer prices are more likely to be discounted then. Regardless of when you sample, it is best to be consistent from one year to the next.

Phosphorus and Potassium

A grazing situation is different than a haying situation. Each ton of dry matter removed per acre from the field as alfalfa hay also removes about 12 to 15 pounds of P_2O_5 and 55 to 60 pounds of K_2O. To maintain optimum soil fertility, a producer would want to use fertilizers or manure to replace these nutrients.

In an intensively grazed pasture, on the other hand, over 80% of the nitrogen, phosphorus and potassium are recycled back to the pasture. The fertilizer recommendation for a legume-grass pasture with a yield of 4.1 to 5.0 tons of dry matter per acre is 60 pounds of P_2O_5 and 240 pounds of K_2O. Thus, due to nutrient recycling, each ton of dry matter removed per acre from a legume-grass pasture actually removes about 2 pounds of P_2O_5 and 10 pounds of K_2O. Therefore, based on estimated dry matter removal, fertilize accordingly to maintain optimum levels of phosphorus and potassium. Since the timing of phosphorus and potassium applications is not critical, they can be applied separately, together, or in combination with nitrogen fertilizer.

Taking a cutting of hay on some of the pasture acres to help regulate growth is a normal practice for many graziers. Each ton of dry matter removed per acre from a legume-grass pasture will also remove about 12 pounds of P_2O_5 and 48 pounds of K_2O. To maintain optimum soil fertility, a producer would want to use fertilizers or manure to replace these nutrients.

Since legumes are desired in pastures, special care should be taken to ensure adequate phosphorus and potassium levels. Grasses are more competitive for phosphorus and potassium than are legumes. Thus, lower levels of phosphorus and potassium would give grasses a competitive advantage and would decrease the legume portion of the pasture over time.

Sulfur and Boron

An intensively grazed pasture may also require sulfur and boron. To determine sulfur needs, do a soil test. A sulfur availability index (SAI) is calculated by estimating the sulfur released from organic matter, sulfur in precipitation based on location, subsoil sulfur, and sulfur in manure if applied. If the SAI is 40 units or more, response to added sulfur is unlikely. If the index is between 30 and 40, the sulfur need should be confirmed by plant analysis. If the index is less than 20, sulfur should be added. Generally, each ton for forage removes 5 lb of sulfur so consider application accordingly.

A legume-grass pasture has a high requirement for boron. If a soil test has a low reading for available boron or if a deficiency appears, top dress 2 pounds of actual boron per acre every 3 years. For a legume-grass pasture on sandy soils, top dress 0.5 to 1.0 pounds of actual boron per acre annually. This annual application will minimize the leaching effect with boron.

Nitrogen

If your current pasture production is less than desired, applying nitrogen fertilizer can increase pasture yields dramatically. Measured pasture yield increases of 400% or more have been noted in past research. Nitrogen and moisture are the main factors which limit pasture growth. If you have noticed lush, dark green growth surrounding manure and urine spots in your pastures, this is an indication of nitrogen deficiency.

A 30 percent stand of legume in the pasture can supply 30 to 50 pounds of nitrogen per year to the grasses in the pasture. The cycling of nitrogen from urine, manure, dead plants, etc. may supply an additional 15 to 30 pounds of nitrogen per year depending on cow numbers and frequency of grazing. While this is significant, recent University of Wisconsin research showed a positive economic return with up to 100 pounds of nitrogen fertilizer per acre applied to mixed pastures.

Fertilizing with nitrogen is a short-term management tool since its effect is usually immediate and does not last more than one grazing cycle. Additions of nitrogen fertilizer may cause a shift to more grass content in the year of application and beyond.

Soil pH

Last, but not least, do not forget about the soil pH. If there are mainly grasses present in your pastures, a soil pH of 5.8 to 6.0 should be adequate. A slightly higher soil pH of 6.3 to 6.5 is desired if you have mixed grass/legume pastures. This higher pH will help the legumes persist longer in the pasture.

Before establishing a pasture, apply lime at the recommended rate and incorporate into the plow layer at least six months to one year before pasture seeding. Although working the lime into the plow layer is the most desirable, this is not practical for many pasture situations. Topdressing lime to your established pastures will still be beneficial over time. Surface application of lime without incorporation will only move about 1/4 to 1/2 inch per year through natural processes. The rate of movement depends on the soil texture and fineness of the lime applied. Use as fine a grade of lime as you can obtain. You may need to topdress lime every few years until the desired soil pH is reached.

4.0 CONCLUSION

By the end of this unit you are able to know the pasture maintenance tips, how to adequately utilize pasture and method of fertilization.

5.0 SUMMARY

In this unit we have learn about various ways or method of pasture management and fertilization. You also learn pasture utilization

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain in detail fertilization in pasture production
2. How do develop a grazing plan?
3. List the tips stated by Steve Barnhart to be considered for the months of June and July

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UNIT 3 FORAGE YIELD DETERMINATION CONSERVATION

CONTENTS

1.0 INTRODUCTION

Knowing your forage yield is vital to creating an accurate grazing plan. In these videos, Dr. Joe Brummer at Colorado State University's Department of Soil and Crop Sciences demonstrates four different methods to estimate your pasture yield: the cut and weigh method, the grazing stick method, the falling plate method, and the rising plate method.

Forages can be conserved to feed livestock during periods of shortage caused by limited pasture growth or inadequate pasture conditions, or fed as a supplement. Conserved forages can take the form of hay, haylage, and silage. Although several methods have been proven as efficient ways to store and preserve forages, it is important, to keep this fact in mind: *At best, conserved forages can rarely match the nutritive value of fresh forage because some losses of highly digestible nutrients (sugar, protein, and fat) are unavoidable during conservation and storage.* Our goal in forage conservation is to focus on minimizing losses, which start immediately after cutting.

When selecting a conservation method, a producer should consider the suitability of the forage for a given method, storage capability, weather conditions, and the intended use of the conserved forage. The selected conservation technique should maximize nutrient conservation efficiency and minimize production costs.

