Unit-1. Introduction

Exploitation of forest resources

↓ Animal population

↓ Feed materials

↓ Animal Nutrition

↑ Forest Exploitation

↓ Environmental condition

1. Improvement of pasture land
2. Plantation of fodder trees
3. proper range management

1.1 Definitions

Pasture:
- annual/perennial fodder / forage
- domesticated species
- more frequent cultivation
- harvested by grazing

Two types-
1. Temporary pasture-
-annual grasses
- Low carrying capacity
- grazed at 10% growth and maturity

2. **Permanent Pastures**
- Annual grasses
- grazed year to year
- High carrying capacity

Forage:

-herbaceous Plants
- Palatable
- For grazing

Fodder:

- Herbaceous Plants
- Palatable
- Cut- and -carry system

Herbage:

- Non-woody plants
- Palatable or unpalatable
- for grazing
- cut -and –carry system

Tree fodder:

- harvested with branches/ twigs

Brows:

- Twig/ leaves
- Woody perennial(Shrubs/ trees/ Vines)

Grassland:

- Herbaceous species

Two types-

1. **Natural Grassland**:

- Perennial grasses
- Few or no shrubs
-trees absent
- Determined by climate
- Low moisture available
- Just enough population
- Between deserts and forests

2. **Artificial Grassland**

- More recent in origin
- Established by destroying forests
- Cutting and Fire
- maintained by grazing
- Appears in succession
-Absence of shrubs and forests (Original)
- maintained by mowing, grazing, browsing
- Present in areas with high population

Range:

- Natural
- Uncultivated grassland
- scrublands
- forestlands

For grazing and browsing

Characteristics

- moisture stress and low rainfall area
- Not agricultural crops can grow
- High and low environmental temperature
- Degraded/ stony lands

- low soil fertility
- shorter growing season
- prevalence of rain shadow
- desert like environment situation

Rangeland:

-Native grass, Forbes, shrubs
- Sufficient quantity for grazing
- Valuable for forage supplies
-Eg. Woodlands, Natural grassland, Savannahs

Different between Rangeland and Pastureland

Rangeland	Pastureland
Natural/ uncultivated	uncultivated
Perennial grasses	Annual/Perennial grasses
Indigenous species	Exotic species
Permanent	Temporary
No frequent cultural practices	Frequent cultural practices
Highly diversified	Less diversified
Natural and open	Fence or protected

Range Science:
Dealing with sustainable use of rangelands to obtain return of the resources to meet the desire/need of the people.

Range Management:
- art and Science3 of planning and directing the use of rangelands
- To obtain sustained return based on objective of land ownership
- Considering need and desire of the society

Alternate
- Science and art of obtaining maximum livestock production
- Being consistent with the conservation of land resources.

An Integrated aspect of-
Forestry, Agronomy, Animal husbandry, Plant ecology, entomology, Veterinary science, Wildlife management, Watershed management etc.

An integrated system within
Soil-plant-animal complex
- Management of soil and plant
- Management of herd

The main objective of the Plant management:-
-To provide rest/ recovery
→ To the plants during grazing cycle
→ To build plant vigor and reserves
-To take care of palatable species for light and nutrients
- To take care of key species for excessive use
- To safeguard from soil erosion

Main objectives of Range management:-

To maintain the vegetation at the best stage in the succession for grazing animals ensuring continued vigor of the notorious and palatable species.

1.2 Range Ecosystem

Ecosystem: Interaction of the entire organism including plants/ animals with its entire physical environment.

Range Ecosystem:-

The ecosystem where plant and animal communities along with the interaction of biotic factors such as , soil, water, air, temperature, topography, solar energy, etc.

Distribution of Grazing Land:

- 24% of world vegetation
- 17% of world surface rangelands
- 10% of Farm lands

World Grazing land Classification:

Tundra Type:

- Lichen, Moss, Dwarf plants
- Wild ass, wild yak, snow bear, mountain goats
- very cold, covered mostly by snow
- polar region

Temperate Type:

-Poa, Andropogan
- Wild horse, wild ass, sheep
- Short growing season
- Low rainfall
- Part of North America, Asia, Europe

Tropical Type:

-Imperata, Penicum, Andropogan
- Zebra, Giraffe
-warm and prolong dry season
-track of leveled lands
- Vegetation, treeless or dotted patches
-Africa, Australia, South America

Desert type:-

-Cactus and thorny plants
- Very low rainfall area
- Big variation between day and night temperatures
-eg. Sahara of Africa and Australia, Gobi of PRC, Thar of India.

Nepalese Range Ecosystem:

15% of total hilly area

10% of total area of the country
1178000 hectare (High hills)
582000 Ha (Mid Hills)

Classification of Nepalese Grassland:

1) Alpine: -Above the tree line through the North region
-57% of total range land of hills
- Grass and shrubs Junipers, Rhododendron, etc.
- Low productivity
- Seasonal grazing value
- Short growing period
- Sheep, goat, cattle, yak, etc.

2**) Steppe**:
- Transhimalyan area (Dolpa , Mustang)
- Low precipitation
- 10% of total range land
- Caragana Astrogalos
- High solar radiation
- Dry chilling wind

3) Open grazing land :
-33% of total rangeland
-mostly manmade
-subtropical to cool temperature region
-high biotic pressure
-forest converted to range land
-Burning common
- Tropical/sub-tropical grass

Nepalese Feed Resources:

-Cropland-33%
-range land-30%
-Forest land-20%
-Wasteland-16%

Nepalese Land Types:

Croplands:

-Terrace,risers, bunds and fallow lands
-Crop residues, grass, weeds and leaf fodder
-33% of total feed stuffs

Rangelands:

-Alpine meadow, steppe, and open grazing lands
-30% of total feed stuffs

Forestlands:

- Leaf fodder, grasses
- -20% of total feed stuffs

Wasteland:

-Waste leaf fodders
-16% of total feed stuffs

1.3 Forage Resource of Nepal:

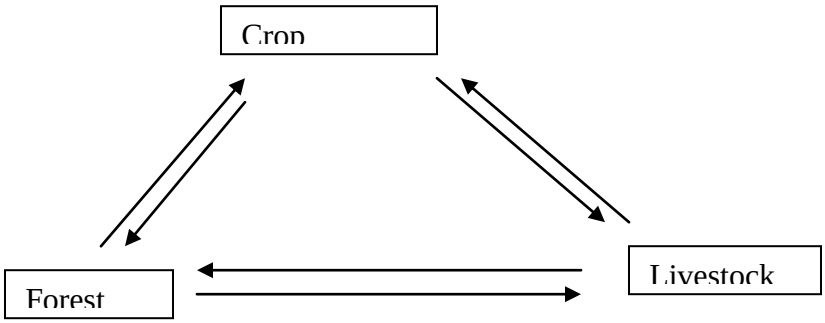
-Livestock units- 6.5 million
- Per household- 3.3 LU

- World's highest livestock population
- Very low productivity per LU
- Main problem:-Lack of feed >70%
- Sources of nutrients provided by-
  1. Straws-51%
  2. Green grass-30%
  3. Fodder tree leaves-12%
  4. Concentrates-7%

