Class 13: Requirement and importance of green fodder, carrying capacity and forage cycle.

IMPORTANCE OF GREEN FODDER

Animals as well as man , could not exist were if not plants , and among them are GRASSES, the most useful of all plants.

Green fodder is the primary only source of vit A for lactation

vit 'A' is present in the form of precursor.

Req. of vit A -50 I.U/live wt M : 87 I.U(M+P)

→Maintenance& function of the mucous membrane

→ is directly related to vision.

→ is essential reproduction a. conception, b. early embryonic mortality, c. maintenance of pregnancy, d.shedding of placenta.

→is essential for the respiratory tract

→is essential in the Gastro intestinal tract/ digestive tract-deficiency causes diarrhoea, mal absorption of nutrientsetc.,

→ is essential for the urinary tract –deficiency causes stones in the kidney , ureter , bladder.

→During lactation 2000 I.U. of Vitamin 'A' is eliminated in every litre of milk-It is to replenished

→laxative in action

→cheap source of Vitamin'A'

→source of minerals ,Crude protein, Total digestible nutrients and dry matter

→unidentified factors.

Carotene Content of some fodder

a. Agathi 18.3 mg / 100 dry matter
b. Lucerne 15.6 mg / 100 dry matter
c. Guinea grass-14.2 mg / 100 dry matter
d. Desmodium 7.09 mg / 100 dry matter

Feed should be available to cows at least 20 hours / day.

Feed at least 60 % of ration during night in the hot weather (Summer)

Cows → reduce feed intake by about 3.3% for every 2.2 rise in temperature over 24^0 C

High producing cows will eat up to 12 meals / day each averaging 23 minutes.

First calf Heifers with spend 10to15 % more time eating time when compared to old cows

Water should be available *At libitum.*

IMPORTANCE OFGREEN FODDER PRODUCTION

INTRODUCTION

Green forages have cooling effect on the animal body, more palatable contain easily digestible nutrients, provide fresh effectively utilizable nutrients in natural form and slightly laxative. The use of concentrates no doubt will give the greatest animal production per unit feed intake, but this may not be economical in countries like India where grains and concentrates are costly and/or in short supply. On the other hand animals yielding as high as 8 litres of milk can easily be maintained solely on green fodder without any concentrate. But unfortunately only 6.9 million ha or 4.4% of the countries area is under fodder cultivation and hardly any scope for further expansion because of pressure on agriculture land for food and cash crops.

India has about 15% of world livestock population with only 2% of world's geographical area. The projected green and dry fodder requirements for the year 2000 A.D. are 1136 million and 949 million tons respectively. The current feed and fodder resources in India can meet only less than 50% of the requirement of its livestock population of 450 million. The grazing intensity is very high viz., 2.6 cattle unit per ha as against 0.8 cattle unit per ha in developed countries. We are highly deficient in various livestock products, though we have about one-fourth of the total cattle population of the world. The analysis of this situation reveals that one of the main reasons for the low productivity of our livestock is malnutrition, under-nutrition or both, besides the low genetic potential of the animals. ***Fibre for rumen health.***

- Forage dry matter consumption should be near 2%of the body weight.
- At least 19-21% acid detergent fibre should be in the total ration.
- At least 28-30% neutral detergent fibre should be in the total ration.
- Provide at least 2 Kg of fibre a day.
- Rumen PH should be above 6.0. A lower PH could limit fiber digestion and protein synthesis.

- Fibre particles should be long enough to stimulate 15 minutes of cud chewing time per half a kg. of dry matter.
- Fibre length should be chopped at ½ inch to stimulate rumen buffering from cud chewing.
- Sodium carbonate or its buffer equivalent should be added at 0.75% of total ration dry mater, especially with high-corn-silage or high moisture corn rations.
- Feed should be available to cows at least 20 hours/day
- During hot weather feed at least 60% of ration at night.
- Cows reduce dry matter intake by about 3.3 for every 2.2° rise in temp. over 75°F(24°C).
- High producing cows eat up to 12 meals/day each averaging 23 minutes.
- Heifer calves will spend 10-15 minutes more time when compared to old cows.

SYSTEMS OF FODDER PRODUCTION

The system of fodder production vary from region to region, place to place and farmer to farmer, depending upon the availability of inputs, namely seeds, fertilizers, irrigation, insecticides, pesticides, etc. and the topography. An ideal fodder system is that which gives the maximum yield of digestible nutrients per hectare, or maximum livestock products from a unit area. It should also ensure the availability of succulent, palatable and nutritive fodder throughout the year.

Fodder production for intensive Livestock farming

The requisites for intensive livestock-farming are that (i) fodder is required in uniform quantity throughout the year, (ii) the fodder crops in the rotation should be high-yielding, (iii) the area for production of fodder should be fully irrigated, and (iv) other inputs, such as fertilizers and pesticides, should be available in optimum quantity. The different systems of fodder production fall into two categories, viz. the overlapping cropping and the relay-cropping. In the overlapping system, a fodder crop is introduced in the field before the standing crop completes its life cycle. In relay-cropping, the fodder crops are grown in successions, i.e. one after another, the gap between the two crops being very small.

Overlapping system

The overlapping cropping system is evolved by taking advantage of the different growth rate of different species. It ensures a uniform supply of green fodder throughout the year. One such system continues for three years. The best rotation in this system is berseem + sesame - Hybrid Napier + cowpea - Hybrid Napier. This system of intensive fodder production is economically viable only for 3 years. After three years Hybrid Napier is uprooted and fresh planting is taken up. When the stumps of Hybrid Napier become old and the tillering capacity diminishes considerably. This system ensures green fodder throughout the year. It takes care of the dormancy period of Hybrid Napier during winter. The inter-row spaces of Hybrid Napier are efficiently utilized for raising berseem or other legumes in winter and cowpea in summer. The growth of legumes enriches the soil.