3.0 MAIN CONTENT

3.1 Forage yield determination

Method of forage yield determination

1. **Cut and weigh** is the most accurate method. Using a 0.25 square meter frame, trim the forage that falls within the quadrat to ground level. You should take at least 10 cut and weigh measurements across your pasture to get accurate results. Assuming the grass is 20% dry matter, multiply the wet grams of forage by 0.2 to get the value in dry matter. If your quadrat is 0.25 meters squared, multiply the average grams of dry matter by 35.69 to convert to lbs/acre (conversion rate for a 0.25 square meter quadrat). The conversion rate you choose will depend on your ground cover and forage type.

2. **Using a grazing stick** is the most commonly-used method for estimating forage yield. Walk the pasture and take about 30 different height measurements to get a good estimate of your forage height. Measure the forage height to the last number you can easily see on the grazing stick. Take the average of all of your height measurements. Multiply this average forage height by 250 lbs/acre/inch of height depending on your forage type and coverage. Check your grazing stick to find the correct conversion rate for your pasture conditions. The result of the conversion will give you forage in lbs/acre.

3. **The falling plate method** uses a grazing stick or yard stick to measure the height of forage under a heavy plate. The compression of the grass under the plate leads to a more accurate height estimation because you are not eye-balling the forage level. You should do repeat measurements across your pasture with this method as well. Using the average plate meter height in inches, multiply by 432 lbs/acre/inch of forage height to get a forage estimation in lbs/acre.

4. **The rising plate method** uses a rising plate meter, a piece of equipment developed in New Zealand. If you have a rising plate meter, walk the pasture and take about thirty measurements. To take a measurement, press the rising plate meter onto the pasture surface and push to the ground. Pull up the rising plate meter and it will beep, showing you the forage height measurement. The rising plate meter will also calculate the average height measurement after you take several measurements. Take this average forage height value and multiply by 126 lbs/acre/cm of height to convert to lbs of forage per acre. These conversion factors

are estimates for the specific pasture conditions at the irrigated pasture at Colorado State University, so you may need to do some research to see if these conversion rates will be accurate for your pastures. The rising plate method may be the most convenient, but the rising plate meter cost CSU $700.

3.2 Forage Conservation

Silage and Haylage Production

What is Silage?

Silage is the final product when forage of sufficient moisture (> ~50%) is conserved and stored anaerobically (oxygen-free), under conditions that encourage fermentation of sugars to organic acids. The acidity generated by the organic acids (mainly lactic acid, but also acetic and propionic acids) and the lack of oxygen prevent the development of spoilage microorganisms. Three of the most critical factors for silage production are (1) rapid removal of air, (2) rapid production of lactic acid that results in a quick lowering of the pH (this is the result of adequate fermentation processes), and (3) rapid feedout once the silo is opened and exposed to air to avoid heating and spoilage.

Differences between Silage and Haylage

The main difference between silage and hayage is the initial dry matter (DM) concentration level at which the forage is clipped and packed to achieve optimum anaerobic and fermentation conditions. Three different moisture levels can be achieved: high-moisture silage (≤ 30% DM), medium-moisture silage (30% to 40% DM), and low-moisture (wilted) silage (40% to 60% DM). Low-moisture silage is referred to as haylage. When baled and wrapped, haylage is referred to as baleage. High-moisture silages are more prone to potential seepage losses (that is, effluent or leachate from the silo), undesirable secondary fermentation (resulting in butyric acid, which results in a rancid smell), and high dry matter losses (silo shrink). On the other hand, preservation as haylage depends more on achieving adequate packing (high density) to maintain anaerobic conditions. Achieving high density at packing is more difficult in drier forage. Nevertheless, high density is critical in haylage to maintain anaerobic conditions because microbes are less active and fermentation is lower in haylage than in higher moisture silage.

The Ensiling Process

Biology

Silage fermentation can be classified as either primary (desirable) or secondary (undesirable) Primary fermentation is carried out by lactic-acid-producing bacteria and is classified as homofermentative (the one product of fermentation is lactic acid) and heterofermentative (multiple products of fermentation are lactic and acetic acids and ethanol).

Secondary fermentation is carried out mainly by enterobacteria (which produce lactic, acetic, succinic, and formic acids, and ethanol), clostridia (produce butyric acid), and yeasts (produce ethanol). Lactic acid production is preferred over the other fermentation products due to faster and lower pH drop (stronger acid), and limited silo shrink. Shrink occurs from plant and microbial respiration, fermentation, runoff, and loss of volatile organic compounds. If anaerobic and acidity conditions are not met, silage is more prone to shrinking during storage compared to hay. Good fermentation should result in DM losses of less than 10%.

Phases of silage fermentation

An overview of the four phases of the silage production process as shown in Figure 1. The phases are as follows:

1. **Aerobic:** This phase usually lasts for approximately one day. During this period, plant cells and microbes will metabolize sugars and starch in the presence of oxygen, generating heat in the process. Silage temperature is elevated to about 90˚F, and water may be lost (as seepage) because of respiration and compaction. If anaerobic conditions are not achieved quickly, high temperatures (>120˚F) and prolonged heating will occur due to the growth of unwanted aerobic bacteria, yeast, and molds that compete with beneficial bacteria for substrate. Therefore, it is critical to ensure good compaction, proper moisture, and good sealing, all of which lead to a rapid transition to anaerobic conditions.

2. **Fermentation***:* Once anaerobic conditions are achieved, lactic acid bacteria and other anaerobes start to ferment sugars into lactic acid, mainly, and other organic acids to a lesser extent (such as acetic and propionic) that will drop the silage pH from about 6.0 to a range of 3.8 – 5. Alcohols such as ethanol will be generated too, but with no contribution to the acidification process. Rapid decrease in pH prevents breakdown of plant proteins and helps inhibit growth of spoilage microbes. Consequently, lactic acid production is preferred to ensure a low silo shrink. The fermentation phase usually lasts from one week to more than a month, depending on crop and ensiling conditions.

3. **Stable***:* As long as anaerobic conditions are maintained, silage can be stable for months and up to years. However, under practical conditions, silage should be used within a year of its production. Slow entry of air through areas that were not properly sealed can slowly deteriorate material, thus silos should be constantly checked and maintained to avoid any potential break of seal integrity.