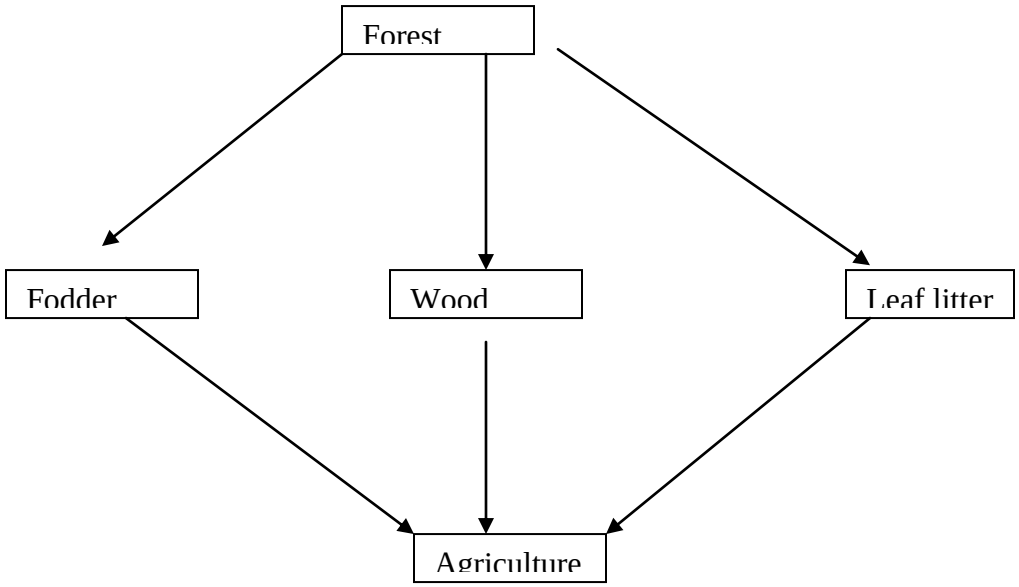
Demand and Supply of Feed:

Animal type	LU	DM	TDN	CP
Cattle	3360190	8918	5083	760
Buffaloes	2639186	6725	3832	573
Sheep	62504	122	70	10
Goats	427799	834	475	71
Total	6489679	16598	9461	1414
Feed available		15024	6639	691
Feed deficit		1574	2922	723

Forestry in Nepalese Farming System:



The transfer of Fertility:



Fodder Scarcity:

December- May/June (Winter to the onset of monsoon)
Most deficit period- March-April/May
3 ha of forest land for 1 ha of cultivated field

1.4 Important of Livestock in Nepalese Agro-ecosystem:

-Agriculture is the main stay (66%)
- Livestock's role is important in Agriculture
>2500m – Hills – 35 %(35.21)
500-2500m- Midhills - 42 %(41.67)
<500m Terai - 23% (23.11)

Hills

-Yak, Chauri, Chyangra, Baruwal
- Milk, fibre, manure, fuel
- males-Transportation and meat(Post death)
- Mules, sheep and goats – trading and transport

Midhills

- Integral part of agriculture system
- Secondary to crop cultivation
- Cattle and buffalo- source of milk, manure
- Sheep and goats- meat, fibre and draft
- Cultivation and transportation- Oxen

General Introduction

Livestock population (MOAC 2005)

Cattle- 6966436 (7 million) Buffaloes- 3952654 (4 million) Sheep- 824187 (0.8 million) Goats- 6979875 (7 million)	Ruminants
Pigs- 935076 (1 million) Poultry- 23023979 (23 million) Ducks – 405212 (0.4 million)	Non-ruminants

- Contribution of agriculture to NGDP= 38.35%
- Contribution of livestock to AGDP= 32.30%
- Contribution of Livestock to NGDP = 18.00%

In contribution of livestock,
High hills- 8.6%
Hills – 53.8%
Terai – 37.6%

Unit -2. Rangeland Ecology and Animal Behavior

2.1.1 Defoliation: Removal of leaves or any live parts including leaves.

- By grazing
- Human intervention

Effects of defoliation on:

1. Plant morphology

Removal of terminal buds

- ↑ Lateral bud growth
- | Foliage
- | Crown thickness
- ↓ hedging

2. Plant physiology

Any form affect metabolism

-Damage of photosynthetic tissue

- | CHO reserves in root system
- | Root growth
- ↓ Forage production

3. Seed production:

Heavy defoliation affects entire physiology

- | Plant vigor
- | Seed production
- | Seed size
- ↓ seed number

4. Vegetative reproduction

As a result of heavy defoliation

- | Food synthesis
- | size of rhizomes/ bulbs
- ↓ Vegetative growth (Close grazing, frequent, early grazing)

5. Root system

Severe in draught prone areas

- ↓ nutrient uptake
- ↓ Root size and spread
- ↓ water intake
- ↓ stops root growth

6. Soil condition

Causes soil deterioration

- Soil compaction ↑
- Infiltration ↓
- Surface runoff ↑
- Root development ↓
- Seed germination ↓

7. Plant condition

Deteriorates plant's condition

- Plant injuries ↑
- Sod forming grasses ↑
- Transpiration surface ↓
- Birds and wildlife diversity ↓
- susceptible to adverse temperature

Effects of Physical Environment on Defoliation:

Defoliation is affected by physical environments-

- Precipitation
- Humidity
- Temperature
- Soil and rocks
- Topography

Precipitation,

- Plant growth(More moisture available, more moisture storage)
- Moisture stress
- defoliation

Humidity,

- ↑Plant growth(more moisture available)
- Less moisture stress
- ↑water movement
- ↑ Defoliation

Temperature (Higher/ Lower),

* Metabolism
* Cell division
* Photosynthesis
* Respiration
* Reproduction

Soil and rocks,

- physical/ chemical condition changed
- Soil texture changed
- Soil fertility affected
- Soil-water aeration(Root development affected)
- ↓ Defoliation

Topography (Slopes and Aspects)

= Steep slopes (Limit plant growth)

- Swallow soil
- Less moisture available
- Less nutrients available
- ↓Water holding capacity
- ↑Infiltration
- ↓ Production
- ↓ Defoliation

= North and west aspect

- Timber and tree production
- Low radiation
- Low evaporation
- High moisture

= East and south aspect

- High radiation
- High evaporation
- Low moisture
- Draught condition
- ↓Defoliation

Frequency of Defoliation:

- Interval of time between defoliations and the no. of these occurrences.
  - Yearly
  - Monthly
  - Weekly

Intensity of Defoliation:

- Degree of herbage removal
- portion of herbage consumed or destroyed
  - By animals through grazing
  - By human beings by clipping off

There is interaction between REGROWTH INTERVAL and CUTTING HEIGHT.

