TAMIL NADU VETERINARY AND ANIMAL SCIENCES UNIVERSITY
Veterinary College and Research Institute, Orathanadu

Training manual on

"Recent Advances in Fodder Production Technology"

Organized by

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IMPORTANCE AND NEED OF GREEN FODDER PRODUCTION TECHNOLOGIES

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Green fodder plays an important role in livestock rearing. The sustainability of the livestock production system in the country is handicapped due to shortage of feed and fodder even though the livestock industry by and large dependent on agricultural residues, waste materials and naturally available green fodder.

Green fodder provides nutrients for production and reproduction at cheaper cost. In spite of its importance, in the country, green fodder production has not been given proper place in the cropping pattern in providing proper nutrition to livestock. At this juncture, it should be noted that only 3.5 per cent of cultivable land of the country is allotted for green fodder production. Fodder plays an important role in economizing the cost of production.

There exists a substantial gap between the demand and availability of fodder in the country, particularly during the lean periods and at the time of natural calamities including droughts/floods.

Following measures/technologies may be taken for ensuring maximum availability of fodder for sustaining livestock production.

Optimum utilization of land

The number of livestock is growing rapidly, but the grazing lands are gradually diminishing due to pressure on land for agricultural and non-agricultural uses. Due to the importance of food crops and other cash crops, it is unlikely that the area under fodder cultivation would increase substantially.

Therefore, the need of the time is to adopt the practice of land use with multiple crops in a sustainable manner. Adopting Silvi-pastoral and Horti-pastoral models suitable to the area can help in enhancing the availability of forage for the livestock. Emphasis should also be laid on the non-cropped areas in the agricultural land which are not cultivated viz. bunds, pond embankments, basins of plantation and horticultural crops, hedges with fodder crops etc.

Improving fodder production

Use of quality fodder seeds including dual purpose grains like bajra, maize and jowar, etc., is essential for improving productivity.

Enhanced fodder seed production

Inadequate availability of quality fodder seeds is a major constraint. Fodder seed production is not remunerative in many of the fodder crops. Initiatives may be taken to encourage farmers for taking up the production of quality fodder seeds of high yielding varieties.

Adopting suitable crop combination

Productivity of most the agricultural lands can be improved through not only crop rotation, but also adopting suitable crop combinations.

Improvement of grassland/wasteland and other community land

Grassland development can be taken up in waste land, range land, grass land, non-arable land and forest land. Besides, other marginal lands like roadside land, canal side land, land along the railway tracks, etc., may also be utilized for forage cultivation. Wasteland like waterlogged areas and saline soils can also be utilized for cultivation of fodder varieties suitable for such areas.

Conservation and utilization of crop residues/byproducts

- Avoiding burning of agricultural residues in the fields.
- Installation of chaff cutters and construction of manger can result in reduction of fodder wastage by 30%.
- Surplus green fodder is available during the monsoon goes waste or is improperly stored, reducing its nutritional value. The farmers may be trained in making silage and it can be used during scarcity period.
- The availability of dry fodder can be enhanced by installation of fodder block making units.
- Promoting the use of crop residues and agricultural wastes/bye products as animal feed by enriching by treatment of straw with urea and molasses.

Development of fodder banks

Creation of fodder banks through silage or fodder blocks and enrichment of crop residues, etc will improve the fodder availability. States with surplus dry fodder may indicate the quantity and type of fodder available with them, so that necessary arrangements for supply to scarcity area can be made.

Hydroponic fodder production

To meet this increasing demand for green fodder, one of the alternatives is hydroponic fodder to supplement the meager pasture resources. Hydroponic green fodder can be produced both in large, sophisticated, automated commercial systems with environmental control, or in low cost systems, where the ambient environment is suitable for fodder production. Fodder seeds utilize tap water, or nutrient-enriched solutions for plant nourishment in the absence of soil.

Today, hydroponics are used in harsh climates such as deserts, areas with poor soil or in urban areas where high land costs have driven out traditional agriculture. Hydroponic fodder production is probably best-suited to semi-arid, arid, and drought-prone regions of the world, suffering from chronic water shortages or in areas where irrigation infrastructure does not exist. Hydroponic fodder production is a boon for farmers whose soil is rocky and infertile. It is a viable farmer friendly alternative technology for landless farmers for fodder production. Fodders including maize, barley, oats, sorghum, rye, alfalfa and triticale can be produced by hydroponics. Others, including cowpea, horse gram, sun hemp, ragi, bajra, foxtail millet and Jowar have also been grown successfully by the use of hydroponics.

Schemes that supports fodder production

1. National Livestock Mission (NLM)
2. National Food Security Mission
3. Rashtriya Krishi Vikas Yojana (NADP)

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IMPORTANCE OF FEEDING GREEN FODDER FOR THE LIVESTOCK AND THEIR NUTRITIVE VALUE

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Green fodders are tastier and helps in reducing body temperature or heat stress during summer. It is important to feed balanced feed throughout the year to the livestock to obtain maximum production.Generally in our country livestock are maintained mainly on crop residues and agricultural wastes. These feed resources low in nutrients and their digestibility is also low.It is highly essential to feed green fodder along with concentrate to high yielding dairy animals for better productivity.

Advantages of feeding green fodder

- The palatability of green fodder is high compared to dry fodder.
- Green fodders contain about 70 – 80 % moisture. They help in reducing body temperature.
- Help to combat heat stress thereby sustains productivity.
- Green fodders are very good source of highly digestible fibre and carbohydrates. This will increase milk fat by producing more acetic acid in the rumen on fermentation.
- Green fodders contain highly digestible protein. Legume fodders contain about 15-25% crude protein and non legume fodders contain about 6-10% crude protein. These proteins help in normal growth, production and reproduction of livestock.
- Green fodders contain good amount soluble carbohydrates. They are very good source of nutrients for rumen microbes such as bacteria, protozoa and fungi. These microbes are highly essential for proper digestion of nutrients in ruminant stomach.
- Green fodders are very good source of soluble minerals. Legume fodders are rich in calcium. Cereal fodders and grasses are rich in phosphorus.
- Green fodders are rich in carotene, it is the precursor of vitamin A. This vitamin is important for proper growth and reproduction. Deficiency of this vitamin results in infertility, abortion and retained placenta.
- Feeding of green fodders will reduce the quantity of feeding concentrate to livestock. This will reduce feeding cost thereby increase the profit to the farmers.
- Feeding of green fodders along with crop residues and agricultural wastes will improve the digestibility of nutrients and thereby augment the productivity.
- Surplus fodder produced during rainy season can be preserved as silage or hay and it can be used as green fodder during lean season and fodder scarcity period. It will helps in sustaining productivity.

Classification of green fodders

Non legume fodders		Legume fodders	Tree fodders
Cereal fodders	**Grasses**		
Maize Sorghum Combu	Combu Napier Hybrid – CO1,CO2, CO3, CO4, CO5 Guinea grass Cenchrus	Desmanthus Lucerne Stylosanthus	Subabul Agathi Glyricidia Neem tree Baniyan tree Arasan tree etc.