NUTRITIVE VALUE OF FODDER CROPS

These are highly digestible (55 – 65%) mostly when harvested at a proper time. The crude protein may range from as little as 3% in very mature forages to over 30% in young heavily fertilized grass (on DM basis). The soluble carbohydrate of grasses ranges in the dry matter from 4-30%. The cellulose and hemicellulose are generally within the range of 20-30% and 10-30% of the dry matter respectively. Grass proteins are particularly rich in arginine, glutamic acid and lysine. Green forages are excellent source of carotene 250mg/kg), the precursor of vitamin A.

Generally leguminous fodder contain 8-12% DCP and 45-60% TDN. The phosphorus content of leguminous fodder are poor. It is advisable to supplement a ration containing a large amount of leguminous fodder with a limited quantity of wheat or rice bran, which is rich in phosphorus. The non-leguminous fodder are having 2.5% DCP and 45-60% TDN on dry matter basis. Green fodder is the primary source of vitamin A. Vit.A is present in the form of precursor. Green fodder contains 100 mg carotenes /Kg when compared with about 20 mg /Kg in silage. Carotene requirement of milch animals is 60 mg for production,30 mg for pregnancy, for growth requirement is 11 mg carotene per 100 Kg live weight.

Vit A is directly related to vision, maintenance and function of mucous membrane, essential for reproduction (for conception, maintenance of pregnancy, shedding of placenta), deficiency leads to diarrhoea, mal absorbtion of nutrients, incidence of stone in the kidney, ureter & bladder. During lactation 2000 I.U. of Vit.A is eliminated in milk.

VALUE OF TREE FODDER

Trees, which can be grown either in combination with agricultural crops or on separate land usually not fit for agriculture, offer opportunity of producing green nutritious fodder for the livestock. It is seldom realised that in some parts of our country, probably more animals feed on shrubs and trees than on grass or grass legume pasture. Trees can produce as much, if not more, green fodder per unit area as agricultural fodder crops. The more important desirable agronomic features of a tree species are

- Be reasonably easily and reliably established
- Exhibit a good competitive ability against weeds
- Remain regally productive under repeated ability or grazing and browsing.
- Be well adopted to the particular climatic and edaphic features of the environment
- Require, no or little fertilizer
- Be resistant to local pests and diseases
- Have adequate forage production or be reliably vegetatively propagated and
- Have good nutritive value and reasonable palatability and acceptability to animals.

Multipurpose trees (MPTS)

The term ‘multipurpose tree’ refers to all woody perennials that are purposefully grown so as to provide more than one significant contribution to the production and/or ‘service’ functions of the land-use system they implement.

Nitrogen fixing trees (NFTS)

No flowering plant grows without nitrogen and few crops grow economically without adding inputs of this plant nutrient. Many farmers and tree growers cannot afford to buy nitrogen fertilizers, so yield suffers. A NFT lives in a symbiotic or mutually beneficial relationship with root micro-organisms: the latter transform atmospheric nitrogen into a form usable by the trees which in return provide carbohydrate to the micro-organisms. Such a built-in living nitrogen fertilizer factory often allows an NFT to grow more rapidly with fewer inputs in nitrogen-poor soils than most non-nitrogen-fixing trees. Thus the nitrogen can be used not only for the NFTS growth, but as a green manure for other crops and trees. Protein rich leaves and pods make many NFTS excellent forage that animals readily eat.

Nutritive value of fodder trees

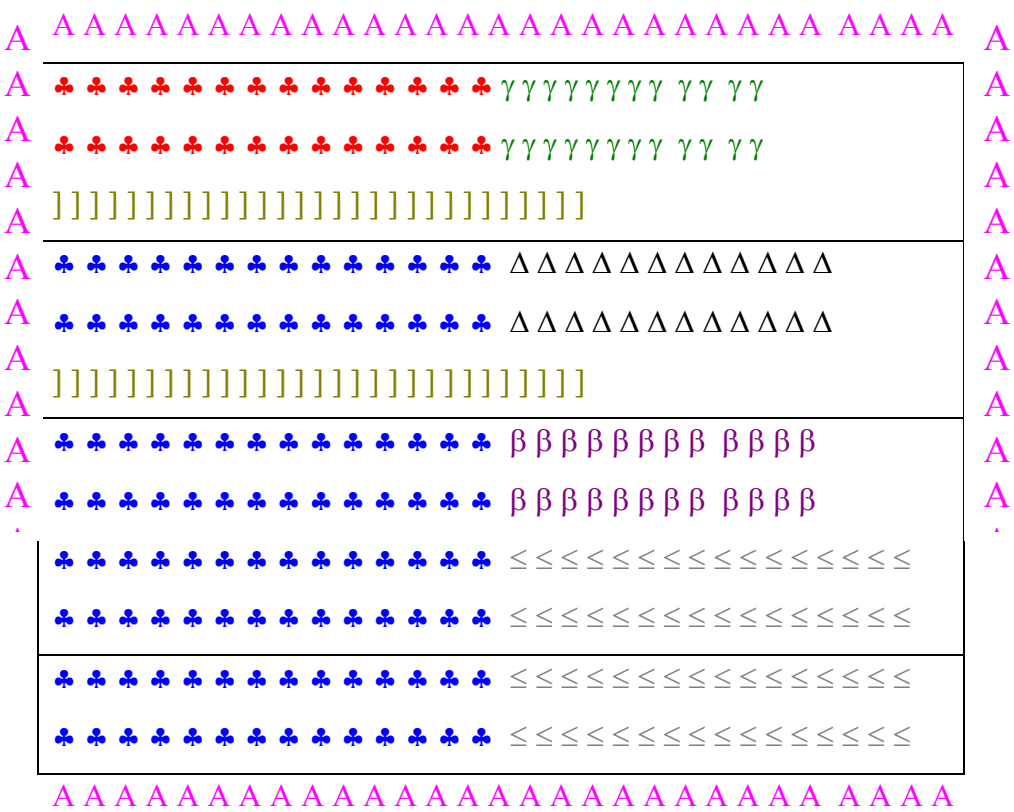
Shrubs and leguminous trees are good source of digestible crude protein (DCP) for supplementary feeding to farm animals. Tree leaves are useful as protein supplements to straws and low protein fodder. Tree leaves are good sources of calcium but low in phosphorus. The nutritive value of shrubs and tree species vary widely due to varying inherent nutritive value between species and within species because of climatic and edaphic conditions, cutting and grazing strategies and the soil in which the plant is growing.