Severe Defoliation:

- Ability to regrow
- May stop root growth
- Nutrient uptake
- Plant vigor
- Weeds invade the rangelands

Recommended plant heights,

Napier about 20-30 cm
Paragrass 45-55 cm
Guinea grass 15-20 cm
Signal grass 30-40 cm

2.1.2 **Plant Tolerance to Defoliation**:

Plants react to defoliation in many Ways-

Removal of live parts,

- ↑Branches and seeds
- ↓ Growth rate
- ↓Pant size

Response of defoliation varies with- **species**

Miniature species	withstands closer grazing than
Buried crown species	upright ones

3rdly Lower height, delayed floral differentiation, lesser erectness, lesser proportion of reproductive shoots, delayed shoot apex, delayed leaf replacement potentiality-**Resistant**

Dry season with heavy grazing-

- Inferior performance
- Slower recovery
- Encourage selective grazing
- Discourage the development of new runners

Grazing Resistance:

Ability of plant to survive maintaining its abundance and productivity within a plant community subjected to herbivores.

Mechanism of Resistance:

1) Avoidance mechanism:-

That reduces the probability of defoliation

- Select the plants with large no. of small tillers
- Reduced leaf number
- Reduced leaf blade area

* Reduced amount of biogass removal

* ↑No. of epical meristem

* ↑Growth after defoliation

2) Tolerance mechanism:-

That facilitates regrowth following defoliation

- Species not elevating *apical meristem*
- Species producing lower proportion of reproductive tillers

2.2 Plant Succession and Community Composition

Several factors defining types of grasslands

1) Natural factors:
   - Climate
   - Temperature
   - Relative humidity
   - Soil
   - Soil depth
   - Soil moisture
   - Soil fertility
   - Water holding capacity

Natural grassland

2) Artificial factors:
   - Precipitation
   - Tillage operation
   - Seeding
   - Fertilization
   - Plant protection

Artificial grassland

2.2.1.1 Physical factors causing stress

Stress: Climate and edaphic factors that inhibits growth/ and reproduction.

Climatic factors:-

- Humidity
- Temperature
- Precipitation

Edaphic factors:-

- Soil depth
- Soil texture
- Soil structure
- Soil moisture
- Soil fertility
- Soil water- table

Competition: Also known as Interface

When plants are grown together in a community, they affect each other, and as a result, there is a process what we call competition.

No competition occurs even if plants are together, so long

- Soil water content
- Soil nutrient level
- Amount of light

In excess to their need

Beets (1982) – Process that results from the reaction of one plant upon the –

- Physical
- Environmental
- Modified factors

Vandermeer(1989)- Process in which there is interaction between 1) Two individual plants

2)Two population of plants

Where at least one exerts a negative effect on the other.

Human and Natural Disturbances:

- Fire
- Grazing
- Land clearing
- Plant succession

Fire:-

- Principal tool for rangeland management
- Help remove undesirable plants
- Also, considered to have negative effect to environment
- Increase in fire frequency decrease in productivity especially in aired and semi-aired rangeland
- Reverse, in case of humid or in Savannahs (Tropical) wild and uncontrolled fire?
- Add tastes to the pasture grass.

Grazing:-

- Another principal tool of vegetation
- Heavy grazing weakness the pasture particularly the legumes
- Encourages weed development
- Decrease ability for plant regrowth

- Decrease photosynthesis process
- May stop root growth decrease nutrient uptake
- Weeds may invade the pasture

Land Clearing:

- Performed mainly for cultivation
- Harmful to range grasses
- Negative impact on ground coverage
- Exposes the soil
- Increase surface run-off
- decrease soil permeability
- Increase soil erosion
- Increase land slides

Useful if applied to clear unwanted grass species.

2.3.2 Plant Succession:

Change of range vegetation from earlier stage to more advanced stage.

- Progressive development of plant community
- Involvement of replacement of species
- Modification of physical environment
- Attainment of relatively stable species composition(CLIMAX)

Primary Succession:

- Originates in the primary areas such as, delta, dunes, landslide, recent land clearing areas.
- Adverse physical condition
- Absence of pioneer species
- Need of mobile plant propagates
- Suitable for successful growth.

Secondary Succession:

- Originates due to imposed disturbances
- Not natural process of succession
- Effect of animal grazing and/ human intervention
- Pioneer species are grasses and shrubs.

Two types of successions due to grazing-

1) **Retrogressive succession**:-

Succession achieved due to,

- disturbances of plant community by any causes
- modification of physical environment
- Causes of replacement of species to the earlier condition

Leading the vegetation away from climax:-

-destruction of soil

- Destruction of vegetation
- Improper grazing management, eg. Common grazing land of Nepal.

2) **Progressive Succes**sion:-

- Succession leading the vegetation back to the climax.
- Can happen if the rangelands are not much disturbed, eg. Distribution of soil through over grazing.

Edaphic Factors:

- basic factor of ecosystem
- Major ecological factors
- Interaction between plants and soil

Significant change in ecosystem is reflected if any cultural practice is imposed.

Influence of Soil:

- Critical factor for plant community eg. texture, fertility, water, etc.(Govern root growth)
- Soil water and aeration (Ability of root to support plant).

Effects of Humus:

-Mainly from decayed roots

- Very small amounts from exposed parts
-Increase by annual grasses (Being more fibrous roots)

Effect of Leaching:

-Important factor for plant growth
-Humid with open ground Decrease leaching
-lesser loss of chemical nutrients
-Increase Plant growth (Tropical Zone)

Soil Fertility:

Ability of soil to provide –

- Sufficient nutrients
- In available form

Nutrients are grouped into two-

1) Macro/Major nutrients:- Plant community requires them larger amounts of Nitrite, Phosphate, Calcium, Potassium, Mg.
2) Micro/minor Nutrients: - Their requirement to the plant community in relatively smaller amount of Copper, Cobalt, Zinc, Manganese.

- Nutrients must be in adequate amounts to ensure optimum plant growth.
- Deficiencies may limit or inhibit plant growth and there by productivity.
- In excess supply may be toxic to the plant community
- Aired soils have higher salts and are harmful
- Rangelands are low in N, P, and K. Most are rich in P and K but not in available from(Insoluble form)
- Dry soils have lower P and K than the wet ones:-

= Reduced plant size

=Legumes are more vulnerable-good for N-deficient area.

2.4. Grazing Behaviors of Livestock and wildlife :

Cattle:

- Less severe in pasture
- Less selective
- Brows edible shrubs following its path
- Eat mainly grasses

Sheep:

-closer grasser
-Graze tall grasses
-Select much nutritious

Horse:

- Selective grazer
- Graze close to ground
- Ignore the brows

Goat:

-Mainly brows

Camel:

-Usually brows
-Generally coarse grasses and twigs

Zebra:

-Upper part of the grass
-Selective grazer

Buffalo:

- Mostly tall grasses
- Ignore the brows

Elephant:

- Clumps and grasses
- Bark and branches of trees

For the best and optimum utilization of vegetation, grazing practices with mixed herd is practical. Bush invading the area-Cattle and Goat combination.

Unit -3. Range Inventory

-Making systematic record of something's / activities is Inventory.

- Making systematic list of different parameters of a range is a Range Inventory.