4. **Feedout***:* Once a silo or bale is opened, it should be used as quickly as possible to avoid aerobic deterioration of the material. When oxygen becomes available in the ensiled material, yeasts metabolize the organic acids, which in turn cause the pH to increase, and further restarts the

aerobic activity (such as molds), causing greater silage spoilage. The design of a typical silo face should allow for the daily removal of approximately 6 inches of face material (for reference, each 6-inch daily removal is equivalent to one week of exposure to air). Silo opening should occur only after the fermentation phase has been completed (that is, after three to six weeks). The suggested approach is to wait approximately two to three months before opening a silo.

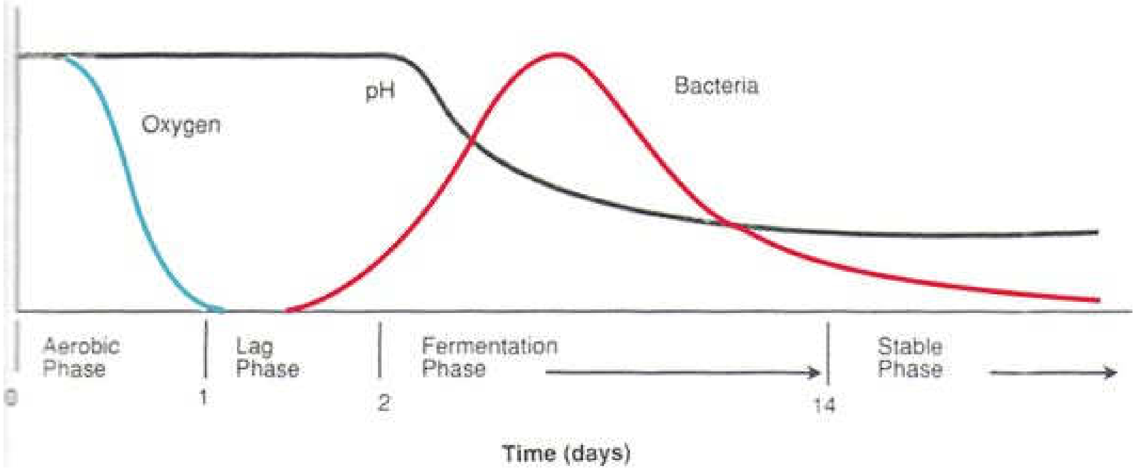


Figure 1. The phases of silage fermentation.
Adapted from Collins and Owens, 2003.

Management Practices for Making Better Silage

Crop factors

An ideal crop to be ensiled should have an adequate level of sugars (measured as water-soluble carbohydrates) to be fermented, low buffering capacity (that is, the resistance to changes in pH), and a stand with a dry matter concentration above 20%. Corn is usually considered an ideal crop for ensiling because of higher water-soluble carbohydrates (WSC) compared to other forages and because dry matter concentration is usually about 30% to 35% when harvesting at milk stage. The concentration of WSC is critical for fermentation and varies among crops. Minimum WSC concentration levels as a function of initial DM concentration and silage crops are shown in Table 1. Legumes have higher buffer capacity (resistance to allowing a drop in pH) and, therefore, require further wilting relative to other crops (35% – 45% DM) for adequate ensiling. In general, crop suitability for ensiling follows this order: corn, sorghum > ryegrass, orchardgrass, fescue, smallgrains > switchgrass, bermudagrass > legumes.

Harvest maturity

Harvest stages that optimize for yield, nutritive value, and fermentability of different crop and silo types are presented in Table 2. In the case of legumes, grasses, and cereals, maturity stage defines optimal harvest time and wilting is required in most cases to achieve the target DM concentration for ensiling. Corn, however, is different. Although examining the kernel milk line is always recommended, the decision of when to harvest should be made based on the DM concentration of the standing crop because it is ensiled directly afterwards.

Moisture

Moisture concentration affects the rate and extent of fermentation. Forages should not be ensiled with more than 70% moisture (or less than 30% DM concentration) due to potential seepage losses and growth of undesirable bacteria (such as clostridia), which results in undesirable fermentation. Wilting is needed in most cases when ensiling grasses and legumes.

As moisture decreases, less acidity is needed to inhibit undesirable bacteria that are more sensitive to low moisture than the desirable lactic acid bacteria. Low moisture is one of the factors that explain why wilting is beneficial for legumes and grasses. When wilting forages, adjust the mower-conditioner for a narrow swath, and then allow the swath to dry without further manipulation until the crop is chopped. Research shows that this procedure minimizes field losses of the plant leaves, which are of higher nutritive value than stems. Recommended DM concentrations at harvest for different crops are included in Table 1.

Particle size

The optimal particle chop length is a balance between the particle size needed to achieve good compaction in the silo and the effective fiber requirements of ruminant livestock, especially lactating animals. The recommended theoretical length of cut (TLC) is 3/8 to 1/2 inch for unprocessed corn and legume silages, and 3/4 inch for kernel-processed corn silage (Muck and Kung, 2007). Sorghum silage should have a similar TLC to corn silage and grasses, and cereal silages should have a similar TLC to legume silages. Kernel processing is highly recommended when making corn silage to improve starch digestibility. Kernel processing should not be done, however, if whole plant DM concentration is less than 30% due to risk of increased seepage losses.

Packing density

Attaining a high density in a silo is important because it determines the porosity at which air moves into the silo and subsequently the amount of spoilage that occurs during storage and feedout. Silage density is influenced by DM concentration, TLC, and packing intensity. Different types of silos require different packing strategies and target densities for appropriate ensiling. In general, a shorter TLC and processing will result in higher silage densities due to a decreased stiffness of the material.

Silage density recommendations are provided in the silo type section, and a general rule is to try to achieve a packing density of about 14 lb/ft^3.