NUTRITIVE VALUE OF TREE LEAVES (%DMB)

S.No	Tree species	CP	EE	CF	NFE	TA	DCP	TDN
Nitrogen fixing trees								
1	Gliricidia sepium	17.21	4.25	15.50	51.65	11.40	14.90	62.20
2.	Inga dulci	15.21	4.37	13.81	55.71	10.91	-	-
3.	Albizia lebbek	16.85	3.16	15.21	51.98	10.82	14.70	57.30
4.	Sesbania grandiflora	29.88	3.02	8.61	46.08	12.52	-	-
5.	Leucaena leucocephala	16.74	4.90	12.94	53.32	12.10	16.70	65.00
6.	Erythrina indica	17.52	4.29	13.76	50.51	13.92	-	-
7.	Acacia nilotica	14.00	4.30	12.50	64.70	4.50	10.20	66.50
Non-nitrogen fixing trees								
1.	Artocarpus heterophyllus	14.01	5.63	18.74	50.53	11.07	8.04	68.19
2.	Ficus bengalensis	11.40	5.17	15.46	53.59	11.93	6.22	46.63
3.	Ficus religiosa	9.84	3.97	23.20	49.17	13.82	6.24	40.00
4.	Millingtonia hortensis	8.444	4.81	22.49	50.08	14.18	8.29	54.85
5.	Lannea Coromandelica	12.06	5.23	20.61	53.72	7.48	5.93	55.15

FODDER CULTIVATION PER ACRE (40 GOATS)

A varieties of green fodder are relished by goats. For better feed conversion and weight gain the goats are to be fed with mixture of leguminous and non leguminous fodder. The fodder obtained from one acre of land is sufficient to maintain 40 heads of goat with its followers. A model out lay of various types of fodder crops to be raised is given below.



A Subabul ---------- Live fence

♣ C03 (Cumbu napier) ---------- 60 cents

] Agathi ---------- 1 meter gap (on the bunds of the water channel)

γ Maize ---------- 20 cents

or

Δ Soya /Cowpea ---------- 20 cents

or

β Sorghum ---------- 20 cents

≤ Hedge Lucerne ---------- 20 cents

Strategies for improvement

Several combat strategies have been suggested in different forums to take on the feed and fodder deficiency and a few are listed below:

1. Control of number and better utilization of improved breeds.
2. Increasing the efficiency of available feed.
3. Increasing green fodder production.
4. Judicious use of concentrates.
5. 3Identification and utilization unconventional feed and fodder.

Allocating more land for their production could not narrow the existing fodder deficiency. Alternatively the Animal Nutritionists globally are searching for Unconventional New Feed Resources (NFRs) like Agro-industrial by products, cellulose wastes livestock wastes, Top feed resources etc.

Unconventional Feed resources

The NFRs in general are poor in available nitrogen, fermentable energy and minerals. The fibre is complex due to signification. Several anti nutritional factors in them further reduce the nutritive value and affect production and re-production adversely in livestock. The levels of inclusion of various unconventional feeds are given in the tables.

Optimum level of inclusion of unconventional feeds

Newer feeds	Species	Level %
Fallen tree leaves	Cattle & goat	50
Ground nut haulms	Cattle & goat	40
Cotton seed hulls	Cattle	40
Sun flower straw	Bullocks	50
Sun hemp leaves	Poultry	8
Poultry excreta	Poultry	5-15
	Sheep	20-30
	Cattle	30
Rice husk	Sheep	5
Sugarcane bagasse (Untreated)	Bullocks	10
Sugarcane bagasse (Treated)	Sheep	20-30

Spent tea leaf	Calves	17-20
Castor bean meal	Bullocks	10-30
Mango seed kernel	Calves	20
	Bullocks	40
	Cows	10
Rubber seed meal	Pigs & Poultry	20
	Calves & Cow	20-30
Sorghum straw	Ruminants	20-46
Wood pulp waste		12.5-50.0
Fallen teak leaves		17.5-70
Fallen mango leaves		30-60
Saw dust		30
Cotton straw		45
Castor bean meal	Sheep	10
	Buffalo	30
Safflower cake	Cattle	10
Sunflower head meal	Sheep	48
Niger cake	Cattle	8
Tamarind seed hulls	Calves	10-25

Toxic principles

Type of feed	Toxic principle
Banana waste, stems and leaves	Tannins
Cassava leaves, peeling and pomace	HCN (17.5 mg/100g in leaves)
Castor seed meal	Ricinoleic acid (0.2%)
Cocoa seed husks	Theobromine (trace)
Coffee seed hulls, pulp	Caffeine and tannins (2.8% DM)
Cottonseed cake	Gossypol (0.05-0.20%)
Cowpea seed meal	Trypsin inhibitor
Guar meal	Trypsin inhibitor and gum
Kapok	Cycloponopeniod acid