Cereal fodders

- Maize, sorghum and combu are cereal fodders.
- They are low in protein (6-10%) and high total digestible nutrients (TDN) (50-60%).
- Yield is high compared to other green fodders hence farmers prefer cereal fodders to cultivate.
- They are rich in soluble carbohydrates hence suitable for silage making.
- Rich in phosphorus and low in calcium.

S.No.	Fodder and variety	Yield (tonns/hectare)	Remarks
1	Fodder maize African tall Ganga-5	 35- 40	Harvest 65 to 70 days after sowing.
2	Fodder sorghum CO10 CO27 COFS29 COFS31 (Harvested 5-6 times in a year)	Irrigated- 35 to 50 Rainfed – 20 to 25 150 to 170 (5 harvest)	Immature and drought affected fodder contains **HCN**. It should not be fed to the animals. Fodders should be harvested at flowering stage.
3	Fodder combu CO8	30	Harvest 60 to 65 days after sowing.

Grasses

- Combu napier hybrid, guinea grass, cenchrus, para grass are examples of grasses.
- They are low in protein (6-10%) and high in total digestible nutrients (TDN) (50-60%).
- Yield is high compared to other green fodders hence farmers prefer grasses to cultivate.
- They are rich insoluble carbohydrates hence suitable for silage making.
- Rich in phosphorus and low in calcium.

S.No.	Grass and variety	Yield (Tons/hectare/year)	Remarks
1	Combu Napier Hybrid CO1 CO2 CO3 CO4	 300 (8 harvest) 350 (8 harvest) 400 (8 harvest) 450 (8 harvest)	 First harvest 75 days. Subsequent harvest after 45 days.
2	Guinea grass CO1 CO2	 200 (8 harvest) 270 (8 harvest)	 First harvest 60-65 days. Subsequent harvest after 45 days.
3	Cenchrus CO1	 40-45 (Rainfed) (4-6 harvest)	Harvest 70 to 75 days after sowing. 4-6 harvest/year. Suitable for pasture development.
4	Para grass/water grass	30-40 (8-10 harvest)	First harvest 65-75 days. Subsequent harvest after 30-40 days.
5	Others Rhodes grass Setaria grass Emil grass Mangoliagrass	150 (8 - 10 harvest)	Suitable for pasture development.

Legume fodders

- It contains 15 – 25% crude protein. Rich in calcium.
- The yield per hectare is low compared to non legume fodder.
- Five kg legume fodder is equivalent to one kg concentrate feed on protein equivalent. It will helps in reducing feed cost.

- Legume fodders contain saponin and soluble proteins. Excess feeding may cause bloat.
- Legume fodders should be fed along with other grasses and dry fodders.

S.No.	Legume fodder and variety	Yield (Tons/hectare/ year)	Remarks
1	Lucerne/Alfalfa	70-80	First harvest after 60 days. Subsequent harvest after 30 days.
2	Desmanthus CO1	100-125	First harvest after 90 days. Subsequent harvest after 40-45 days.
3	Fodder cowpea CO1	30-35 tons/harvest	Harvest 50-55 days after sowing.
4	Stylosanthus	30-35	First harvest after 75 days. Suitable for pasture development.
5	Berseem	60-100	First harvest after 60-65 days. Subsequent harvest after 30 -35 days.

Tree fodders

- Tree fodders are good source of feed for goats.
- Tree fodders can be incorporated in the ration to reduce the feed cost.
- Trees are good source of fodder even during summer and drought.
- Tree fodders are rich in calcium and low in phosphorus.
- Supplementation of mineral mixture is essential along with tree fodders.
- Many tree fodders contain anti-nutritional factors such as mimosine and tannin.
- Leaf meal can be incorporated in the concentrate mixture and total mixed ration (TMR).

Classification

- Legume tree fodders
  - Examples – Subabul, Agathai, Glyricidia, Kalyanamurungai, Velvel, Vagai etc.
  - These tree fodders contain more protein (15-30%)
- Non-legume tree fodders
  - Neem, Baniyan, Arasan, mango etc.

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FODDER MANAGEMENT DURING DROUGHT AND NATURAL DISASTERS

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Feeding is crucial to the survival of animals during disaster times and natural calamities. At least the basic nutritive supports to sustain the life of animals are essential which will ensure the prevention of mortality of animals. Under this context, it is imperative that appropriate strategies are to be followed for feeding livestock during disaster times. Further feed security for animals should be considered as important as food security for humans. The following feeding strategies should be followed:

1. Complete feed block (CFB):

Complete feed is a system of feeding concentrates and roughages together in blended form. Complete feed block is composed of forage, concentrate and other supplementary nutrients in desired proportions capable to fulfil nutrient requirement of an animal. Minimizing feed cost and labour cost and maximizing production is the need of time and can be achieved by complete feed system. This system is economical and efficient as it allows inclusion of low cost agro industrial byproducts, locally available crop residues and non-conventional feeds with their efficient utilization. The chaffed untreated or urea treated rice straw can be used as basal roughage supplemented with ingredients like mustard cake, rice bran, molasses and binder, with or without hay. Complete feed supplies readymade, balanced, low cost ration for ruminants for the benefit of landless labourers and small farmers. The blocks can be prepared in the surplus season and can be fed during scarcity and or transported easily to the deficit region for feeding of animals to save heavy loss of livestock.

2. Urea molasses multi-nutrient blocks (UMMBs):

The urea molasses mineral block (UMMB) is a strategic feed supplement for ruminant animals. It is a blend of energy, protein and minerals in the ration of ruminants to enable animals to survive until pasture conditions improve during natural calamities. The UMMB is a convenient and inexpensive method of providing a range of nutrients to the animals. UMMB can improve the utilization of low quality roughages by satisfying the nutrient requirements of the rumen microorganisms, creating a better environment for the fermentation of fibrous material and increasing production of microbial protein and volatile fatty acids. The blocks can be made from a variety of components depending on their local availability, nutritive value, price, existing facilities for their use and their influence on the quality of blocks. UMMB developed by different private and government agencies are very helpful in saving life of animals during scarcity. NDDB developed such licks containing urea 15%, molasses 45%, mineral mixture 15%, cotton seed cake 10%, salt 8%, calcite powder 4% and sodium bentonite 3%. These blocks can easily be stored, transported and distributed as against the common bulky diets available in scarcity.

3. Urea treatment of straws/stovers:

Natural fermentation of straws/stovers with urea is one of the attractive ways to improve the nutritive value of poor quality crop residues. The straw is moistened to 40% moisture by the addition of 3.5% urea solution. This is fermented by open stacking method for 9 days. The recommended treatment rate is 40 g urea/kg straw with the urea usually being added as a solution in water (40 g urea/l water) which is then sprinkled on the straw. It was observed that more than 85% of the added urea was hydrolyzed by 9th day, thereby eliminating the chances of urea toxicity to animals fed urea treated straw. The 9-day fermented wheat straw or rice straw daily supplemented with mineral mixture and vitamin A (or carotene) could meet both energy and protein requirements for maintenance of adult buffaloes and cows. The method proved to be highly applicable under field conditions. It has universal application in improving the nutritive value of many cereal (wheat, rice, barley, oat) straws, maize stovers, sorghum and pearl millet stalks. The shelf life of the fermented straw is more than one year without any deterioration in the quality. The processed straws/stalks/stovers if used judiciously could save livestock population suffering through the cruel hands (floods/draughts) of nature.