Sealing

Good sealing with plastic sheets and concrete barriers will keep the carbon dioxide in and prevent oxygen from entering the silo. Care must be taken to seal any holes with UV-resistant tapes, especially in low-moisture silages where porosity is greater. Oxygen barrier film technology, compared to standard polyethylene films, has proven to further reduce DM losses and increase aerobic stability from the outer layers of silos.

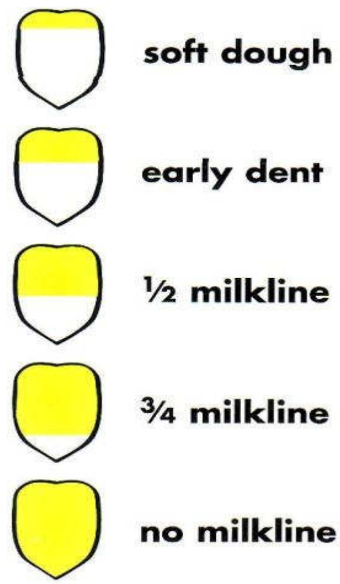
Additives

Several types of additives are available that can be used for silage making. Additives can help in every phase of silage making. Nevertheless, good harvesting practices are the main drivers of silage quality. In general, additives can be classified as stimulants or inhibitors of fermentation, and nutrient sources (Kung et al., 2003). Specific effects of additives include the following:

- Provide fermentable carbohydrates (Table 3)
- Inhibit undesirable types of bacteria and promote desirable bacteria
- Furnish additional acids (such as propionic acid) directly to decrease pH
- Modify moisture (Table 4)
- Extend aerobic stability during feedout (bunk life)

Inoculants, enzymes, and sugars can be considered as stimulants of fermentation that promote rapid pH drop, produce more lactic acid, and reduce ammonia production (by preventing protein degradation) in most cases. These factors lead to a reduced silo shrink. Inoculants can be found as homofermentative, heterofermentative, and containing a combination of both types of bacteria. Inoculants containing heterofermentative bacteria, such as *Lactobacillus buchneri*,can extend bunk life during feedout by producing acetic acid, which is a powerful antifungal. However, a small increase in silo shrink may be observed in some instances due to the transformation of some lactic acid to acetic acid by *L. buchneri*. This effect has been compensated for in most cases by combining *L. buchneri* with fast-growing homolactic bacteria. Fibrolytic enzymes are also added to most silage inoculants to help release extra sugars from fiber, thus stimulating fermentation, and to improve fiber digestibility. Other additives include inorganic and organic acids, which are considered inhibitors of fermentation and are usually used in silages that have more than 70% moisture. Ammonia or urea are sometimes added to prevent fungal growth and supplement nitrogen in forages with low crude protein levels to improve forage nutritive value.

Silo Types



Bunker and piles

These silo types consist of a layer of concrete or asphalt to protect from soil contamination and a polyethylene plastic sheet covering the silage (sometimes the wall as well). The bunker silo is a variant with two or three concrete wall sides (Figure 3). This silo type is the least expensive but also has a large surface exposed to the air. Consequently, adequate lining of the inside walls with plastic is needed to avoid outer layer forage damage, in addition to the plastic sheet for the top. Sealing is most critical to ensure good preservation and forage quality. Plastic films must be at least 5 mm thick and be UV-resistant. Tires or gravel-filled bags must be used to keep plastic sheeting in place. Moreover, achieving at least 14 lb of DM/ft^3 is essential to minimize losses, whereas the best silos can achieve densities of 20 lb of DM/ft^3. The forage crop should be packed to form progressive wedges and maintain a minimum slope of 1 (rise) to 3 (run) to avoid tractor rollover. The forage should be spread in a thin layer (no more than 6 inches deep) as much as possible to aid the compaction process.

Pressed bags

Increasingly more used, pressed bags provide the advantage of flexibility in terms of storage and movement of stored silage (Figure 4). The bagging machine regulates silage density in the bag, and achieving a smooth bag surface requires expertise. Pack as tightly as possible without creating an irregular surface (ripples), which creates air passages that can spoil much of the material being ensiled. Target density should be 14 lb of DM/ft^3 to achieve good results. Use a clean hard surface on which to place the bag.

This type of silo requires constant checking of each bag's integrity so that punctures are quickly fixed and no air comes inside the silo.

Towers

Silage is filled by blowing the material through a pipe attached to the outside wall that ends in a distributor at the top of the tower silo. In concrete stave silos that unload from the top (Figure 5), the unloader blows the silage through doors located in the side of the silo and down a chute. The density in this type of silo is determined by the weight of the material on top and wall friction. Consequently, material at the bottom needs to be ensiled at a high DM (35% to 40%) to prevent effluent release. The upper surface of the silo is exposed to the air, and spoilage can occur of up to 1 meter deep, which is discarded when emptying starts. The losses in DM during ensiling tend to be lower in tower silos compared to other types. Oxygen-limiting tower variants, primarily unloaded from the bottom, are available to limit spoilage even further.

Figure 3. Bunker silo.
"Loaders compacting silage, Revivim 2007" by Felagund - Own work. Licensed under CC BY-SA 3.0 via Commons - https://commons.wikimedia.org/wiki/File:Loaders_compacting_silage,_Revivim_2007.jpg#/media/File:Loaders_compacting_silage,_Revivim_2007.jpg

Figure 4. Bag silo filling.

Figure 5. Concrete stave tower silos.

4.0 CONCLUSION

By the end of this unit, you able to know, the various ways of methods of determining forage yield and different methods of making silage and haylage,

5.0 SUMMARY

Silage production is a bacterial driven process in which crop, moisture, theoretical length of cut (TLC), and density interplay to generate the proper anaerobic and acidic conditions necessary for producing quality silage. When the proper conditions occur, they inhibit the growth of spoilage microorganisms, such as molds and yeasts. The main objectives are to obtain a silo with less than 10% shrink, and silage that is stable for several days once exposed to air, high in nutritive value, and free of toxins. Strategies for achieving these objectives under different conditions have been outlined in this publication.