Purpose of Range Inventory:

- Collect data systematically
- Evaluate it scientifically
- produce a practicable and workable

Range Management plan under improved management system.

Inclusion of Range Inventory:

- Classification of range
- Mapping of range vegetation type
- Over all range condition
- Range suitability
- Range improvement process
- Prevailing range condition
- Vegetation trend –production and utilization
- Readiness of the range
- Season of range use

Range Analysis:

-Critical study of range classes in individual form

- Each parameter is studied one by one.

Objective of Range Analysis:

Objectively, it is carried out to determine,

- The areas suitable for grazing
- Range condition-trend and vegetation type
- Proper utilization of standards
- Initial stocking plan under present condition
- improvement of existing condition
- Prioritize additional need for improvement
- desired grazing management plan
- Grazing capacity under the aforementioned management plan.

Species Listing:

Process of identification and listing of all the available species of grass, grass-like plants, forbs , shrubs including trees.

Inclusion of Species Listing:

- Survey of the area
- Collection of all the vegetation species
- Identification of all the plant Species

Species listing is carried out in a specialized format:

- Local name
- English name
- Scientific name
- Symbol/ code

Species Classification:

- Performed after species listing
- Based on preference of animals

Classes:-

1) Desirable species
2) Intermediate species
3) Least desirable species
4) Undesirable species

SN	Classes	English Name	Local Name	Scientific Name	Code
1	Desirable species				
2	Intermediate species				
3	Least desirable species				
4	Undesirable species				

Requirements of Classification

1) Local condition
2) 2) Local experience

Some species :- Area specific, Not recognized, Not identified= Brought to the specialists.

SN	Grouped Type	Abbreviation
1	Grass species	GS
2	Brows species	BS
3	Forbes species	FS
4	Grass-like species	GLS

General Observation

- The general condition of vegetation species is observed

- All the parameters of vegetation analysis is performed
- Subjective study and so may vary from range manager to manager
- Requires a lot of experience

Cover

Vertical position of the crown, shoot or the basal area of a species to the ground surface. Expressed in -

- Fraction
- Percentage
- An estimate of biomass
- An indicative of degree of domination of a particular species in the community
- Great ecological importance in determination of plant distribution

Cover at the ground level - BASAL AREA

1. Visual Estimation
   - Estimation of cover
   - Through guess-work
   - Based on experience
   - Subjective method
   - Performed in several quadrants

Eg. Sp_1 - 5%
Sp_2 - 7% 22% (1) Occular Estimation
Sp_3 - 10%
(100 - 22) = 78% (Bare ground / undesired sp.)

Plot size

Circular plots – 0.12 to 100 sq.ft.
Rectangular – 2.00 to 6.00 sq.ft.

- Circular is better than square
- Square is better than rectangular

2. Point Method
   - Point Hit Frame Method
   - Point Analysis Method

Consists of –

1. A metallic frame
2. Slidding pins at equal intervals
3. Cross bars set in vertical positions

Length of the pin

Few inches – a foot
Depends upon type of vegetation

The ratio of total hits on a particular species to the total no. of pins lowered → Percent Cover of a particular species.

Procedure

Occular survey → Species identification → Random

Frame Setting → Pull up the pins → Lower the pins → Record the hits

$$\%\,\text{Cover} = \frac{\text{Mean of all the hits}}{\text{Total no. of pins lowered}} \times 100$$

Drawbacks

- Broad leaf plants have more hits
- Blunt pins over-estimates
- Wind velocity biasness

3. Line Interception Method
   - Linear Intercept Method

   Consists of –
   = A metallic tape of 100 meter length
   - The recording the horizontal linear measurements of plants along a line.
   - Plant foliage intercepted along the line and the total intercepts of the plant species along the line → % cover of a plant species.

Procedure

- Survey the sample area
- Identify the plant species
- Draw the transacts randomly
- Stretch the metallic tape at a uniform height
- Record the interception of plant foliage

$$\%\,\text{Cover} = \frac{\text{Distance intercepted}}{\text{Total length}} \times 100$$

Density

No. of individual plant species in a unit area.

Expressed in –

1. Fraction
2. Percentage
   - More precise than estimate
   - Little or almost no estimate
   - Actual count of plant species

Sample area –

$2.5 \times 2.5\ m^2$ depending upon veg^n type

Frequency

No. of occurances of a species in a given no. of plot.

Expressed in –

1. Fraction
2. Percentage

- Good indicator of spatial distribution of a species over a particular area

Grazing capacity
The number of animal that can graze each year on a given area for specific number of days without inducing a downward trend of forage prod^{n} in terms of quality of both forage and soil.
Limiting factors –

- Quantity of vegetation
- Seasonal availability

Carrying capacity
The maximum number of individual animal that can survive the greatest period of stress each year on a given land area.

Alternatively,

The total weight of animals that can be supported in a given range permanently depending upon the range condition.

Carrying capacity includes more than the number of animals that can survive without damaging the range condition.

Animal unit

- Also known as livestock unit
- Abbreviated as au or Lu

A mature cow with its calf and 1000 lbs body weight.

Converting on this basis –

Cow	-	1 au / Lu
Horse	-	1.25 au / Lu
Goat	-	0.17 au / Lu
Sheep	-	0.20 au / Lu

Animal Unit Month (aum)
Amount of forage required by an animal unit for a month of grazing.

Stocking Rate:

Actual number of animals or animal units that can support per unit area of land for a specific period of time usually for a grazing season.

Garaging Pressure: relationship between demand for forage and the combination of daily herbage increment and vegetation standing.

Determination of Carrying Capacity:

Requirements of Determination-

1.Available biomass

2. Requirement of grazing stalk

3. Vegetation for regeneration

Procedure:

- Access and list of the species likely to be grazed
- Find the percent composition of species of total
- Multiply each species composition by its use factor to get actual forage available for grazing
- Sum up the forage avaivality of all the species to get the weighted use factor for all the species
- Multiply this by the density of the cover type to get the forage index/ forage acrage factor
- Multiply this by surface area of the range to get the total fodder acrage available

Carrying Capacity:

CC=Total forage production in the RL/ Forage acre requirement/year

Limitation of CC Concept:

- Not suitable when the type of animal, its distribution and the season to use not obvious
- Likely to be under utilized when based on the production of the lowest production year
- Likely to be over utilized when based on the production of the highest production year
- Based on the optimum stocking rate in the deficit season of the year, not good in flush season

(It *is usually adjusted to avoid over-utilization of forage resources except in extreme condition*).

3.5 Range Condition Classification (RCC):

Range condition is the comparison of the current year's forage production with that of the previous year.

Range condition classification of a range-land is the potentiality of a particular area that is capable of producing forage.

The condition classification is the state of the health of a rangeland based on what it is naturally capable of producing forage.