4. Silage technology for scarcity period:

The process is very simple and involves spraying of urea solution uniformly over the straw and storing it for a specific time period. A large amount of fruit left over is getting waste every day. These fruit by products are generally rich source of soluble carbohydrate containing little amount of protein to facilitate microbial fermentation. Therefore, these by products which cause a great disposal problem can be ensiled with paddy straw and poultry droppings. Paddy straw should be chaffed and mixed uniformly with other two components. Such silo should be kept for 4 weeks at least; after that it is ready for feeding of animals.

5. Ensiling of paddy straw and poultry droppings:

Paddy straw, poultry dropping, green grass and molasses in the ratio of 40: 40: 10: 10 on dry matter basis form very good silage and is highly relished by the animals.

6. Tree leaves and vegetable leaves:

Besides common fodder, shrubs and herbs like pipal, neem, mango, kathal, etc. other non-toxic tree leaves may also be fed to farm animals to supply part of their nutritional requirements. The availability of digestible protein for most of the green tree leaves is limited to 1-2% and energy equivalent to 10-15% of total digestible nutrients, on fresh basis containing about 15% dry matter. They are good source of protein (6-20% CP), calcium (0.5-2.5%) and vitamin A. The vegetable leaves and creepers like cabbage, cauliflower and potato can also be used as animal feed during scarcity; moreover, they are rich source of crude protein and fair source of soluble sugars.

7. Use of conventional and unconventional feeds:

The different kinds of conventional and unconventional feed stuffs for the preparation of different categories of rations for feeding of flood affected animals been listed below:

i. Crop residue:

Paddy straw constitutes the basal roughage of cattle and buffaloes in different states of India. It is usually stored on wooden or bamboo platform raised over the ground. This is required to minimize spoilage in the heavy rainfall areas. Crop residue available in abundance can be used for the feeding of livestock. As it contains negligible digestible protein and supply little amount of energy but it satisfies the appetite of the animal. However, treated crop residues can form a good maintenance diet for livestock.

ii. Sugarcane residue:

After harvesting the sugar cane, the green tops available as a waste can be used for the feeding of cattle and buffaloes. Sugarcane trash mostly used as fuel for the preparation of jaggery, may also be used to supply part of the roughage requirement after chaffing and enriching with more palatable and nutritious feeds. The by-product of sugarcane i.e. sugarcane tops, sugarcane bagasse, molasses can be fed to cattle and buffaloes during scarcity period.

iii. Aquatic plants:

Several types of aquatic plants are available in river, pond and other water logging areas may be used for the feeding of farm animals. Although the palatability of most of the aquatic plants is not good but the voluntary intake often exceeds 1 kg dry matter per 100 kg body weight in cattle and buffaloes. Besides supplying protein and energy, they are rich sources of carotenes. So far the common aquatic plants tested for the feeding of farm animals are water hyacinth, aquatic spinach, stalks and leaves of lotus plant (Neumbiull sp.), water chestnut (Trapa natans), hydrilla, pistia and aquatic weeds. They are available readily at most of the places during floods, which can be used in different forms for feeding of animals during scarcity.

8. Fodder Banks:

Grasses from periphery of forest area, wastelands and farmlands may be harvested and stored as hay in briquettes and high density stacks. Crop residues of the major cereals like rice and wheat straws, coarse cereals, legumes, haulms left after removing grains from the crops may be stored in these banks. This programme is used to meet the fodder needs in drought prone areas of arid and semi-arid parts of the country.

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IMPORTANCE OF FEEDING TREE FODDERS FOR THE LIVESTOCK

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Introduction:

Fodder shrubs and trees (browse) play a significant role in farming systems, protected as fallow species and livestock production. The importance of browse increases with increasing aridity and is generally most essential in the dry seasons when most other feed resources depreciate in quality and quantity. Generally, trees occupy a significant niche in the farming systems and overall way of life in animal production. The leguminous trees and shrubs are often higher in crude protein and other nutrients and play a vital role as dietary supplements of low-quality grasses in dry seasons. Livestock depends largely on browsing for their dietary protein. Browse intake increases total dry matter intake, increases crude protein intake, and improves the digestibility of low-quality forages. The effect of browse feeding on livestock is shown in increased survivability (i.e., lower mortalities, especially over the dry season) and increased productivity.

A shortage of high-quality dry-season fodder supply has been widely recognised as one of the main constraints to animal production in the tropics, where long drought periods frequently occur. Tropical trees have been used over many years as sources of fodder, fuelwood, and timber in Africa, Asia, Latin America and Australia. Increasing attention has been given to species that fix atmospheric nitrogen such as Leucaena spp.; G. sepium and Acacia spp., which are now an essential component in the farming system in many countries in the tropics. A great diversity of tree species could be integrated successfully into the small farming systems worldwide.

Choice of tree species

Essential characteristics required of an alley farming tree species include the following: fast-growing, nitrogen-fixing, nitrogen-rich leaves, tolerance to pruning, ability to coppice vigorously and good fodder value. In addition to these, such other characteristics as high foliage productivity, vigorous taproot development, and dry season leaf retention are advantageous

Important Fodder Trees

Sr. No.	Common / English Name	Scientific name	Commonly grown area's
1	Subabul	*Leucaena leucocephala*	Sub humid, Semiarid
2	Gliricidia	*Gliricidiasepium*	Humid, sub humid
3	Ardu	*Alianthusexcelsa*	Arid and semiarid regions
4	Agathi	*Sesbania grandiflora*	Arid and semiarid regions

5	Shevri	*Sesbania sesban*	Arid and semiarid regions
6	Khejri	*Prosopis cinereria*	Arid and semiarid regions
7	Mahua	*Bassia latifolia* - Flower	Semi arid
8	Babul	*Acacia Nilotica*	Dry and moist tropics
9	Neem	*Azadirachta indica*	Dry and moist tropics
10	Kachnar	*Bauhinia variegata*	Sub tropics, moist and dry tropics
11	Safed siris	*Albizia procera*	Wet tropical and subtropical
12	Lallei	*Albizia amara*	Dry tropics
13	Siris	*Albizia lebbeck*	Moist and dry tropics
14	Shisham	*Dalbergia sissoo*	Moist tropics
15	Mulbery	*Morus alba*	Moist tropics
16	Bola	*Morus laevigata*	Subtropics
17	Drum stick	*Moringa oleifera*	Moist tropics, sub humid Humid
18	Kikkar	*Prosopis chilensis*	Dry tropics
19	Ber	*Ziziphus mauritiana*	Dry and moist tropics

AGRONOMIC TECHNIQUES FOR TREE FODDERS

Soundal / (Koobabul) (*Leucaena leucocephala)*

Common Names: Subabul, Leucaena &ipil-ipil, etc.