6.0 TUTOR-MARKED ASSIGNMENT

1. List and explain the different methods of determining forage yield.
2. Differentiate between silage and haylage.
3. Discuss the phases of silage fermentation
4. Explain the management practices in making silage

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MODULE 4 NUTRITIVE VALUE

UNIT 1 PASTURE NUTRITIVE VALUE

CONTENTS

1.0 INTRODUCTION

The performance of livestock grazing grasses is directly related to the quantity and quality offered. There are many factors that influence intake of grass, the most important being digestibility and crude protein. Digestibility is a measure of the proportion of grass that can be utilized by an animal. Grasses that are green, leafy and actively growing will have a higher digestibility than those that have dried. The crude protein of early to late vegetative stage is higher than late flowering stage. Young growing grasses have a crude protein value of 8-16 percent but most matured grasses have 3.5-8 percent.

Most tropical grasses only have energy and crude protein for maintenance only. Thus, growing and lactating animals who require higher levels of protein in their diet must have protein rich supplements included in their diets

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- define range management.
- know the systems of grazing management
- know how to determine forage yield

3.0 MAIN CONTENT

3.1 Pasture Nutritive Value

Pasture Nutritive Value. The nutritive value of pastures can be assessed in several different ways. Energy content of the herbage is the most important value. Livestock obtain energy from the pasture when rumen microbes break down the digestible proportion of the dry matter.

The nutritive value of pastures can be assessed in several different ways. Energy content of the herbage is the most important value. Livestock obtain energy from the pasture when rumen microbes break down the digestible proportion of the dry matter. The more digestible a pasture is the more of it is utilised and the more energy is obtained from each kilogram of dry matter.

Metabolisable Energy (ME) content of the pasture is expressed as **Megajoules of Metabolisable Energy per kg of dry matter** (MJ ME/kg DM).

Digestibility is the proportion of the pasture eaten that is retained by the animal to gain weight, produce milk, wool or grow a foetus. If 70% of the pasture eaten is retained and used by the animal and 30% passes out as faeces, the pasture has a digestibility of 70%. The digestibility of plants declines as they mature and enter their reproductive phase. This is caused by thickening of cell walls, increased stem:leaf ratio and movement of sugars from the leaves into the seeds. This means that ruminants obtain less energy per kilogram of pasture as plants send up a seed head and dry off.

Relationships between ME and Digestibility are shown below based on the equation ME = 0.203 X DOMD – 3.01

Converting Digestibility to Metabolisable Energy (MJ/kg DM)	
Digestible Organic Matter (%)	**Metabolisable Energy (MJ/kg DM)**
35	4.1
40	5.1
45	6.1
50	7.1
55	8.1
60	9.2
65	10.2
70	11.2
75	12.2

It is important to differentiate between the **energy content** of the pasture or supplement expressed as MJ/kg DM and the **energy intake** (MJ/day) that a particular animal might obtain from the pasture. This is discussed under the "**Feed and ME intake**" tab.

Protein Content (%) is also important. Generally, the higher the energy content, the higher the protein content. However, legume based pastures and legume grains have a higher protein content for any given energy value than grass based pastures or cereal grains.

Energy content is normally the limiting factor with pastures, but in dry pastures some native species, low protein content may limit animal production especially in young animals. Therefore, it's important to know both the protein and energy content of supplements and pastures.

Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) are measured in some laboratories. In general, as the concentration of fibrous material increases the rate of digestion and digestibility decreases. For most pasture based systems, energy content and protein % are sufficient to determine feeding value of the pasture and supplementary feed requirements.

Nutritive value testing is undertaken by a number of laboratories across Australia. Search on line for *Feed testing laboratories* in your region.

3.2 Livestock Management on Pasture and Rangeland

What is Range Management?
RANGE MANAGEMENT is the care of natural grazing lands. It may be further defined as planning and administering the use of rangeland to obtain maximum livestock or game production consistent with conservation of the range resources.

Management of the Range
The objective of range management is maximum production of meat and wool without damage to the land. Too optimistic estimate of the grazing capacity of ranges throughout the world in the past have resulted too often in overgrazing and deterioration of the vegetation. Where misuse was continued to the point of the vegetation, soil erosion and devastation of the land resulted. The modern range manager's chief duty often is to prevent further damage to the land and to restore it to its original condition.

Phases of Management
Major phases of scientific range management include the following:

1. Deciding proper grazing use.
This involves selection of the correct kind of grazing animal, i.e. cattle, sheep, game, or some combination. It also involves making a forage resource inventory to aid in determining the right numbers of animals, the season of year they are to be grazed, and the best grazing system. The grazing system may include such things as how to herd sheep and how to rotate the grazing between different areas of range and different seasons of the year.

2. Improving forage production.
Forage yield sometimes maybe improved by seeding new and better forage species, killing undesirable and sometimes poisonous weeds and brush to allow better growth of more palatable forage, fertilizing the soil, spreading flood-water over adjacent land, and poisoning insects.

3. Increasing usability of range.
Many ranges have rough topography and poorly distributed watering places so that it is difficult to get uniform grazing use, especially when the animals are unattended by herders. This problem can be solved in part by building properly located fences to control distribution of the animals. Developing new water holes, digging wells, and building storage reservoirs or tanks will enable the animals to reach distant parts of the range without excessive travel for water. Placing salt in ungrazed portions of the range helps draw stock to these areas. Building trails will aid animals to reach mountainous lands normally in-accessible.

4. Managing the livestock.

Profit from the ranch and efficiency of range land use are directly influenced by the husbandry of the livestock. The manager should know the effect of nutrition on reproduction, weight gain, and wool yield. The cost and return from supplemental feeding of livestock on the range must be studied. The problems of livestock buying and marketing are complex and affect ranch income directly. Animal breeding influences quality and yield of livestock. The man-ager must know good livestock quality and how to emphasize it through an understanding of genetics. Diseases must be known and avoided or cured. Proper protection and care of livestock are especially important during calving or lambing and during cold winter months.