Factors deteriorating RCC:

*****Early grazing
* Over grazing
* Selective grazing
* Climatic variability
* Invasion of undesirable species

Criteria of RCC:

1) Soil type:

- Depth of soil
- Soil erosion
- Soil moisture
- Moisture retention capability
- Soil texture
- Soil structure

2) Vegetation Composition:

- Vegetation species
- Age, Density and vigor
- Litter formation
- Status of regeneration
- Reproducing capability

3) Forage Value:

- Nutritive value
- Forage palatability
- Forage productivity

Methods of RCC:

1. Based on plant succession:

Stage	% Climax species	Condition
Climax	76-100	Excellent
Initial stage	51-75	Good
Advance stage	21-50	Fair
Weed stage	0-20	Poor

2. Based on species composition:

Parameters	Stage

Most desirable Most palatable First selection	1st
Vegetation grazed heavily Very frequent grazing Very close grazing	2nd
Less vigorous plants Less seed production Plant disappearance	3rd
Less desirable Less palatable Occupy major area	4th
Low quality plants Grazed heavily Scarcity of forage resource	5th
Least desirable plants Not palatable Occupy more land area	6th

3. USDA forest service method:

Vegetation type	% Composition	Range condition
Decreasors	60-90	Excellent
Increasors	10-20	
Invadors	0-20	
Decreasors	50	Good
Increasors	25	
Invadors	25	
Decreasors	25	Fair
Increasors	35	
Invadors	40	
Decreasors	5	Poor
Increasors	25	
Invadors	>70	

RCC of Nepal:

Palatable grass, herbs, forbes and browse	75-100	Excellent
Above species in less amounts	50-75	Good
Above species in lesser amounts	25-50	Fair
Above species in very less amounts	0-25	Poor

3.5.3 Condition Trend Analysis:

1. Nutritive value of forage with growth and maturity
2. Nutritive value of forage is proportional to age of the crop
3. Protein content is higher during early growth period when green and rapidly growing
4. Increasing maturity causes decrease in protein
5. Biomass increases in later stages
6. higher nutritive value and palatability at mid of maturity

- Biomass is optimum
- advisable to be fed
- Maximum benefit

7. Increase maturity, decrease phosphorus content and increase carbohydrate content
8. Mature grass, more fibre and less palatable and decrease vitamin content

Unit-4 Range Improvement

It is a special treatment and the method to increase the range forage to facilitate forage use.

Direct method-

- By range seeding
- Cultural operation(Weeding, hoeing)
- Continuing undesirable species
- Applying fertilizer
- Irrigating the Range land
- Pitting/ Furrowing

Indirect method-

- Improving water availability
- Improving fences
- Improving trails
- Grazing management
- Effective utilization

Improvement is based on-

- Ecological principles(Competition/Succession)
- Increase of desirable species
- Decrease undesirable species
- Inducing succession(Biologically and herb controlling)

Manipulating of Vegetation with grazing Animals:-

Different animals have different grazing behavior and different dietary preferences. Thus, vegetation of Rangeland can be manipulated but needs careful utilization of rangeland resources.

Forage Preference of Grazing Animals:

Animals	High	Medium	Low
Cattle/Buff.	Ground grass	Forbes/Shrubs	-
Sheep	Forbes/Shrubs	Lower proximity	-
Goat	Shrubs/Browse	Forbes	-
Deer	Shrubs/Browse	Forbes	Grass
Horse	Close grass	Forbes	Grass

Requisites of Manipulation:

- Right combination of animals
- Right season of grazing
- Right system of grazing
- Appropriate stocking rate
- Intensity of grazing

Best way to combine different types of animals for proper utilization of Rangeland.

For example- Cattle/Buff. - To increase grass- to decrease Shrubs/ Forbes
Goat- Decrease Grass- to increase shrubs/forbes.

Right Combination:

For pasture with grass, forbes and shrubs, Cattle/buffaloes and goats is the best combination.

Reasons for Manipulating Vegetation:-

- Improve range condition
- Utilization of range resources uniformly
- Reduction of noxious hazards
- Suppression of undesirable species

Grazing:-

It is defined as the partial defoliation of rangeland plants of course, by the animal in course of grazing.

Animal's production depends upon-

- Quality and quantity of herbages
- type and physiological condition
- Climatic condition
- Management practices
- Management skill of the manager

Unit- 5. Grazing Management

Wise and skillful manipulation of two basic biological elements, the pasture and the grazing animals.

Factors controlled by the manager-

- Choice of species
- Manipulating agronomic practices
- Selection of livestock species
- Use of supplying feeding
- Choice of system of grazing.

Grazing System:

System based on the principle of scientific management of grazuing land to improve the grazing resources and ensure sustainable yield of goods/sevices from the grazing land.

Aim:-

- To meet forage demand
- Efficient use of forage resources
- To maintain high quality in greater amount
- To maintain high animal productivity

Objectives:-

- To restore vigor of vegetation
- To allow plants to produce seeds
- To attain uniform utilization
- To maintain animal production
- To maintain ecological stability

Major Grazing System:-

1. Continuous Grazing
2. Rotational Grazing
3. Deferred Grazing
4. Deferred –Rotational Grazing
5. Strip Grazing
6. Alternate grazing

1. Continuous Grazing: - Extensive system of grazing in which the stocks are grazed in the same grazing area over a prolonged period of time.

- long time use of rangeland
- High stocking rate
- Pasture deterioration (Soil)

2. Rotational Grazing:- Intensive system of grazing in which stocks are grazed in different area moving from one part to another in rotation.

- Useful when grasses are young and nutritious
- Allows adequate recovery production
- vegetation have chance to regrow well
- Continuously available to the stock
- Persistency and productivity better

- Soil erosion reduced
- Stocking rate increased
- Better condition of animals

3. Deferred Grazing:
   Delayed grazing until the key species set seeds or rhizomes for further reproduction.

- Good for degraded pastures
- Plants are allowed to mature before grazing
- Plant vigor is built up
- Root system allowed to develop
- self sown and established

4. Deferred-rotational Grazing:-
   Similar to deferred grazing but grazing is practiced in a rotational manner.
   Land is divided into 3 Compartments. Each of them is grazed while others are deferred successively for one or more years.

- Chance to regrow and reproduce
- Seedlings established well

5. Strip Grazing:
   An intensive form of rotational grazing system.

- A movable electric fence
- Replaced across the grazing paddock
- Moved forward once/twice daily
- Good for high producing dairy herd
- Good method for nutritious and productive pasture land.

6. Alternate grazing:

4.1.2 Fire as a Management Tool:

- In general, fire and grazing are two principle tools of vegetation management
- Role of fire is controversial.
- Remove undesirable plants
- Increase fire frequency, decrease productivity(Arid and semi-arid areas)
- Reverse in humid and tropical savannah
- Wild and uncontrolled fire, devasting(Perinial vagetation)
- Environment problems
- Restricted by many contries
- changes soil moisture, temperarature, organic matters, micro-organisms.
- Changes vegetation from woody to shrubs and grasses
- Changes soil PH
- Natural system
- Changes eco-system
- Increase transpiration and evaporation
- Increase run-off and erosion
- Decrease biodiversity in an area

4.1.3 Weed Control With:-

Control means keeping the undesirable species to the density to minimige the interferences with the production and utilization of range land forage.