Distribution: It is one of the fast growing hardy evergreen species. It is a vigorous coppicer and responds well to pollarding, lopping & pruning. It has deep and strong taproot and even the seedlings are deep rooted. Can be grown in Kanchipuram, Tiruvallore, Vellore, Tiruvannamalai, Cuddalore, Villupuram, Salem, Namakkal, Dharmapuri, Erode, Coimbatore, Tiruchirapalli, Perambalur, Karur, Thanjavur, Tiruvarur, Nagapattinam, Pudukkottai, Ramanathapuram, Tirunelveli, Thoothukudi, Kanyakumari, Virudhunagar and Sivagangai districts.

There are four types of subabul viz,

Hawaiian type: The plants are short bushy and remarkably drought tolerant. It is suited to hilly terrains in drought prone areas. It is a prolific seed producer and is good for fodder purpose.

Salvador type: Tall, tree like and fast growing having maximum annual biomass production. Possesses large leaves, pods and seeds than Hawailian types. Responds to high fertilization.

Peru: Tall and extensively branching type and is ideal for fodder purpose.

Cunningham: It is a cross between Salvador and Peru types.

Ecology: Subabul is best suited for warm regions and grows well between 22 and 30oC in regions of 500 to 2000 mm annual rainfall. Because of its strong and deep root system, the tree is highly drought resistant. It is restricted to elevations below 500 m but withstands variations in rainfall, sunlight, windstorm, slight frost and drought.

Soil: It cannot withstand water logging. It requires deep well drained neutral soil and can tolerate saline and acid soil. It can also be grown in steep slopes, hilly terrains, gravelly areas and sandy loams. It can grow under a wide range of conditions as a range plant, roadside plant, in pastures, etc. The land should, however, be cleared of bushes, ploughed and levelled before sowing.

Phenology: The leaves are bipinnate, 15 to 20 cm long with 10 to 15 pairs of pinnate leaves. Inflorescence is globular and the flowers are white.

Commercial Uses: Subabul wood can be used for light construction, poles, props, pulp, furniture, flooring and fuel wood. Subabul wood is an excellent fuel wood with a specific gravity of 0.45-0.55 and a high heating value of 4000 kcal/kg.

Subabul forage has a high protein and carotene content and pellets or cubes are internationally marketed as animal feed.

Season and Variety

Jun - Jul Hawaiian giant (lvory coast), CO1

Rainfed (Sep - Oct) K 8, Giant Ipil - Ipil, CO 1

Package of practices

a) Ploughing the field: Plough twice with an iron plough and 3 or 4 times with country plough to obtain good tilth.

b) Application of FYM: Apply and spread 25 t/ha of FYM or compost on the unploughed field and incorporate the manure into the soil during ploughing.

c) Forming Ridges and Furrows: Form ridges and furrows (using a ridger) 6 m long 1 m apart and form irrigation channels across the furrows. Spacing is 100 x 30 cm. Wide spacing is given for fodder purpose.

d) Application of Fertilizers

a. Apply NPK fertilizers as per soil test recommendations as far as possible. If soil testing is not done, follow the blanket recommendation of 10:60:30 kg NPK/ha.

b. Apply full dose of NPK basally before sowing

e) Sowing

a. Maintain a seed rate of 10 kg /ha for fodder and 1.25 kg for fuel.

b. Hard seeds require scarification to obtain high and uniform germination. Scarification of seeds can be done by pounding the seeds with sand in mortar. Acid scarification is done by dipping the seeds in concentrated sulphuric acid for three minutes and washing thoroughly with tap water.

The easiest method is hot water treatment. Seeds are soaked in hot water (80^{o}C) for 4 minutes. (Boiling water removed from the flame and kept for 4 minutes comes down to 80^{o}C)

c. Seed treatment with Rhizobial culture. After scarification, treat the seeds with Rhizobial inoculants using rice kanji as binder

f) Water Management: This may be done wherever the crop is raised under irrigation. Once established, this plant can withstand several months of dry weather. However, to ensure rapid seedling growth, the land should be adequately moist upto 5-6 months. In summer, irrigation once in 6 weeks is adequate.

g) Harvesting: Plants can be harvested in as short as 6 months after planting. However, the initial cutting should not be done until the trunk has attained atleast 3 cm diameter or the plant has completed one seed production cycle. Harvests can be repeated once in 40 - 80 days depending upon growth and season. In drought prone areas, allow the trees to grow for two years to ensure deep root penetration before commencing harvest. The trees can be cut at 90 to 100 cm height ground level. For fuel purposes, allow the tree to grow straight without cutting for 2.5 or 5 years as the case may be.

h) Yield: As green fodder under irrigated conditions, a pure crop yields about 80 to 100t/ha of green fodder. Under rainfed conditions 40t/ha of green fodder is got after 2 years of initial growth and pruning to a height of 100 cm.

i) Forage management

Leucaena may be lightly grazed in the first year after seedling and heavily grazed after the second year. Average yield ranges from 3 to 30 t DM/ha/year depending on soil, temperature and moisture conditions. For optimal yields, harvest interval can vary from 6-8 weeks in very productive sites to 12 weeks in less productive ones.

Gliricidia

Species: *Gliricidia sepium* and *Gliricidia maculate*

Phenology: *Gliricidia sepium*(Jacq.) is a small thornless, semi-deciduous tree normally growing to 15 m if allowed, and will develop a trunk of about 30 cm diameter; however it is often grown under management systems which keep its overall size and development much smaller than this and its overall shape within agricultural environments tends to be modified by lopping and pruning. The leaves are alternate and pinnate meaning that each complete leaf is made of a group of smaller leaflets. Commonly the total leaf is 15-30 cm composed of 7-17 leaflet

pairs plus a terminal leaflet. The tree produces flowers called racemes or panicles measuring 5-12 cm, these are borne at the base of the leaves. The tree produces flattened pods typical of many leguminous trees; these can vary from 10-15 cm and contain 3-8 circular and flattened seeds.

Distribution: *Gliricidia sepium*is a native of Central America and Mexico. It has now been widely introduced as an exotic in many parts of the tropics due to its high productivity and adaptability to a wide range of sites. It is easy to germinate, to establish and to grow either as an agroforestry species or as a pure crop.

*Gliricidia sepium*is a tolerant species suited to moderate altitudes (0-1,200 m). Its rainfall range is 600-1,500 mm and can tolerate dry season for 3-6 months. The species grows best in deep, well textured soils with good drainage and almost neutral in terms of acidity. However, it will tolerate shallow soils and those with high lime content and can be considered for both

clay and sandy textured soils. It can also be used in slightly saline soils. Because of its acceptance to a wide range of sites, its potential range is extremely wide.