5. Correlating grazing with other land uses.

As range land becomes increasingly less isolated from society, uses other than grazing become more and more important in management decisions. The manager of private range is primarily a stock raiser, but he often finds it economically desirable and socially necessary to consider other land uses in planning his operations. Even more so, the manager of public ranges is involved in the social of multiple use of land and must decide the relative importance to society of hunting, fishing, sightseeing, picnicking, growing trees or producing water. Livestock grazing must be properly correlated with these other uses so that the multiple uses will at least interfere with each other and so that the land use program, in its entirety, will benefit society the most.

3.3 Techniques for Improving Range Management

1. Bulldozing

Management use

i. Cutting /crushing brush.
ii. Grubbing trees and stumps.
iii. Removing scattered tree/brush stands.
iv. Used on oak, aspen, pinyon-juniper, willow.

Advantages

i. Operate on steep slopes.
ii. Can stimulate aspen and willow growth.

Disadvantages

i. Soil disturbance ranges from light to heavy and can increase erosion.
ii. Expensive.

Limitations

i. Not suitable on rocky areas; best on uniform areas.
ii. Not effective on young plants.

Season of use

i. Winter.

2. Blading

Management use

i. For rapidly clearing large areas.

Advantages

i. Good on frozen soils.
ii. Leaves under story relatively undisturbed.

Disadvantages

i. Can spread invasives including the prickly pear.

Limitations

i. Not suitable on rocky areas; best on uniform areas

Season of use

i. Winter (best), spring and fall.

3. Tree dozing (V-shaped blade with cutting edge)

Management use

i. Removing aged, mature, non-sprouting –species.

Advantages

i. Enhances herbaceous undestroyed vegetation.

Disadvantages

i. Can't operate beneath ground surface.

Limitations

i. Not suitable on rocky areas

Season of use

i. Winter, spring, fall.

4. Chaining

Management use

i. Thin old stand of non-sprouting brush; released herbaceous undestroyed
ii. Opens thickets of sage brush, gambles oak, chokecherry, black brush, grease wood
iii. Preliminary treatment prior to burning root plow, and broadcasting seeding.

Advantages

i. Increase ground cover, less erosion; forage production leaves debris to enhance moisture for growth
ii. Useful on rocky, steep slopes.
iii. Lower cost acre c0mpared to other treatment

Disadvantages

i. Usually require seeding to enhance herbaceous production
ii. Erosion possible early after treatment

Limitations

i. Heavy chains eliminate young,flexible trees.
ii. Light chains do less damage to herbaceous undestroyed

Season of use

i. Early spring or late fall

5. Cabling

Management use

i. For thinning only; less harsh treatment.

Advantages

i. Reduce killing of small trees/shrubs of desirable species.
ii. Essentially no damage to shrubs undestroyed in pinyon-juniper areas
iii. Tractor travel faster with cable

Disadvantages

i. Need to add weight to achieve desired kill.

Limitations

i. Not effective on sage brush
ii. Not effective in areas with dense shrubs

Season of use

i. Spring fall

6. Railing

Management use

i. Thinning small, brittle shrubs to enhance herbaceous undestroyed growth.
ii. Covers broadcast seeded areas.

Advantages

i. Rides over smaller plants and flexible shrubs.
ii. Relatively low cost.

Disadvantages

i. Can spread invasive.

Limitation

i. Does not stimulate sprouting

Season of use

i. Early spring, late fall.

7. Mowing

Management use

i. Use to control small non sprouting brush

Advantages

i. Prostrate plants not damaged
ii. Little effect on soil
iii. Effectively controls upright annuals

Disadvantages

i. Does not kill perennial herbaceous plants
ii. Spread rabbit brush when done in the fall

Limitation

Not suited for rocky areas or steep slopes

Season of use

i. Best in early spring to prevent spread of rabbit brush invasives.
ii. Can be done in late fall to prevent disturbing sage growth.

3.4 System of Grazing Management

3.4.1 Principles of forest grazing

Managing a forest to produce forage for livestock, desired wildlife habitat, quality water, quality fisheries, timber production, and many other desired forest products requires an understanding of the forest ecosystem and how it responds to the manager's decisions.

Some forest ecosystems managed for timber production have limited capabilities for livestock grazing. Livestock grazing can cause detrimental effects, such as reduced regeneration of desired woody species, adverse soil compaction, or soil erosion on steep, highly erodible sites. A decision must be made to determine if the forest ecosystem will support livestock grazing that is designed and managed to meet the needs of the cooperator and the forest ecosystem. Many forests can be grazed where grazing management is designed to meet the needs of the soil, water, air, plants, and animals. In most forests, solar energy is the major ecological component affected in the management process. Solar energy is intercepted by the canopy of the tallest trees. This causes a filtering or reduction ofsolar energy as it penetrates to the next layer of vegetation, whether it is a mid-story of woody plants or grasses and forbs growing on the forest floor. Managing the forest ecosystem for the desired plant community and the desired production is, in a large part, accomplished by managing the plant populations in the different stories (over story, mid story, and understory) to provide the most efficient use ofsolar energy by the desired plants. Managing forest or forage and timber production requires the Timber Management Plan and the Prescribed Grazing Plan be coordinated to produce the desired effects on the plant community and all of the ecological components.

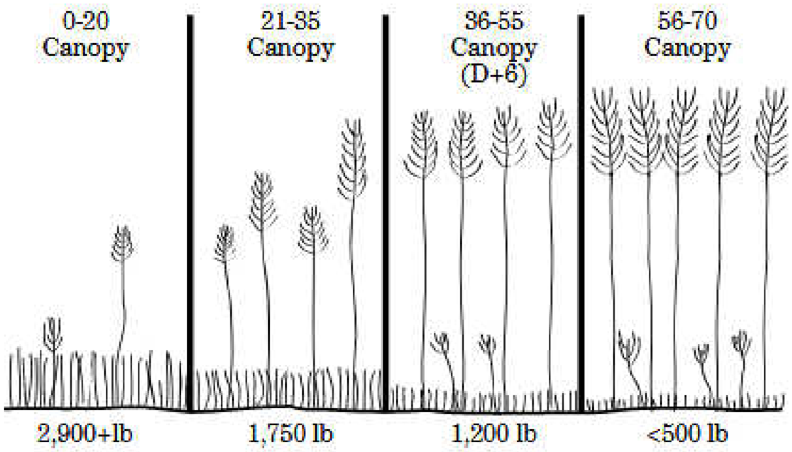
3.4.2 Management of the over story

The ecological site descriptions for forest land are in Section II of the Field Office Technical Guide FOTG). They provide information for each forestland ecological site in the field office area. Each forest land ecological site contains a description of the over story canopy classes that are on the site. Plant species adapted to the site and the amount of sunlight that penetrates to the ground level are listed for each canopy class. The description of the under-story composition includes the production (in pounds) of each plant or groups of plants and the total production for the canopy class.