Aim:-

- To control than eradication
- To increase productivity of forage

Means of control:-

- Chemical means
- Mechanical means

Herbicide:

Herb= Vegetation and cide means =Killer

Advantages:-

- Can be used where mechanical means are not workable
- Enable to control weeds rapidly
- Can destroy to the root level
- Can clear the area for longer time
- Cheaper way of control

Disadvantages:-

- Health hazards
- Pollution of water, soil, air
- May affect the following crops
- Toxic to the animal life

Classification:

Contact Herbicide: Kills the plant parts coming in contact

Translocated: Sprade all over plant parts

Selective: Kills only particular species

Non-selective: Kills all the plants that come in contact

Soil sterilant: Kills plants through soil

Timing of Use:

- Prior to or during flowering(Annual)
- At the peak re-growth level(Perennials)
- In the morning of the day
- Not in the monsoon period
- Minimization in its use

Range Fertilization:

- To increase forage yield
- To maintain plant vigor
- To enhance palatability
- To establish quicker even in harsh condition
- To maintain soil fertility

Types of Fertilizer:

1. Nitrogenous Fertilizers:- Examples,
    - Ammonium nitrite
    - Ammonium Phosphate
    - Ammonium Sulphate
    - Urea
2. Phosphorous Fertilizers:- Examples,
    - Calcium Phosphate
    - Calcium Metaphosphate
    - Super Phosphate- Single, double and triple.
3. Potassic Fertilizers:- Examples,
    - Potassium sulphate
    - Potassium Chloride
4. Sulphate Fertilizers:- Examples,
    - Calcium Sulphate
    - Magnesium Sulphate

Commonly Available Fertilizers:

Name of Fertilizers	Nutrient Content (%)			
	N	P	K	S
Ammonium Sulphate	21	-	-	20-25
Complexal	20	20	-	-
Complete fertilizer	19	19	10	-
DAP	18	46	-	-
SSP	-	16	-	-
DSP	-	32	-	-
TSP	-	48	-	-
Murate of Potas (K)	-	-	60	-

Urea has only one nitrogen fertilizer having at test double (46%) the amount of nitrogen than others.

Range Irrigation:

- Method of range development
- Less animal concentration required
- Increase animals cause negative(-ve) impact

Range Seeding:

- Method of rangeland development and rehabilitation
- Good in inadequate regeneration
- Disappearance of particular vegetation species
- Quick and instant development of Rangeland
- Protect soil from erosion and water run-off

Factors affecting Range seeding:

Following are the factors that affect range seeding-

- Site of Rangeland
- Climatic condition

- Financial Viability
- Time availability

Site Selection for Range Seeding:

- Slopes of the roadsides
- River banks
- Water ways
- Critical erosion area
- Natural land area
- High potentiality area
- enough soil for root system
- medium textured soil
- medium water holding capacity
- Forest degraded lands
- Shrub lands
- Low quality farm lands
- Over grazed land
- watershed area
- Desirable vegetation area

Seed Treatment:

- Inoculation with specific rhizobium culture for legumes sown first time
- Soaking in water for 24 hours in hard coated seeds
- Maxing with soil or sand or manure in small sized seeds
- Hot water or acid treatment in some cases
- Mechanical scarification

Species selection:

- Managemental
- Inherental

Managemental:-

- Purpose and objective
- Seed avaibality
- Requisite and preference of animal
- Local demand
- Suitable climatic condition
- Appropriate topography
- Mono/mixed culture

Inherental:-

- Nitrogen fixing as legume
- Resistant to adverse condition as cold and draught
- Easily establishable
- High producing indigeneous and native
- Aggressive and naturally spreading
- palatable in nature
- Preferably perennial species

Seed-bed Preparation:

Depends upon,

- Type and amount of vegetation
- Nature and scale of erosion
- Degree of slope of the land
- Condition of land (Stoniness)
- Depth and texture of soil
- Accessibility
- Cost involvement

Method of seed-bed Preparation:

1. Mechanical Method-
    - Uses machines and tools
    - Needs flat lands
    - Should have no chance of erosion
    - Mechanical equipments useable sites
2. **Preparatory Method-**
    - Ploughing followed by planting
    - Reduce soil erosion, evaporation and weed growth
3. **Controlled burning-**
    - Practical method of seed bed preparation
    - Direct burning keeping under control
    - Makes the soil firm and suitable for plant growth

In Nepalese condition, manual method by using agro-tools, simultaneous practice of soil and water conservation. Principle of minimum tillage is better-

- Planting/sowing in strip/patches
- Direct sowing with out seed bed preparation
- Smaller seeds on finer seed bed at shallower depth.

Seeding Method: Broadcasting and transplanting in Rangeland in Nepal, broadcasting is more practical.

Selection of plant Species:

- Resistant to draught and cold
- Easy to establish and aggressive
- Palatable and perennial
- Prolonged survival

Potential Vegetations Of Nepal:

- White clover introduced in Kathmandu in 1940's during the Rana regime for landscaping
- FAO contributed in this area
- In Rasuwa, Lucerne, Cock's foot, Perinnial Rye Grass, Festuca, Agrostis, Phleum (Imported from Newzealand and Switzerland).
- In 1960 at Pokhara, research on sub-tropical app. Pennistum, Penicum, Brachiaria, Chloris, Cenchrus, Stylo
- Tested in Jumla, Rasuwa, Solu, Bandipur and Khumaltar.
- During mid-eighties, HPFRN and HAPDP contributed at higher altitudes
- Most cultivars from NZ., Australia, Switzerland, Holland, Germany , Belzium, USA and India.
- FLDP and SLDP popularized Berseem, Oat, Stylo, Kudzu, Desmodium(Terai and hills)

Performance in Rangeland:

- Cock's foot, Perennial Rye Grass and White clover are over sown
- Range land failed to establish due to lack of proper management, moisture, severe cold, weed composition and over grazing.
- White clover almost like weed in Kathmandu and Rasuwa.
- Inoculating, Pelleting legume seeds with minimum tillage found better.