Propagation: Standard method for propagating this species tends to be through the use of cuttings since the species propagates so easily in this manner. However it can also be propagated without problems from seed. Unlike many legumes, seed treatment is not required prior to sowing. Cuttings of about 50 cm long and 1-2 cm in diameter should be prepared at the onset of the wet season. Larger material can be used especially if it is to be planted as a hedge or a live fence rather than as a fuel wood plantation.

Spacing: Pure crop - spacing should be within the range of 2 x 2 metre to 1 x 1 metres

Manures and fertilizers: For most soils the use of fertilizer for the Gliricidia would not be warranted

Yield: The leaves of this species are widely used as a fodder for cattle and goats. The leaves provide a high nutritive value with a crude protein content of 18- 30% and an in-vitro digestibility of 60-65%. Green fodder yield is 40 t/ha/year.

Forage management

*Gliricidia sepium*can be lopped around 7 months after establishment on plants grown from cuttings and 14 months after seedling. Thereafter lopping can be done every 2 to 3 months during the rainy season and every 3 to 4 months during the dry season, provided regrowth reaches 1-2 m high before harvest.

Sesbania - (*Sesbania grandiflora)* - Agathi

Phenology: Agati (*Sesbania grandiflora* (L.) is a legume tree used for fodder in humid tropical regions. *Sesbania grandiflora* is a fast-growing perennial, deciduous or evergreen legume tree, up to 10-15 m high. Its lifespan is about 20 years. Its roots are heavily nodulated and some floating roots may develop in waterlogged conditions. The trunk is straight with few branches. The leaves, up to 30 cm long, are pinnately compound with 20-50 oblong leaflets, 1-4 cm long and 0.5-1.5 cm broad.

The flowers are white, yellowish, pink or red and borne in axillary racemes. The pods are 50-60 cm long, glabrous and indehiscent, and hang vertically. They contain 15 to 50 dark brown seeds, 5 mm long and 2.5-3 mm broad.

Utilisation: *Sesbania grandiflora* is a valued fodder for ruminants. It is used in grazed paddocks as mature trees are out of browse height, or as cut-and-carry forage integrated into cropping systems. Its low tolerance to defoliation makes it badly suited to direct grazing. The leaves, flowers and pods of *Sesbania grandiflora* are eaten as a vegetable in Southeast Asia. The dried leaves are used for their ethno medicinal properties. Other uses include firewood and green manure.

Distribution: *Sesbania grandiflora* is native to Asia and is now widespread in most humid tropical regions of the world. It is often cultivated on the low dikes between rice fields or in association with Guinea grass.

Optimal growth conditions are 22-30°C mean annual temperatures, 2000- 4000 mm annual rainfall, at an altitude from sea level up to 800-1000 m. Agathi is adapted to a wide range of rainfall zones and soil types. It can be grown on heavy clay, alkaline and saline soils, as well as poorly drained soils and poorly fertilized soils. During waterlogging and floods, it

develops floating adventitious roots and protective spongy tissue. Agathi withstands acidic soils, 6- to 7-month drought periods and can survive with 800 mm annual rainfall. It is intolerant of high winds that can break stems and branches. It does not thrive in temperatures below 10°C. The leaves of sesbania trees are highly palatable and mostly liked by goats. The protein content in agathi is about 25 %.

Season: Grown throughout the year under irrigation. Comes up in soils with good drainage

Package of practices

a) **Ploughing the Field:** Plough two to three times with an iron plough to obtain good tilth.

b) **Application of FYM:** Apply and spread 25 t/ha of FYM or compost on the unploughed field and incorporate the manure into the soil during ploughing.

c) **Forming ridges and furrows:** Form ridges and furrows 100 cm apart using ridger and irrigation channels across furrows.

d) Application of Fertilizers

a. Apply NPK fertilizer as per soil test recommendations as far as possible. If the soil testing is not done, follow the blanket recommendations of 10:25:12.5 kg NPK /ha.

b. Apply full dose of NPK basally before sowing.

c. Open a furrow 5 cm deep on the side of the ridges and place the fertilizer mixture at the above rate along the furrows and cover with soil.

d. Top dress 12.5 kg Phosphorus once in two years.

e) Sowing: Seed rate is 7.5 kg /ha, sow the seeds at a spacing of 100 cm x 100 cm (100 cm between ridges and 100 cm between plants within the ridge)

f) Water Management: Irrigate immediately after sowing, and thereafter once in 15 days

g) Weed Management: Hoeing and weeding are given as and when necessary.

h) Harvesting: First cut after 8 months subsequent harvests at an interval of 60-80 days. Green fodder yield of 100 tonnes per year is obtained from one hectare.

i) Forage management: *Sesbania grandiflora* is notable for its rapid early growth (up to 2 m high within 100 days after seedling). If the trees are cut back to a suitable height, a large supply of fresh fodder can be obtained for most of the dry season, when only rice straw and dry grass are otherwise available.

FODDER ESTABLISHMENT AND MANAGEMENT

Planting methods Direct seeding Trees such as Gliricidia spp., Sesbania spp. and Leucaena sp., can be planted by direct seeds in rows into fully prepared seed beds or into cultivated strips in existing grasslands.

Vegetative propagation

Vegetative propagation has the advantage of the more rapid establishment of new stands that are genetically identical to the parent lines without seed collection. Disadvantages are that it requires more hand labour and the root development of cuttings may be shallow and devoid of a strong taproot compared with seedling grown trees. Shallow rooted trees are more susceptible to drought and wind damage.

Most of the tree fodder species can be propagated by seed but a number, including G. sepium and Erythrina spp., can also be established vegetatively using stem cuttings. G. sepium is

commonly planted vegetatively from cuttings and is ideal for shade trees, support trees or living fences. Cuttings should be mature branches >7 cm in diameter which are brownish-green in bark colour. The cutting is normally cut obliquely at both ends, discarding the younger tips, and the base inserted 10-20 cm into the soil deepen ding on the length of the cutting. The Sesbanthias pecies seed prolifically and are normally planted from seed, although research suggests that some sesbanias can be established from cuttings.

Seedlings

Most tree fodder species are readily established from transplanted seedlings. Seedlings are first grown in nurseries in polythene bags or in small plastic dibble tubes until they reach a height of 30-5 0 cm. After that, seedlings are directly transplanted into the field into moist soil. Stump cuttings can be made from seedlings which reach 60-90 cm in height and 10-20 mm diameter in nursery seedbeds. They are carefully removed when the seedbed is thoroughly wet and stem and roots cut 15-20 cm above and below the crown.

Method of harvesting the tree fodder

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

1. **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 vigour diminishes. Subabul and *Gliricidia sepium* are examples of good coppiciers.

2. **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.

3. **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 fodder resources and consequent soil erosion.Intensity and frequency of lopping depend upon the species, age, growth rate of the tree, soil type etc.

4. **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, Gliricidi asepium, Subabul, Acacia etc. respond for pruning.

5. **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 pollard 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.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.