Mango seed kernel	Tannins (5-10%)
Neem seed cake	Tannins
Palm oil mill effluent	High ash 912-26% DM)
Rubber seed meal	HCN (9mg/100g)
Sal seed meal	Tannins (6.2-13.7%)
Spent tea leaves	Tannins (12% DM)
Water hyacinth	Oxalic acid (2.4% DM)

Fodder	Toxin	Toxin effect
Acacia leaves	HCN, tannins, fluro-acetic acid, oxalates	Laboured respiration, depression, coma and death
Albizia foliage and many other tree leaves	Tannins	Depression in dry-matter and protein digestibility, impaired kidney and liver functions
Blighia sapida seeds	Hypoglycin	Hypoglycaemia
Delphinium spp.	Alkaloids	Stiffened joints, bloat and death
Indigofera herbage	Indopicine, 3-nitropropanic acid	Hepatotoxic agent
Lantana foliage	Lantadene	Hepatotoxic agent, photo-phobia and blindness
Leucaena foliage	Mimosine	Goiterogenic and alopasia
Robinia foliage	Robin phytotoxin	
Sambuscus nigra	Sambunigrin (glucoside)	Depressed respiration, coma and death.

Sugarcane tops as livestock feed – on study on sugarcane tops feeding to sheep and calves to conducted under NATP project at IAN Kattupakkam Sugarcane tops with either grass, groundnut haulms or sorghum straw were fed to animal in the form of complete ration. The feed efficiency

of these economic feed rations was 15 – 17. Kg. and 5.9 – 6.1 Kg. for sheep and calves respectively. feed cost to produce 1 Kg. live weight was Rs.44 – 51 for sheep. The feeding of sugarcane tops increased to growth rate of ram lambs by 29.4% and calves by 29.2%.

Ardu leaves

Two species of the genus Ailanthus, Viz. Ailanthus grandis and A. grandulosa are commonly found in India. These species grow into enormous trees with clear cylindrical holes. A fully grown tree gives 6 to 7 quintals of edible leaves twice a year.The leaves are quite palatable to both small and large ruminants. The voluntary intake is from 1.5 to 2.0 per cent of the live weight. It contains 13 per cent digestible crude protein (DCP) and 63 per cent total digestible nutrients(TDN). Adult ruminants can be maintained exclusively on ardu leaves.

Bamboo leaves (Dendrocalamus strictus)

Bamboo grows in many parts of the tropical region. Its leaves are primarily used for paper manufacture. Nearly 90 to 150 tonnes of leaves are available from a hectare of bamboo forest. The tender bamboo leaves are relished by the livestock. The ruminants can consume about 3.4 to 3.7 per cent of dry matter of the body weight. Fresh leaves contain 40 to 65 per cent dry matter, 15 to 22 per cent crude protein, 3 to 4 per cent ether extract and 20 to 34 crude fibre. The leaves contain about 9.4 per cent DCP and 94 per cent TDN. Negi et. al, (1979) indicated that in spite of the higher crude protein content during the early stage of growth in bamboo, the digestibility of the crude protein was 10 per cent higher at the later stage.

Banyan (Ficus bengalensis)

Bargad or banyan is a large evergreen tree. It produces numerious serial roots from the branches, which, upon reaching the ground, thicken rapidly and form support to the branch.There are many species of Ficus such as pepal (Ficus religiosa), pilkan (Ficus infectoria).

Beduli (Ficus glomerata)

Almost all the ficus tree leaves are lopped for feeding the livestock especially the goats. F.scandens leaves form a very good nutritive fodder. They are fed as protein supplement to the

lactating animals in the hills during winter. The Ficus species are mostly found in plains up to 1,000 m above sea-level. The figs (fruit) of F.palmata and F.roxburghii are consumed by human beings.

Biul (Grewia optiva syn. G.oppositifolia)

Biul also known as bhimal is a small, medium-sized tree mostly found at an altitude of 500 to 2,500m above sea -level. It is also found in the plains. A tree gives about 15 to 20 kg of green leaves per year. The bark of the tree is used for rope manufacture.

The leaves are highly palatable and nutritious (Sharma et al., 1966; Negi et al., 1979). They are lopped for animal feeding during winter months. The leaves contain 17 to 23 per cent crude protein, 2.5 to 5.0 per cent ether extract, 17 to 24 per cent crude fibre, 11 to 13 per cent ash, and 35 to 45 per cent N-free extract. The tannin content is negligible while the digestibility of crude protein is very high (75 per cent). The voluntary intake of the leaves is very high (3.5 per cent of the body weight). It contains 15 per cent DCP and 62 per cent TDN. It forms an excellent leaf-meal (Pachauri et al., 1974).

Beri (Ziziphus jujuba)

Beri or Chinese dae is a very common shrub in the arid regions of the tropics (Indian subcontinent, Southeast Asia, North Africa, etc.). It is commonly found in the desert regions of India. The leaves are highly palatable and are used as a conventional fodder for sheep and goats. In Rajasthan and Gujarat, that the beri leaves are dried and stored for use as a protein supplement with the normal grazing. It contains about 18 to 20 per cent crude protein, but has poor digestibility owing to the presence of high amount of tannins. Z.nummularia is also a good fodder.

Erythrina spp.

It is a leguminous shrub. It is also used as a live fence in southern India and SriLanka. It produces high proteinous leaves (22-25 per cent protein). There are two species common in the subcontinent. One is E.indica, a thorny drought-resistant plant commonly found growing in dry

zone. The leaves are lopped for goats and cattle. E.lithosperma a non-thorny plant common in hill country, is found growing in areas up to 500 to 1,500 m height above sea-level.