5.1 Indigenous Herding System of Nepal:

Govern by the factors-

- Cropping intensity
- Availability of vegetation
- Proximity of forest species
- Animal species
- Productive stage
- Labor availability
- Animal population
- Farming system

Common Herding system: Three common systems-

1. Transhumance herding system:-
    - In high Himalayan region
    - Herd migrates from one place to another place through out the year
    - Utilizes forage resources from alpine pasture(Monsoon)
    - Utilizes crop residue of fallow land (Winter)
    - During migration, upward/ downward under growth of the forest
    - Yak, Sheep, Goat and Cattle, Sometimes, Buffalo too.
2. Sedentary Herding system:-
    - Livestock travels daily in the morning and returns in the evening
    - During summer scrubland/ community grazing areas
    - Working males, dry herd, and cattle sometimes, goat and sheep
3. Stall feeding:-
    - In the area with intensive cultivation
    - abundant availability of crop residue
    - Tree leaves and other grasses and weeds
    - people remains busy for most time
    - most of high value animals(milking and exotic and crossbreeds)

5.2.4 Constraints of Herding Systems:

Excessive Population on limited Natural Resources-

- Livestock, integral part of farming system
- Demands considerable labour inputs
- Return is minimal
- Sustaining crop productivity
- Substantial source of livelihood
- challenging environment
- Expected until other alternatives

Severe Forage Deficit:

- Scarcity of forage and fodders
- major constraint in winter and early summer
- Additional demand to heat loss in addition to maintenance and production.
- 9.48% DM, 30.88% TDN and 51.13% CP

Diseases and their Effect:

- High incidence of diseases and parasites
- mal and under nutrition
- Reduced productivity
- Many are endemic to Nepal
- Many yet to be diagnosed

High labor Inputs and Minimum Return:

- High labour involved for farming
- In sedentary and stall feeding, 80.3-Men; 208.0-women; and 106.6-Children days per annum
- 7.73 heads/HH
- 7.50 hours/ day of all categories
- minimal return- return Rs. 1862, Against Rs. 1373(1:1.36)

Poor Potential of Individual animals:

- Very low milk production of cattle/ buffalo
- Increase calving interval
- Late puberty and sexual maturity
- Native goats-better producers(Exotic)
- Sheep-poor wool producer

Poor marketing system:

- No organized market
- No realized remunerative price
- Few hat-bazaars
- Direct vending system
- Markets controlled by middlemen
- No specialized industries
- Forced to maintain unproductive animal
- DDC collects only 2% of total milk volume
- Concentration at peri-urban areas

5.1.2 Transhumance Sheep Herding System:

- In hills and high hills of Nepal
- Animals-moved to different areas
- Based entirely on grazing
- 7-8 gms NaCl supplemented/day/ha
- Migrates from lower hills to alpine
- Oldest form of herding system
- Two or more shepherds with a dog
- All animals –not of one HH
- Shepherd may be owner or hired
- Sheep and goats run together

- Goat takes the leading role
- Eg. Sheep- Baruwal, Bhyanglung, Kage, Lampuchhre and Goat- Sinhal, Chyangra, Khari, Terai.

Rotation System:

- This is also accomplished as the one implied in the range land grazing system.
- Here, patch of hills of larger area is considered under rotation.

5.2. Socio-economic Factor Influencing Livestock Herd:

- Socio-economic situation on geographical region on high hills
- Ethnic group- Yak, Hybrids, mules, Horses and sheep
- Integral part of life style
- Animals, as pack animals too,

♥Ethnic specialization more prominent in hilly regions
♥Women as decision maker in livestock farming
♥Men as in official matters at community level

Unit – 6. Forage Management in the Context of Community Forestry

Forage Resource Development in Community Forestry:-

- Nearly 66% of population involved in agriculture

- Traditional farming system
- Intensive labor
- Complex in nature
- Livestock, Agriculture and forestry interdependent
- 0.5 ha, average land holding/hh
- Hardly meet the basic demand of food
- deteriorating situation
- continuous reduction in land holding size
- Shortage of traditional litter (forest and animals)
- Declined crop yield
- reduced off-farm earning
- Reduction labor wages
- poors are more dependent on forest- fodder, litter, fuel wood, timber, medicinal plants and herbs.

Consequence:

- Increased soil loss
- Increased surface run-off
- 40-200 mt/ha/ annum in midhills
- degradation of local farming system
- Sustainability based on forest

Over 3 decades,

- Increased human population
- Enhancing animal population
- Forage shortage limits the manure
- reduced volume of livestock products

Consequently,

- Reduction in forest area- 6.5 million ha in sixties, 5.5 m ha in nineties
- Decreased primary and traditional feed resources
- conversion of forest into arable lands
    - To support increase human population
    - to support increase animal population
    - Resettle the landless people
    - Exporting timber to India
    - Shifting cultivation
    - Development projects (Roads, Canals, Electricity transmission lines etc.)

In present situation, 50% of total fodder required derived from forests. Fodder development can not be dealt in isolation:-

- Integrated agri-silvo-pasture
- Arable and non-arable lands
- Users involvement- responsibility and accountability.
- Public and private sector(Sustainable rehabilitation, management and development)
- Poorest hh in the community

Forest-Based Forage Development:

Community Forestry- indirectly supports in livestock development through,

- supply of bedding materials

- fodder tree resources
- Indigenous natural grasses
- No attempt to use under storey

Leasehold Forestry- increased fodder output for the livestock,

- 22 districts
- Grasses-32 %(20% Stylo, 10% Molasses and 2 % Napier? Amriso)
- Fodder development, major thrust.
- Approx. 1 ha land/ hh in Leasehold forest
- Managed collectively/ individually group of 10-15 members.

Forage and Pasture Intervention in Community Forestry:

- Protection from grazing to facilitate natural regeneration of-
  - Indigenous species
  - Naturalized exotic species
  - Other pasture species

Strategic use of Fodder and Pasture species:

- Exotic species planned to enrich local flora
- Native grass- shorter period of growth
- To be improved by crossing
- More palatable specie3s affected by overuse
- Species regenerating higher level of fertility
- Encouraged the draught and cold resistant species
- Disease resistant species
- Mixed vegetation management
- Good for warm climate- Stylo(*Stylosanthes guinensis*), Molasses(*Melimins minutiflora*), and For cold- White clover(*Trifolium repens*), Cock's foot(*Dactylis glomerata*), Rye grass(*Lolium perenne*).

Multipurpose Fodder Tree Plantation:-

- MPFT of legume to be established(N2 Fixation)
- 400 tree/ ha + pasture species
- Initial stage critical for both
- New fodder tree in place of unpalatable ones in common forest
- Broom grass, Bamboo, Nigalo should be established:-
  - Fodder in scarcity period
  - Raw materials for cottage industries
  - Sources of rural income
  - Environment protection
  - Check soil erosion
  - No competion with existing farming and forest system

6.3 Multiple Use of forest grazing land:-

Management of grazing land for variety of purposes-

- Forage production
- Wildlife management
- Fuel wood production
- Timber production
- Litter production
- Medicinal herb production
- Eco-tourism

Fodder Production from Grazing Land:

- Supports both- Wildlife and Domestic animals
- Should base on – Over storey and under storey
- Criteria for species selection-
  - Well recovering
  - longer producing
  - Compatible with tree
  - Soil stabilizing
  - Shade tolerant

Fuelwood and timber Production:

- Utilizes nutrients from sub-soil
- Brings nutrients for companion crops
- Should exploit more minerals
- Deep rooting spp. pumps them up
- Establishment of shrubs and tree species
- Fast growing forage spp. on sub-soil
- No excessive removal of biomass
- Pumping up is important for P
- Plants to some extent good without P
- No storing of P
- Fertilization of agricultural and rangelands
- Supply of minerals to the stocks is better

Therefore, the additional characteristics,

- Compatible with grass
- Deep rooted
- Light shading

Litter Production:

- Integral part of Nepalese farming system
- 50% litter is removed
- Manure production depends upon-
  - Stall feeding
  - No. of livestock
  - Amount of forest biomass
- Expected to be used more where application of fertilizer is different.