Importance of Tree fodder:

Leaves, tender shoots, flowers, pods and seeds of all these trees and shrubs can be fed to ruminants (cattle, buffaloes, sheep and goats) and to non-ruminants (pigs, rabbits and poultry). They contain high levels of protein and some important minerals like phosphorus (P) which make your animals grow rapidly. (See table.)

Average percentage of dry-matter content

(%)	Protein	P	Fibre
Leucaena [a]	22	0.12	20
Gliricidia [a]	23	0.20	21
Mesquite [b]	36/14	0.20	6/28
Pigeon pea [a]	23	0.20	30

[a] Green leaves and shoots [b] Seeds/Pods.

They also contain high levels of fibre. This rapidly fills the stomachs of pigs and chickens, so these tree fodders are more suitable for cattle, sheep and goats than for non-ruminant animals.Some tree fodders contain toxic compounds and so you should not feed a lot of this type of fodder to any animal, including cattle, sheep and goats.

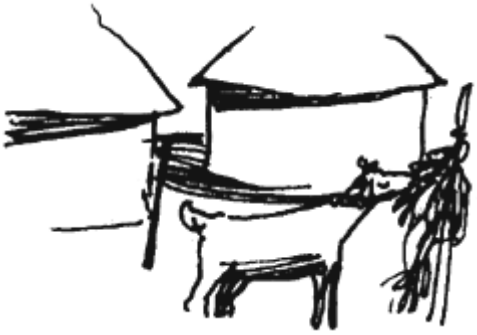
How much tree fodder can you feed to your livestock, and should you feed them green, fresh or dried?

The easiest way to feed the fodder is to let your cattle, sheep, goats or camels browse directly on trees in the range, in fallow land or in your backyard, if the trees are not too tall.

If the trees are too tall, you may have to cut the branches

and carry them to your animals to eat

in the field,



in your backyard,

or in the stall.

In this way, your animals will eat fresh leaves and small stems. Goats will sometimes eat the bark of large stems and this is also good for them.Another way is to feed dry forage. Cut it and dry it in the sun for a few days, then store it for feeding later on.

In this dried form that you should feed the fodder to pigs and chickens. After sun-drying, crush or grind the leaves and small stems to make a leafmeal which you can feed directly or mix with other

feeds.

How much tree fodder should be fed to livestock?

Many fodder trees such as *Gliricidia* and *Sesbania* contain very little or no toxic compounds. Hence these can be fed a lot to ruminants, as much as they will eat, particularly during the dry season when there is no other green feed available.Other trees such as *Leucaena* contain toxic compounds that can harm your animals, including ruminants, pigs and chickens. It is therefore need to mix them with other feeds to dilute the toxic compounds.For example, If you feed a mixture of *Leucaena* and *Gliricidia* to sheep and goats, make sure that *Leucaena* is not more than 30 to 40 percent of the mixture.You can also mix one part of dry *Leucaena* with one and a half or two parts of crop residues such as maize bran or stovers, **but always provide your animals with salt blocks when feeding them *Leucaena*.**If you cannot mix the fodder with other feeds because, for example, your animals go out to eat crop residues, grass, hay or straw in the field, offer them an amount of fodder equal to 2 percent of their body weight to supplement the crop residue, grass or hay.For pigs, rabbits and chickens, the amount you can feed is even smaller. **In any case do not exceed 10 to 15 percent of the diet for pigs, laying hens and rabbits, and 5 to 10 percent for growing chickens.**

Seeds of trees such as pigeon pea and *Prosopis juliflora* also contain some harmful substances that can be destroyed by heating. Treat the seeds with heat to destroy these substances before feeding your animals.

When the farmer feed fodder from these trees and shrubs to *ruminants* as the only feed (100 percent), combine at least two, or more, sorts of fodder and then fed to animals. For example, mix one part of *Leucaena* with three parts of *Gliricidia*. Sheep and goats like this mixture. You can also mix one part (40 percent) of the tree fodder with one and a half

parts (60 percent) of grasses, hay straw or crop residues (fresh, green or dried).**For non-ruminants such as pigs and chickens, dry and grind the fodder, and feed only between 5 to 15 percent of leaves and stems, and no more than 40 percent of pods and seeds in the diet.**

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CULTIVATION OF BAJRA NAPIER CO(BN) – 4 & 5 AND MULTICUT SORGHUM (COFS -29 & 31) SHARING OF EXPERIENCE OF FODDER CULTIVATION IN THE CAUVERY DELTA REGION

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INTRODUCTION

Among various issues to be addressed in the Indian dairy sector, fodder production and feeding have been critical for improved production and productivity. However, although various attempts were made to promote fodder production in field conditions over the years, the farmers have a poor response for fodder cultivation and feeding. This might be due to significant constraints like lack of awareness and inputs, pressure on land for cultivation of food/commercial crops, poor socio-economic status of the farmers, shrinking of common property resources etc. Further, the attitude and knowledge level of the dairy farmers also plays a pivotal role in the adoption of recommended animal husbandry practices, including green fodder cultivation and feeding.

It should be noted that livestock producers meet their fodder requirements by combining crop residues, grazing (on common lands, private lands, forests, fallow agricultural lands and harvested agricultural lands) and cultivated forage crops (primarily by large landholders), while some of them purchase fodder. However, there is an acute shortage of green and dry fodder and a lack of scientific information for the farming community about fodder production.

In this context, various initiatives have been undertaken by various agencies (public, private, NGOs, etc.) to promote green fodder production and distribution of fodder seeds/root slips at institutional and farmers' levels. These agencies are also involved in establishing fodder seed production farms and fodder nurseries to support the production and availability of improved fodder varieties. These farms also serve as demonstration and training units for fodder production and promotion. As a result, the seeds/root slips of improved varieties with a higher chance of survival are distributed at a nominal rate, encouraging fodder production.

FODDER SCENARIO IN TAMIL NADU:

According to the report of Thirunavukkarasu *et al*. (2012), The total livestock population of the state was 81.46 lakh ACUs, of which nearly three-fourths (71.72 Percent) were cattle and 18.24 Percent buffaloes, while sheep and goats were almost equal (5 Percent). Villupuram, Salem and Erode districts had larger livestock populations (6.16, 5.89 and 5.08 lakh ACUs, respectively), while Vellore, Tirunelveli, Thiruvannamalai, Thanjavur and Kancheepuram districts too had substantial livestock wealth. This shows that the distribution of livestock wealth in the state is scattered and not concentrated in a particular area/zone.

Total availability of green fodder in the state was 328.60 lakh tons, of which the enormous amount was produced in Erode district (111.76 lakh tons), followed by Namakkal, Villupuram, Salem, Thiruvannamalai, Karur, Cuddalore and Dindigul districts in that order (with 21.11, 17.97, 14.23, 13.35, 12.20, 11.39 and 11.35 lakh tons, respectively). These

leading districts in green fodder production are located in the north and western parts of the State, with all the districts in the east and southern parts of the state faring poorly.