Gliricidia(Gliricidia maculata)

Gliricidia is a deep-rooted legume. It is mostly grown as a live fence and is used as a support plant for black pepper and as a shade tree for tea plantations in some of the tropical regions (India, Sri Lanka, the Philippines, etc.).

It grows well on very poor and acidic soils without any fertilizers up to 1,000m elevation. It can be propagated both by seeds and stems.

The leaves contain 25-30 per cent protein and can be harvested at every 3-4 months interval. It is highly palatable fodder. Paddy straw (1.5kg), gliricidia leaves (6kg) and rice bran (1kg) supported a growth rate of 500g in a crossbred heifer at Haregama Farm, Sri Lanka (Ranjhan, unpublished). It is a good fodder for sheep, goats and buffaloes, and can be used as a protein supplement.

Ipil-ipil, subabul(Leucaena leucocephala)

It is a perennial shrub. The young foliage is highly palatable and rich in protein. The seeds can be used as feed concentrate. The leaves contains 21-25 per cent protein. The fodder is suitable for ruminants, but is toxic to pigs and horses because of mimosine, a toxic amino acid. When grown for fodder, the first cut can be taken within 6-9 months of sowing and subsequent cuts at intervals of about 4 months.

Subabul can makeup the protein requirement for maintenance of cattle and buffaloes weighing 400 kg, if given at 25-30 per cent of the paddy straws. Feeding larger quantities to lactating cows gives taint in the milk. It is believed to cause sterilitiy in cows and sows. Feeding up to 25 per cent in daily ration has not shown any adverse effect (Chadokar, personal communication).

Subabul has been extensively propagated in the Philippines, Sri Lanka, Thailand and other tropical countries in Asia for animal feed. In the Philippines, subabul leaf-meal pellets are manufactured and exported to Japan for use in poultry feed.

Jack (Artocarpus heterophyllus)

Jack is a common deciduous tree of 30 m height and 2m girth, in the South and the Southeast Asia. The fruit is used both as vegetable and as a fruit when ripe.

The leaves are palatable to sheep and goats. There is another species of Artocarpus (A. intergrifolia) which is also common in the southeast Asia. The leaves contain 13 to 14 per cent crude protein.

Mulberry leaves (Morus indica)

This tree is grow in up to 1,200 m in the sub-Himalayan tract in India. Mulberry is also grown in the silk-producing areas of India where silk-worms feed on these leaves. The leaves are highly palatable to sheep, the feed intake being 3.4 per cent of the body weight. The stalks contain about 11.4 per cent crude protein. The leaves are highly palatable and contain 7.8 per cent DCP and 48.4 percent TDN.

Melia azedarach

It is a deciduous tree found in the Indian subcontinent. It is a good fodder tree. Its leaves contain 13 to 14 per cent of crude protein.

Neem leaves (Azadirachta indica)

The neem or margosa tree grows in the Indian subcontinent, in the major part of Africa and in the arid and sub-humid tropic. The tree remains green thoughout the year and is drought resistant.

The leaves are not relished by the large ruminants. Sheep and goats consume them in small amounts. The leaves contain 6.2 per cent DCP and 52.5 per cent TDN.

Pipal (F.religiosa)

The leaves are relished by sheep and goats. The dry-matter consumption is about 2.4 per cent of their body weight. However, cattle and buffaloes do not relish them and the palatability is only about 0.9 per cent of their body weight. Leaves form a maintenance ration for goats when fed alone. The leaves contain 5.5 per cent DCP and 39.2 per cent TDN.

Siras (Albizia lebbek)

Siras is a medium sized deciduous tree. The leaves contain about 11 per cent DCP and 50 per cent TDN. Cattle and buffaloes do not relish the leaves very much, however, sheep and goats like them.

Sainjana (Oleifera moringa)

It is a medium-sized deciduous tree common in the tropics. The flowers and fruits are used as vegetable. The leaves are relished by the ruminants. They contain 11 per cent DCP and 62 per cent TDN.

Tamarindus indica

Tamarind tree is very common in most of the tropical countries. It is a tall deciduous tree, grows to a height of about 20m. The leaves are rich in protein (14 per cent) and are relished by small ruminants.

Tapioca leaves (cassava, Manihot esculenta syn. utilissima)

Tapioca is a tuber crop extensively grown in many countries of the tropics. M.esculenta is the most commonly cultivated speices in India. The annual world production is about 117.2 million tonnes; out of this only 3.5 million tonnes is grown in India. About 41 million tonnes are produced in Asia (35 per cent). At harvest time, the tuber is collected and the leaves are thrown away.

Tapioca leaves are rich in protein. They contain 8.3 per cent DCP and 45.5 per cent TDN on dry-matter basis. When fed to growing calves, 2.3 kg of partially dried tapioca leaves can replace 0.7 kg of groundnut-cake. Lactating animals when fed on tapioca leaf-meal show good results. About 50 per cent of groundnut-cake can be replaced by tapioca leaf-meal contain about 7.6 mg of HCN per 100 g of dried leaf-meal (ICAR, 1970). At an intake level of 0.5 to 0.8 per cent of body weight, it does not produce any adverse effect.

Thespia populnea

It is a big deciduous tree that grows in the sub-humid region of the tropics and is common to the Indian subcontinent. The leaves can be included up to 30 per cent in the ruminant's ration along with paddy straw for maintenance without deliterious effect (Chadokar, personal communication). It coantains 19 to 20 per cent protein. Ferric salts have been used to reduce the uptake of mimosine and DHP from Leucaena. They also have a positive effect on the use of high-tannin sorghum by poultry. Polyethylene glycol is effective in counteracting the

effect of condensed tannins by complexing with them to the exclusion of protein (Barry and Balaney 1987; Pritchard et al. 1988). The current price of polyethylene glycol makes it this uneconomic as a supplement but there is always the possibility of natural analogues (soluble, nondegradable polyhydroxy compounds) occurring in other feed plants, with a positive interaction if the plantswere fed together. Activated charcoal can be used as a general agent for binding toxins in the gut.