Criteria for Species Selection:

- Compatibility
- High producing species
- Early and easily decomposable
- No adverse effect on land (Eg. Acid of pine needle)
- The practice of collection affects the nutrient cycle,

Unit-7. Forage Management Context of Farming System

Established forage development programme in Nepal.
example- winter annuals- Oats/ Berseem
Cut-and-carry- stylo/ Molasses
Leucanea cultivation- common

- wide range of genetic matter to be introduced
- Strategy and spp to be country refined and prioritized
- Wide range of strategies and genetic material may be crucial
- community participation for evaluation and modification
- Initial emphasis on the area,
  - Rapid
  - Successful
  - Continuous development
- Strategy should base on,
  - Leguminous spp.
  - Livestock nutrition
  - Stabilizing cropping
- Species recommendation should base on,
  - Local experiences
  - Availability of new genetic
  - Adapted to low soil fertility
- In cut- and – carry system,
  - Addition of organic matter and chemical fertilizer

In case of perennial species,

- To establish at the beginning of wet season
- Plants get well established
- seeds is produced before the onset of winter.

Use of mixture:

- Reduce the risk of failure
- More even production throughout year
- Expose farmers to alternatives

Productivity of land Proportion to livestock and farming system.
Forage yield decrease- Carrying capacity decrease- Productivity decrease.

7.1 Terrace and Bund Improvement:

- Constitutes nearly 24% community hilly land
- Collection of grass / herbs traditional

- Properly management- winter scarce feeding
- Reduction grazing pressure on forest
- Slicing the bunds- Discouraging weeds and rodents/ insects
- No slicing of bunds in some cases- Important winter grasses and Amriso, themeda etc.

Purposes-

- To increase fertility of soil
- To increase forage biomass
- Decrease soil erosion

Characteristics of Bund and terrace grasses-

- Frost resistant
- Draught resistant
- Perennial type
- Easy propagatory
- Competitive to local species

Mixture is better-

- Seteria and Desmodium
- Amriso and Desmodium
- Seteria and Stylo grass

7.2 Utilization of Non-agri Inclusions:

- Lands with low soil fertility
- Harsh conditioned lands
- Stoney, dry, degraded, eroded lands
- Waste lands, Kharbari, Gullies.

Good for-

- Grass production
- Checking erosion
- Soil nutrient improvement
- Forage increment for dry/ winter

Species Selection Criteria-

- Legume and Non- legume
- Shrubs and fodder tree

Species Characteristics:

- Suitable to degraded and poor soils
- Suitable to dry and harsh condition
- Ability to improve soil condition
- Frost and draught resistant
- Soil stability capacity

7.3 Improved Management of Fodder Tree:

- Use of fodder leaves, tradition in Hills
- Comes from farmlands or forest
- Planted on marginal lands
- 15% TDN of total requirement(0.3 million tons in hills)
- > 130 spp. in Nepal.

Advantages-:-

- Natural preservation in trees for long

- Acceptance to animal in dry/ shortage period
- Grown and harvested in varied climates
- Combining with different spp. to get biomass through year
- Grown in the area not suitable for other crop
- Familiar management practices to the farmers

Disadvantages:-

- Late producer
- contains anti-nutritive factors
- Fodder available once or twice/year
- Shading effect on crops
- Production low/ unit area
- single or twice harvesting only

Improvement Options:-

- Planting only selected nutrients species
- More focus on legume spp
- Spp response to multi- harvesting
- Spp that can be hedgerows
- Utilizable by mixing other low quality feed products(Straw).

7.4 Improvement of Crop By Products/ Residue:

- Play important role in feed resource supply
- More important in Nepalese context
- derived from,
    - Cereals straws
    - Pulse residue
    - Sugarcane stalks
    - Excess stuffs from the garden
    - Kitchen wastes
- rice straw- 57.3%, Maize straw-23.4%, Wheat straw-15.6%, Millet straw-3.1%, Barley straw-0.6%= *Inferior feed stuffs increase fibre and decrease protein.*

In the condition of forage deficit,

- Decrease livestock or,
- Increase feed supply

Feed stuff should contain,

- CHO's, Protein, Fat, Vitamins, Minerals, water= Optimum amount.

Supply depends upon the condition of stocks:-

1. Producing animals need extra- milking females, Working males, Breeding males.
2. Pregnant females need additional
    - To maintain her own body condition
    - To build tissues and bones of the calf
3. Young he-and she –calves
    - To manufacture bones and tissues
    - To enhance the immune system

Improvement can be accomplished by,

i) Urea treatment

ii) Ammonia treatment
iii) Stover ensiling
iv) Urine treatment

4. Sick animals need extra support
   - To recoup the affected tissues
   - To back-up the immunity
   - treatment means increase proteins
   - Supplement with high quality forage
   - High quality concentrates

Problems,
- Lack of technology know-how
- Cost factor
- Limited response of animal

7.5 Concentrate Feeding:

- Supplied during forage deficit
- In stressed condition
- Contains high protein

In the form of Cakes and pillets-

Sources,

- Corn, Wheat, Barley, Oats
- Cotton seed, Soyabean, Til, Mustard cakes
- Beans, pear, gram pillets

Concentrates Feeding period-

Winter- Green fodder scarcity
Summer- in case of inaccessibility

Concentrate may be added with,

- Salt
- Bone meals
- Mineral mixture

7.6 Forage Conservation:

- Green forage, not available throughout the year but needed for proper growth, maintenance and good production.
- Mostly supplied in post monsoon period and deficit during dry/ winter season.
- Conservation of surplus forage for dry period supply in the form of Silage and Hay.

Silage Production:-

- Fermented forage crops
- Anaerobic condition
- Can be stored for more than one year
- quality depend upon- time of harvesting, type of forage and storage condition.

Advantages-

- Can be stored without reduction the quality

- Less storage space required
- No problem of weed control

Type of Silage-

i) Pit silage- it is common in Nepal and should be narrow at botton and wide at the top
ii) Tower Silage
iii) Bag Silage

Type of grasses-

- Any forage can be ensiled
- Should have 60-65% moisture condition
- Gramineae family grasses are good
- Liguminaceae is also possible
- Mixture of both is the best

Method of Ensiling-

- Reduce the moisture condition to 60-65%
- Chop the crop to 2-2.5 inch
- Spread plastic sheet at the bottom
- Place the chopped forage and compact
- Upto 1 foot above the ground
- Cover with plastic and plaster with mud.

Temperature reaches upto 30-38 degree centigrade, Not to allow H2O and air into the pit.

Good Quality Silage:

- Soft, smelling like curd, green or dark green/ brown
- PH -4.1, Lactic acid-8.5%, Acetic acid-2.5%, Butyric acid-0.0%, Ammonium Nitrate-1.9%.
- Ready after 3 month
- Start from one part and cover after use
- Animal may not like it
- Slow adjustment is required