The total green fodder required for the livestock in the state estimated based on the rule of 2.5Percent of dry matter per 100 kg body weight was 297.34 lakh tons. As the requirement is based on the livestock population, Villupuram, Salem and erode districts required 22.48, 21.51 and 18.54 lakh tons of green fodder due to their vast livestock wealth. On the other hand, Vellore, Tirunelveli, Thiruvannamalai, Thanjavur and Kancheepuram districts needed more considerable amounts of green fodder due to their impressive livestock wealth.

The paddy producing districts such as Thiruvarur, Nagapattinam, Kancheepuram, Thiruvallur, Thanjavur and Kanyakumari suffered from a severe shortage of green fodder (≤ 2.00 ton per annum per ACU). Thiruchirapalli, Ramanathapuram, Pudukottai, Sivagangai, Perambalur, Salem, Tirunelveli and Vellore were also deficit (-1.00 to -2.00 tons) districts, though not that much severe, while in Krishnagiri, Villupuram, Dharmapuri, Virudhunagar, Madurai and Coimbatore districts, the deficit was modest (-0.99 to 0.00 ton). It needs to be noted that although Salem district ranked second in the state in green fodder output, its quantum was insufficient to support their livestock. Thiruvannamalai, Thoothukudi. On the other hand, Namakkal, Theni, Karur and the Nilgiris districts led the state to be surplus (by 31.22 tons per annum overall and 0.38 ton per annum per ACU) in green fodder.

Fodder sold to the farmers through Fodder Production Unit, Livestock Farm Complex, VCRI, TANUVAS, Orathanadu

Construction in fodder Area Development:

Even through the various institute agencies government taken step for increasing fodder and to reduce the demand go practically faced several hurdles implementing the programme.

The main constraints can be described as;

1. **Reduced area under fodder crops:** The division of the families has fragmented the land. At present, landholdings are minimal and farmers are always biased in the choice of the crops. Due to these reasons, agricultural land ratio does not permit land diversion from food production to cultivated fodder. Thus, an area under fodder crops is meagre.
2. **Uncontrolled grazing:**
   This has led to a decline in biomass availability. The grazing pattern has created various problems in these pastures. The obnoxious weeds have invaded the pastures. Excessive and continuous grazing has severely damaged to soil erosion sand degradation.
3. **Poor crop management Practices:**
   Crop management practices play an essential role in determining the productivity of grasslands. The presence of inferior and unproductive grass species, lack of fertilizer application and absence of legume crop, improper harvesting and indiscriminate grazing are some of the important factors responsible for the poor productivity of grasslands. There is a wealth of indigenous and scientific knowledge for its proper utilisation and management of the natural resource base, but farmers are not interested

to op of the techniques in fodder cultivation pressure for production less adaptation of new techniques causes declining the land productivity.

4. **Intense but unproductive livestock population:** Livestock is an integral component of Indian agriculture since time immemorial. Its contribution to the national economy through milk, meat, wool, and farmyard manure is enormous. We have approximately 20 Percent of the world's cattle, 50 Percent of buffaloes, more than 120 million goats and 60 million sheep (Roy, 1993). However, due to religious beliefs, the population of unproductive cattle is increasing. This considerable population and poor fodder availability have widened the gap between demand and supply forage crops. It is a fact that considerable fodder resources are wasted on the maintenance of an excessive number of poorly fed and low yielding animals, which contributed to the process of pasture destruction.
5. **Fodder tree use:** Globally Indian sub-continent is one of the richest in biodiversities. For instance, the Himalayas supports about 84 trees and 40 shrubs of fodder value, yet farmers extensively use not more than 20 trees. Tree leaf fodder is the primary feed resource during lean periods. Over exploitation and unscientific management of fodder trees have depleted this resource at a substantial environmental cost.

Extension Strategies for Revitalising Fodder Production

Extension strategies can bring the desired changes in the behaviour of fodder cultivating farmers (Singh, *etal*., 2012). The components of extension strategy can be described below:

1. **Creating awareness in fodder cultivation:** There is utmost need to organise method/result demonstrations and organising field days showing the monetary gain and benefits of cultivating high yielding varieties fodder crops.
2. **Strengthening the extension and development activities:** Farmers can be motivated through campaigning for growing perennial fodder crops (e.g. Cumbu Napier and Desmantus) in pond bank, farmhouse, roadside, embankment etc., Extension personnel should also help in the identification of effective technologies and their transfer to fields. Hence, it can be quickly adopted by the stakeholders.
3. **Capacity building programme for farmers and extension functionaries:** The skilled extension staff is loaded with veterinary and artificial insemination activities alone. There is a need to strengthen the human resources of animal husbandry departments across the country, especially in Tamil Nadu, which should be trained in the latest technologies to support the livestock owners both in terms of animal health as well as management aspects. Training must also be conducted to train the fodder growers to keep them abreast with the latest technical know-how.
4. **On-farm evaluation of fodder technologies:** On-farm evaluation and demonstration of existing technologies may be attempted to narrow the gap between yields realised on farmers fields and those on research stations. Providing the basic advice to the farmers is essential, enabling them to withstand a competitive market. In addition, adaptive research on fodder production technology must be encouraged by providing necessary feedback from the farmers' field.
5. **Conservation of forages to meet the demand in crisis:** Fodder scarcity is primarily observed in the dry season and during floods. Therefore, conserved forages enriched

with nutrients like energy, protein and vitamins and low-cost methods of silage making are to be promoted among the farmers.

Scientific Interventions for Revitalising Fodder Production Technologies

The holistic approach of integrated resource management will maintain the fragile balance between productivity functions and conservation practices for ecological sustainability. Some scientific interventions, which could help improve the productivity of forages, are described here.

A. **Agronomic management practice for forage crops:**

Herbage production from grassland sand meadows can be enhanced with the adoption of improved technology. Important components of this technology are:

- Control of bushes and weeds
- Improved pasture establishment
- Introduction of legumes/new grasses species
- Fertiliser application
- Planning to adopt proper Cutting and grazing management

B. Scientific cultivation of fodder crops:

To augment fodder availability, emphasis needs to be given to cultivating fodder crops on large areas. Important fodder crops of the temperate region are; *Avena sativa*, *Brassica* sp., *Medicago sativa*, *Pisum sativum* trifollun, tropical fodder cowpea etc. (Sing *et al*., 2012). The foliage of fodder trees sesbanias glyricidea sepium, *luceana lucachephela* , Desmantus *etc*. could be fed to livestock in a mixture of crop residues and hay. Mixing tree foliage with dry roughage improves their palatability and nutritive value.

C. Adoption of Silvi-pastoral System:

Silvi-pasture implies sustained and combined management of the same land for herbaceous fodder, top feeds and fuel wood, thereby optimising production.

D. Forage production on terrace risers or bunds: (Ex. *luceana lucachephela* + Guniea crass)

Forage grasses/legumes/fodder trees grown on terrace risers and bunds arrest the nutrient loss in runoff water under rainfed conditions. This gives an added advantage to producing forage without any fertiliser or manure.