Although providing supplements may seen impractical in some village farming systems, the low sodium content of tree leaves and, indeed, most forage plants in the humid tropics indicates that optimum growth will not be obtained without salt supplementation(Little et al. 1988).

Leaf meal

Plant leaves are commonly processed in to leaf meals for non-ruminants particularly for poultry. A good quality leaf meal must be free of stems, kiln dried, and dehydrated. It must not be sun dried, because this treatment inactivates a high percentage of the carotenoids. Leaf meals are included in poultry feeds primarily as pigmenting agents because of their low energy value(<6.25MJ/kg) and low protein digestibility. The maximum level in broiler diets is about 3%, as high levels may decreased growth rates. Conversely, good quality leaf meal is almost always used in feed formulations for layers, the usual upper limit being 5% by weight of feed.

In general leaf meals are good pigmenting agent. This due to the presence of several different xanthophylls of the general family of carotenoids. Xanthophylls are the hydroxy derivatives of carotene hydrocarbons. Feeding trials with growing pigs have shown that feeding LLM at 5, 10 and 15% caused no ill effects (Patricio 1956; Iwanaga et al.1957; Rivas et al. 1978). In fact, LLM at 5 and 10 % levels is useful in growing and fattening swine,. Rivas et al. (1978) found that pigs fed 20% leucaena without $FeSO_4$ showed the lowest growth rate, average feed intake and feed conversion efficiency; pigs also lost hair and had defective hoofs and pasterns. Growing finishing pigs, however, could be raised using a diet containing 20% LLM, provided 0.4% FeSO4 was added.

Cutting management

Method of harvesting the tree fodder

Management of tree components at suitable age and interval is one of the vital importance in an agro forestry system. This is primarily required to provide necessary light reception to ground flora.

Many trees and shrubs have the capacity to regenerate new growth after being cut. Several different harvest methods like coppicing, pollarding, lopping, pruning and thinning are advocated as cutting technologies for trees.

Coppices:

It is one of the most widely used harvesting method in which individual trees are cut at base usually between 15-75 cm above ground level. New shoots develop from the stumps. For pole and fodder production 2-3 sprouts should be allowed to grow. Several rotations of coppicing are usually possible for most tree species. The length of coppice period depends on the specific tree products that are needed. For exclusive fodder production, the tree can be coppiced very frequently. The coppice shoot growth of 1.5 years old subabul had been found to be equal to that of original 3 years growth of that tree. Eventually after several harvest sprouting vigor diminishes. Subabul and Gliricidia sepium are examples of good coppiciers.

Pollarding:

In this system all the branches including top of the tree are removed at a height of 1-3 meters above ground level. New shoots sprout from the main stem to form new crown. The main stem continue to increase in diameter but not in height. This system is used for management of live fences, hedge rows in alley farming etc. An advantage of this system is that the new shoots are high enough off the ground and thus are out of reach of grazing livestock. Subabul, Gliricidia sepium, Erythrina indica, Moringa oleifera, Mulbery, Neem etc. respond well for pollarding.

Lopping:

In this system most of the branches are removed. Though this system is widely used in our country, excessive and in discriminate lopping of fodder trees result in depletion of valuable tree foddder resources and consequent soil erosion. Intensity and frequency of lopping depend upon the species, age, growth rate of the tree, soil type etc.

Pruning:

It is the harvesting system usually involves in the removal of smaller branches and stems. These pruned biomasses constitute a major source of fodder, fuel and mulch for tree crops. Pruning is often required for maintenance of fruit and forage trees, alley farming and live fences. Among fodder trees, Gliricidia sepium, Subabul, Acacia etc. respond for pruning

Thinning:

It is a traditional forestry practice followed to maintain desirable trees by eliminating the poor and desired ones to improve the stand by reducing competition for light and nutrients.

Other management factors that affect tree productivity include age at first cutting, cutting height, cutting frequency and season of cutting. It has been generally stated that where trees are older at first cutting, higher rates of regrowth will be observed. This would be expected because older trees would have thicker stems, more carbohydrate 1m is often used for fast growing short rotation trees. Grown up trees could be pollarded at a height of 2-4m in order to facilitate manual working and to avoid frequent browsing by livestock. The cutting interval will be dictated by the purpose for using the trees. In humid climates, where the major emphasis is on leaf production for feeding to animals, shorter cutting intervals (6-10 weeks) will be preferred. This will produce feed of a higher nutritive value. Longer intervals (10 - 14 weeks) would be appropriate if fuel wood is also important. With fast growing trees, the regrowth height will be 1.5m for leaf production and 2.5m for leaf and wood production. In less humid environments, longer cutting intervals may be required. The critical period for food supply to the animals is the dry season. Hence carrying over the leaves of wet season into dry season and successive cuttings during dry season are recommended. The surplus production of foliage during wet season should be conserved as hay and silage for feeding in dry season. Most of the long and medium rotation trees tolerate annual lopping (30-50%). The L.leucocephala, Giliricidia and Sesbania species tolerate recurring lopping.