As canopy closes from totally open to totally **closed (fig. 5–7, a southeast forest site),** the understory spe-cies almost completely change from warm-season to cool-season plants. Forage production will be reduced significantly as a result of the species composition change and the near elimination of sunlight penetration to the ground level.

Management of the over story canopy with timber management practices is essential to the desired production of forage and understory species. The mid canopy densities (21 to 35 and 36 to 55 percent) produce a mixture of the warm- and cool-season plant sand in many instances can be managed to maximize timber production.

Figure 5–7Canopy classes in a southeast forest site



For example, in some southern pine forests the practice of periodic thinning on a 5- to 6-year rotation maintains the desired basal area and canopy of trees for maximum timber production. This canopy allows substantial forage production for livestock and for grazing and browsing wildlife. This periodic thinning is continued until the forest matures. At that time, the forest is clear cut and allowed to regenerate, or it is replanted to the desired tree species. The forage and browse production is excel-lent until the canopy of the regenerated or planted trees closes at about 10 years. Very little understory will be produced for about 5 years. At about the 15thyear of the new forest, the first thinning cut will be made. This will again start the maintenance of the 35to 55 percent over story canopy that maximizes timber production and allows substantial understory forage production.

If in the above example the periodic cutting cycles are not made, the canopy will completely close and shade out the understory. Forage production will be limited, and the wildlife habitat for grazing or brows-ing wildlife will be undesirable (fig. 5–9). Pulp wood rotations, where plantings are made and not thinned until they are fully harvested, are examples of this type management. Many privately owned forests are not managed because of a lack of understanding of timber management, grazing management, or other factors. This causes a canopy closure with the same results.

3.4.3 Management of the mid-story

Many forests develop a mid-story canopy that can completely shade the ground level understory (fig.5–10). Even if the over story is managed to maintain the desired canopy, a mid-story can severely reduce the amount of sunlight reaching the ground level. The effects are the same as if the over story was closed. The understory species composition is changed to those that are shade tolerant, and forage production is reduced severely.

In this case, if understory production is desired, the manager must reduce the mid story. In many cases prescribed burning can be used to control the mid story species. In others forest improvement should be planned to manage the mid story to the desired canopy.

3.4.4 Management of the understory

The understory is made up of grasses, forbs, legumes, sedges, vines, and shrubs. When the over-story and the mid story are managed to permit the desired amount of light to reach the forest floor, a plant community develops that is adapted and sup-ported by the amount of light, water, and nutrients available on the site.

Figure 5–8Forage production clear cut for natural regeneration with periodic thinning

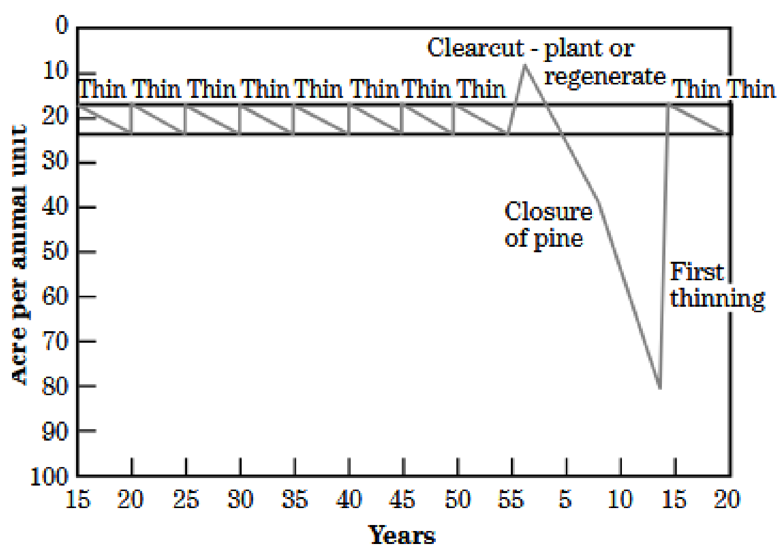
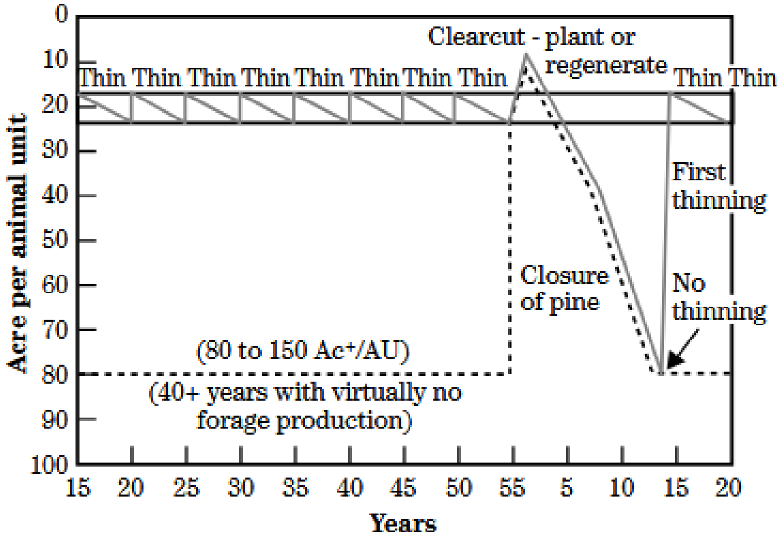


Figure 5–9Forage production clear cut or natural regeneration with periodic thinning (com-pared to clear cut or natural regeneration with no thinning)



Livestock and wildlife grazing and browsing on this site select their preferred species. If they are stocked too heavily and for too long a time, they overgraze the desired species. These species are weakened and reduced in percentage composition, while the less preferred species increase in percent-age composition. If the process is continued, both the preferred and secondary plant species will be severely reduced and replaced with non-preferred species **(fig. 5–11 and 5–12).(40+ years with virtually no forage** production)

3.5 Determination of Stocking Rate

Degree of grazing use as related to stocking rates

Because of fluctuations in forage production or loss of forage other than by grazing use, arbitrarily assign-ing a stocking rate at the beginning of a grazing period does not ensure attainment of a specific degree of use. If the specified degree of use is to be attained and trend satisfactorily maintained, stocking rates must be adjusted as the amount of available forage fluctuates.