Feeding the tree tops during lean periods

All the tropical and subtropical grasses, owing to their faster rate of growth during the monsoon provide grazing for the livestock, mainly in the monsoon and post-monsoon periods. With the advent of winter and owing to the lack of sufficient moisture in the soil in a ready available form, they enter dormancy. Thus during the lean periods of spring and summer, tree-tops come to the rescue of the livestock-owners. The young leafy, succulent material, highly nutritive and rich in crude protein and minerals, serves as a concentrate, even if fed in small

quantities along with other dried grasses and crop residues. The lopping of the trees obtained in spring and summer also contain some substances, which bring the animals quickly into the reproduction phase. Some of the important trees giving lopping and producing gum are koo-babul (*Leucaena leucocephala*) and *Sesbania aegyptiaca* and *Saculeata*. The gum content in the seeds of the two species of *Sesbania* is of superior quality and has a property to reduce the cholesterol content in the blood. These trees, therefore, need immediate attention and may be planted on the boundaries of the fields, in the cattle-yards, etc. to serve as shade-cum-fodder-cum-gum-producing plants. The spacing between the trees should be 6-8 metres or even more in cattle-yards and 5-6 metres on the bunds of the fields.

Besides the use of trees on the farm for various purposes the trees are planted in the pastures as companion species with grasses.

Method of feeding

Physical treatments like sprinkling of molasses, water, salt solution or wilting in shade for 8 hours for Gliricidia or neem leaves, shade welting resulted in the significant improvement in palatability for sheep rather than feeding fresh leaves. Roughage should be fed at the rate of 65% of dry matter requirement in ruminant animals. However, feeding of cereal and legume green fodder alone meet the nutrient requirements for producing up to 10 kg of milk. For small ruminants cereal fodder, legume fodder and tree leaves at 2:1:1 ratio supply the nutrient requirements.

Leaf meals

Leaf meals are commonly included in broiler ration up to 3% and layer ration up to 5% primarily as pigmenting agents for pigmentation of meat and egg. This is due to the presence of xanthophyll. A good quality leaf meal must be free of stems, klin dried and dehydrated. It must not be sun dried because this treatment inactivates high percentages of carotenoides.

NUTRITIVE VALUE OF TREE LEAVES (%DMB)

S.No	Tree species	CP	EE	CF	NFE	TA	DCP	TDN
Nitrogen fixing trees								
1	Gliricidia sepium	17.21	4.25	15.50	51.65	11.40	14.90	62.20
2.	Inga dulci	15.21	4.37	13.81	55.71	10.91	-	-
3.	Albizia lebbek	16.85	3.16	15.21	51.98	10.82	14.70	57.30
4.	Sesbania grandiflora	29.88	3.02	8.61	46.08	12.52	-	-
5.	Leucaena leucocephala	16.74	4.90	12.94	53.32	12.10	16.70	65.00
6.	Erythrina indica	17.52	4.29	13.76	50.51	13.92	-	-
7.	Acacia nilotica	14.00	4.30	12.50	64.70	4.50	10.20	66.50
Non-nitrogen fixing trees								
1.	Artocarpus heterophyllus	14.01	5.63	18.74	50.53	11.07	8.04	68.19
2.	Ficus bengalensis	11.40	5.17	15.46	53.59	11.93	6.22	46.63
3.	Ficus religiosa	9.84	3.97	23.20	49.17	13.82	6.24	40.00
4.	Millingtonia hortensis	8.444	4.81	22.49	50.08	14.18	8.29	54.85
5.	Lannea Coromandelica	12.06	5.23	20.61	53.72	7.48	5.93	55.15

CARRYING CAPACITY OF PASTURE.

Sheep in India are mostly maintained on the Pasture. The type grasses in the pasture are highly variable according to the location. Paddocks which were commonly sown with White Kollukkattai (Cenchrus ciliaris), Black Kollukkattai (Cenchrus setigerus),Blue buffel (Cenchrus glaucus), Kikiyu (Pennsetum clandestinum),Tuber Grass (Phalaris tuberosa), Rye grass (Lolium multiflorum, L.perennae) and clover variety (Subterranean Clover) of grasses.

Eighteen ewes were allowed to graze on the basis of 0.2 ha / sheep in sown pasture and 0.4 ha / sheep in natural pasture. The ewes under the sown pasture paddocks showed better gains than on natural pasture paddocks. It has been proved that under natural pasture paddock there was a reduction of 7 % in the plant cover paddocks. Allowing for improvement of the poor grassland , the grazing capacity for the maintenance is recommended at 2.47 wethers per hectare on year long basis. On an average the wether produced 1099 g of wool per head per year, which compares favourably with the average production of Marwari breed. Growth studies conducted

in lambs showed greatest gain in body weight under continuous controlled grazing on a year long basis.

FODDER CYCLE.

Is directly related to number of heads of livestock that can be maintained with the green fodder bio mass that is obtained from the specified quantum of land. The area of land for forage production will vary according to the type and variety of green fodder.

The requirement of green fodder will vary according to the live body weight of the animal. On an average 8-10 % of live weight of the animal is to be provided in the form of green fodder. An adult Cattle weighing 400 kg body weight will consume 32-40 kg green fodder. Out of the total requirement of green fodder one third of green fodder is to be provided as Leguminous fodder and remaining two third is to be provided as non leguminous fodder.

For an example a mini dairy with 10 cows and 5 calves will require green fodder as follows :

10 Cattle x 35 kg/day x 365 days = 127.75 tonnes.

05 Calves x 20 kg /day x 300 days = 30.00 tonnes.

Totally approximately 150 tonnes /year.

Leguminous fodder : 50 tonnes

Non leguminous fodder : 100 tonnes.

To produce the above quantity of green fodder the land area is to be worked out based upon the type and variety fodder crops that are cultivated.

Eg : Let us taken an example that Co3 variety yields 150 tonnes /acre/year Lucerne yields 80 tonnes / acre means two third acre is to be allotted for production of Co3 grass and 60 cents are to be allotted Lucerne to get sufficient fodder to meet the requirement of 10 cattle with its 5 followers .