When determining initial stocking rates, grazing distribution characteristics of the individual grazing unit must be considered. For example, a Stony Hills Range Site that has steep areas adjacent to a relatively level Loamy Upland Range Site generally receives less grazing use by cattle than the Loamy Upland Range Site. The Stony Hills Range Site may produce enough forage to permit a stocking rate of 2 acres per animal unit per month when it is the only site in a grazing unit. Its grazing use, however, is generally substantially less, in the example just described, by the time the Loamy Upland Range Site has been properly used. There verse may be true if the grazing animal is sheep or goats. Therefore, initial stocking rates for a grazing unit should not be based directly on the initial stocking rate guides without a careful onsite evaluation of factors affecting grazing use of the entire grazing unit. Many methods are used to determine the initial stocking rate within a grazing unit. Often the past stocking history and the trend of the plant community are the best indicators of a proper stocking rate. The Multi Species Stocking Calculator in the Grazing Lands Application (GLA) software is one method for determining stocking rates, especially when the areas grazed or browsed by more than one kind of ani-mal. See also Stocking Rate and Forage Value Rating Worksheet in chapter 5, section 3, (exhibit 5–3).(f) Prescribed grazing schedule A prescribed grazing schedule is a system in which two or more grazing units are alternately deferred or rested and grazed in a planned sequence over a period of years. The period of non-grazing can be throughout the year or during the growing season ofthe key plants. Generally, deferment implies anon grazing period less than a calendar year, while rest implies non grazing for a full year or longer. The period of deferment is set for a critical period for plant germination, establishment, growth, or other function. Grazing management is a tool to balance the capture of energy by the plants, the harvest of that energy by animals, and the conversion of that energy into a product that is marketable. This is done primarily by balancing the supply of forage with the demand for that forage. Such systems help to:

- Maintain or accelerate improvement in vegetation and facilitate proper use of the forage on all grazing units.
- Improve efficiency of grazing through uniform use of all grazing units.
- Stabilize the supply of forage throughout the grazing season.
- Enhance forage quality to meet livestock and wildlife needs.
- Improve the functioning of the ecological processes.
- Improve watershed protection.
- Enhance wildlife habitat.

Many grazing systems are used in various places. Prescribed grazing is designed to fit the individual operating unit and to meet the operator's objectives and the practice specifications. Exhibit 5–6, Pre-scribed Grazing Schedule Worksheet (chapter 5, section 3) may be used in conservation planning. Other formats that contain the necessary information may also be used. The basic types of grazing management systems follow. Many others can be developed to fit specific objectives on specific lands.

- Deferred rotation
- Rest rotation
- High intensity—Low frequency

- Short duration

Deferred rotation grazing: Deferred rotation grazing generally consists of multi-pasture, multi herd systems designed to maintain or improve forage productivity. Stock density is moderate, and the length of the grazing period is longer than the deferment period. An example of a deferred grazing system would be the four pasture, three herd Merrill System. This system grazes three herds of livestock in four grazing units with one unit being deferred at all times. The number of livestock is balanced with the available forage in all four grazing units. Each grazing unit is deferred about 4 months. In this way the same grazing unit is not grazed the same time each year. This type of system will repeat itself every 4 years. Figure 5–2 is a conceptual model of a deferred rotation system.

Figure 5–2Deferred rotation system model

Year one

Mgt. unit	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1			graze	graze	graze	graze	graze	graze	graze	graze	graze	graze
2	graze	graze					graze	graze	graze	graze	graze	graze
3	graze	graze	graze	graze	graze	graze					graze	graze
4	graze	graze	graze	graze	graze	graze	graze	graze	graze	graze		

Year two

Mgt. unit	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	graze	graze					graze	graze	graze	graze	graze	graze
2	graze	graze	graze	graze	graze	graze					graze	graze
3	graze	graze	graze	graze	graze	graze	graze	graze	graze	graze		
4			graze	graze	graze	graze	graze	graze	graze	graze	graze	graze

Year three

Mgt. unit	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	graze	graze	graze	graze	graze	graze					graze	graze
2	graze	graze	graze	graze	graze	graze	graze	graze	graze	graze		
3			graze	graze	graze	graze	graze	graze	graze	graze	graze	graze
4	graze	graze					graze	graze	graze	graze	graze	graze

Year four

Mgt. unit	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	graze	graze	graze	graze	graze	graze	graze	graze	graze	graze		
2			graze	graze	graze	graze	graze	graze	graze	graze	graze	graze
3	graze	graze					graze	graze	graze	graze	graze	graze
4	graze	graze	graze	graze	graze	graze					graze	graze

(190-VI, NRPH, rev. 1, December 2003) 5

The fifth year of this type of system is the same as the first year. Note that the actual length of time grazed and deferred depends on the size of the grazing units, the size of the herd, and the weather for the year. The model in figure 5–2 assumes equal size (in terms of forage supply) for the four grazing units in the system.

4.0 CONCLUSION

In this unit we learn that pasture nutritive value can be determined using various techniques and you also learn the different grazing systems management and stocking rate of animals on range land.

5.0 SUMMARY

The nutritive value of pasture, range management systems of grazing management and determining the stocking rate of livestock on range land were discussed in this unit.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the phases of range management
2. Enumerate the techniques use in range management
3. List and discuss the systems of grazing management

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