To maintain 40 goats with its followers a minimum one acre of land with irrigation facilities is essential to produce sufficient quantity of various variety green fodder. (40 adults x 5 kg x 365 days = 73 tonnes ;

100 kid x 2kg x180 days = 36 tonnes; 73 + 36 =109 approximately 100 tonnes)

UNDERSTANDING PASTURE-STOCKING RATE AND CARRYING

Determining Carrying Capacity

What is Carrying Capacity?

One of the first questions the new owner or potential buyer of a unit of pasture or rangeland asks is "How many cattle, sheep, horses, etc. can I graze on this land?" In other words, what is the carrying capacity.

There is no simple answer to this question. Carrying capacity may vary depending on management goals, grazing systems, season of use, weather, and many other factors. There are several terms related to carrying capacity that need to be defined.

CARRYING CAPACITY is defined as the maximum stocking rate possible which is consistent with maintaining or improving vegetation or related resources. It may vary from year to year on the same area due to fluctuating forage production..

STOCKING RATE is defined as the number of specific kinds and classes of animals grazing or utilizing a unit of land for a specified time period. It may be expressed as animal unit months or animal unit days per acre, hectare, or section, or the reciprocal (area of land/animal unit month or day).

GRAZING CAPACITY, although sometimes used synonymously with carrying capacity, is defined as the total number of animals which may be sustained on a given area based on total forage resources available, including harvested roughages and concentrates.

GRAZING CAPACITY is the relationship between number of animals and area of land at any instant of time. It may be expressed as animal-units per acre, animal-units per section or AU/ha. For definitions of other terms used in this discussion, see the Glossary of Terms Used in Range Management.

The Recommended Method to Determine Carrying Capacity

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By far the easiest and most accurate method of determining the carrying capacity of a unit of land is to obtain past stocking rates and grazing management history from the previous owner/grazer and then assess the ecological status (range condition) and **range trend** of the land.

If range trend has been stable or upward the past few years, then the stocking rates have been within carrying capacity limits and past management practices have been effective. If trend is downward, then an adjustment in management or stocking rate is needed.

Caution! Downward trend does not necessarily mean numbers of animals should be reduced. In fact, stocking rate is the last thing to consider. A more likely cause of downward trend, especially on Idaho rangelands, is poor livestock distribution. This can be easily assessed by doing some simple utilization mapping. If there are areas of a pasture that are under used and others over used, then what can be done to encourage the livestock to make more use of the under utilized areas?

Other factors to consider before reducing stocking rate are:

- Is a change in grazing season warranted?
- Is the grazing system being used working or are changes needed? Would a shorter period of grazing or a season of rest improve the range?
- Is the appropriate kind of animal being used (i.e. is the rangeland better suited for sheep than cattle, etc.)?
- Is there an alternative source of forage available? Or is brush or weed control warranted?
- Has there been a recent extended drought?
- Have other uses increased (i.e. numbers of wildlife) or caused the downward trend?

If it is determined that one or more of these factors is not the cause of downward trend, then an adjustment in stocking rate may be warranted. Make the adjustments you feel may be necessary, monitor trend, and readjust upward or downward as conditions warrant.

Another easy and fairly accurate method of determining carrying capacity is to look at comparable pasture or rangeland in the area and find out what their carrying capacity estimates are. The local Cooperative Extension Service or Natural Resources Conservation Service offices may also be able to assist you in determining carrying capacity. If the unit of land you are interested in is public land, the administrating agency should already have an estimate of carrying capacity.

What if there is no historical stocking rate available?

If there is no historical stocking rate information available or the local Extension Service or Natural Resources Conservation Service offices can not provide such information, they may be able to assist you in measuring annual forage production on the land in question and calculate an estimate of carrying capacity.

This may very well be the case if you have irrigated pasture that is seeded to a forage species or mix of species that is not commonly grown in your area. **Caution!** This method works well in theory, but is based on a series of estimates. The final result is only as good as the estimates. Contact your local Cooperative Extension Service or Natural Resources Conservation Service office for assistance.

Carrying Capacity

In ecological terms, the carrying capacity of an ecosystem is the size of the population or community that can be supported indefinitely upon the available resources and services of that ecosystem. Living within the limits of an

ecosystem depends on three factors:

- the amount of resources available in the ecosystem;
- the size of the population or community; and
- the amount of resources each individual within the community is consuming.

The concept of carrying capacity is closely related to the idea of "capital". The term "capital" is most commonly used to refer to money and material goods. However, in the context of sustainability, communities have several different types of capital that need to be considered - natural, human, social, and built capital. Together, these types of capital are referred to as community capital. All four types of capital are necessary for communities to function. All four types of capital need to be managed by a community. All four types of capital need to be cared for, nurtured and improved over time. A community that is living off the interest of its community capital is living within the carrying capacity. A community that is degrading or destroying the ecosystem on which it depends is using up its community capital and is living unsustainably. Carrying capacity is much harder to measure for human, social and built capital than for natural capital but the basic concept is the same - are the different types of capital being used up faster than they are being replenished?

For example:

- A community that allows its children to be poorly educated, undernourished, and poorly housed is eroding its human capital.
- A community that allows the quality of its social interactions to decline through lack of trust, respect, and tolerance is eroding its social capital.
- A community that allows its buildings, roads, parks, power facilities, water facilities, and waste processing capability to decay is eroding its built capital. Additionally, a community that is creating built capital without considering the future maintenance of that capital is setting itself up for eventual decay.

So, in the context of sustainability, carrying capacity is the size of the population that can be supported indefinitely upon the available resources and services of supporting natural, social, human, and built capital.