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AGRO-FORESTY MODELS IN FODDER PRODUCTION

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Introduction

Livestock are key components of farming systems throughout the world. Although livestock are often associated with wealth in many countries, approximately 1 billion head of livestock are held by more than 600 million poor smallholders, comprising approximately 70 percent of the world's rural poor**.**

Low quality and quantity of feeds are major constraints limiting animal productivity. In both developing and developed countries, the supply of livestock feed has become more scarce because of diminishing land availability due to the reduction in the quantity and quality of rangeland and natural grasslands. Changing cropping patterns, such as the recent increase in the area under crops for biofuels, further exacerbates feed availability. Fodder trees and shrubs encountered these problems and provide the new solutions to feed problems.

Agroforestry is a collective name for land use systems and practices in which woody perennials are deliberately integrated with crops and/or animals on the same land management.

There are different types of agroforestry practices that can be used, these includes improved fallow, Taungya, home gardens, alley cropping, growing multipurpose trees and shrubs on farmland, boundary planting, farm woodlots, orchards or tree gardens, plantation/crop combinations, shelterbelts, windbreaks, conservation hedges, fodder banks, live fences, trees on pastures, and apiculture with trees (Nair, 1993). The different types of agroforestry technologies have been found to address specific human and environmental needs. One of the important benefits is the production of fodder to feed livestock.

Global scenario

Agroforestry is practiced in all continents of the world. A high percentage of tree cover is found in nearly all continents of the world, the highest being in Central America and Southeast Asia. Almost half of the world's agricultural lands have at least a 10 percent tree cover, suggesting that agroforestry, an integrated system of trees, crops and/or livestock within a managed farm or agricultural landscape, is widespread (Franzel*t al*., 2014).

Agroforestry research at the international level is conducted by the International Centre for Research in Agroforestry, now named as World Agroforestry Centre, which was started in 1978 at Nairobi in Kenya. Now it is a CGIAR Consortium Research Centre with five regional offices located in Cameroon, India, Indonesia, Kenya and Peru. The Center's aim is to increase use of trees in agricultural landscapes to improve their food security, nutrition, income, health, shelter, social cohesion, energy resources, and environmental sustainability of small holders.

Indian scenario

Indian agriculture is facing diverse challenges and constraints due to growing demographic pressure, increasing food, feed, pulp, fodder and timber needs, natural resource degradation, and climate change. Diversification of land use with agroforestry as a component can address some of these challenges.

India faces a critical imbalance in its natural resource base with about 18 percent human and 15 percent livestock population of the world being supported only on 2.4 percent

geographical area, 1.5 Percent forest and pasture lands and 4.2 percent water resources. Presently, in India, about 60 Percent the cropped area is rainfed, which contribute about 44 percent food-grain production. Its contribution in coarse cereals and pulses is about 90 Percent, in oilseeds 60 Percent and in the case of cotton it is about 80 percent (FAO, 2005). A significant proportion of livestock population (66 Percent) is also in the rainfed areas. However, these areas are characterized by low input use and low yield levels. For such areas, diversification of land use systems with agroforestry is a necessary strategy for providing variety of products for meeting requirements of the people, insurance against risks caused by weather aberrations, controlling erosion hazards and ensuring sustainable production on a long-term basis.

To meet the requirement of the population in 2050 an increase by 1.5 times in fodder, two times in food grains and fuel wood, and three times in timber production will be required (Table 1).

Table 1. Total domestic demand for various commodities award

Items	2010-11	Projected for 2025	Projected for 2050	Contribution from agroforestry in 2050
Food grains (Mt)	218.20	320.00	457.1	41.14*
Fruits (Mt)	71.20	106.00	305.3	47.74*
Fodder (Mt)	1061.00	1170.00	1545	154.50
Fuel wood (Mt)	308.00	479.00	629	308.00
Timber (Mt)	120.00	171.00	347	295.00
Biodiesel (Mt) required for 20Percent blending of diesel	12.94	22.21	37.92	30.34
Area (Mha) required for TBOS	12.32	15.86	21.67	17.34

*Food-grains/fruits production from systematic agroforestry systems viz. agri-silviculture/agri-horticulture only considered

The organized agroforestry research in India began in the late eighties when the Indian Council of Agricultural Research launched the All India Coordinated Research Project (AICRP) on Agroforestry in 1983. Further, National Research Centre for Agroforestry was established in 1988 at Jhansi to accelerate basic, strategic and applied research in agroforestry, now named as Central Agroforestry Research Institute (CAFRI) in December 2014. At present, there are 37 Centers under AICRP on Agroforestry representing the major agro-ecologies of the country with the project coordinating unit at CAFRI, Jhansi.

At present agroforestry meets almost half of the demand of fuelwood, 2/3 of the small timber, 70-80Percent wood for plywood, 60Percent raw material for paper pulp and 9-11Percent of the green fodder requirement of livestock, besides meeting the subsistence needs of households for food, fruit, fiber, medicine, timber, etc. However, current biomass productivity per unit area and time is less than 2 t/ha/y. Agroforestry practices have

demonstrated that this could be safely enhanced to 10 t/ha/y by carefully selecting tree-crop combinations.

Objectives of Agroforestry

a) **Biomass production**
   The maximum production of biomass per unit area in time is the primary objective of agroforestry systems.

b) **Soil management**
   To manage land efficiently so that its productivity is increased and restored. Agroforestry practices enrich soil by nitrogen fixation and addition of organic matter. Agroforestry helps in meeting nutrient requirement of plants growing in association with trees and at the same time, the soil structure and infiltration rates are also improved.

c) **Soil conservation**
   Compared to the permissible limit of soil loss 4.5 t/ha/y, the average soil displaced is around 16 t/ha/y. Wastelands should be treated through agroforestry.

d) **Agro-based village industries**
   To provide raw materials for developing small cottage industries in rural areas (namely, wood, pulp, fiber, medicinal material ingredients and oils, gum, wax, resin, lac, tannins, dye, green manure, soap substitutes, etc.).

e) **Moderation of micro-climate**
   The micro-environment in the neighbourhood of trees is moderated by adopting an agroforestry programme. The field crops in vicinity of trees receive multidirectional effects and benefits. The impact is more prominent in arid and semi-arid zones.

f) **Basic rural needs**
   To provide basic needs of small and marginal farmers for food, feed, fodder, fruit, firewood, small timber, etc.

g) **Employment**
   To generate employment opportunities to rural poor.

h) **Land improvement**
   Improvement of degraded lands and wastelands is done. Increased productivity Through the increase production of fruits, fodder, fuelwood, and forest products.

Characteristics of Model Agro-Forestry Trees

Characteristics of model trees vary by location and environment but some of the most frequently cited characteristics include:

a) Easy establishment.
b) High productivity under repeated cutting, grazing or browsing.
c) Resistance to pests and diseases.
d) High seed production ability or reliable vegetative propagation.
e) High production of good quality forage in terms of protein, minerals, palatability, and digestibility.
f) Suitability to different environments (e.g., temperature, rainfall, soil acidity, drainage, or salinity).

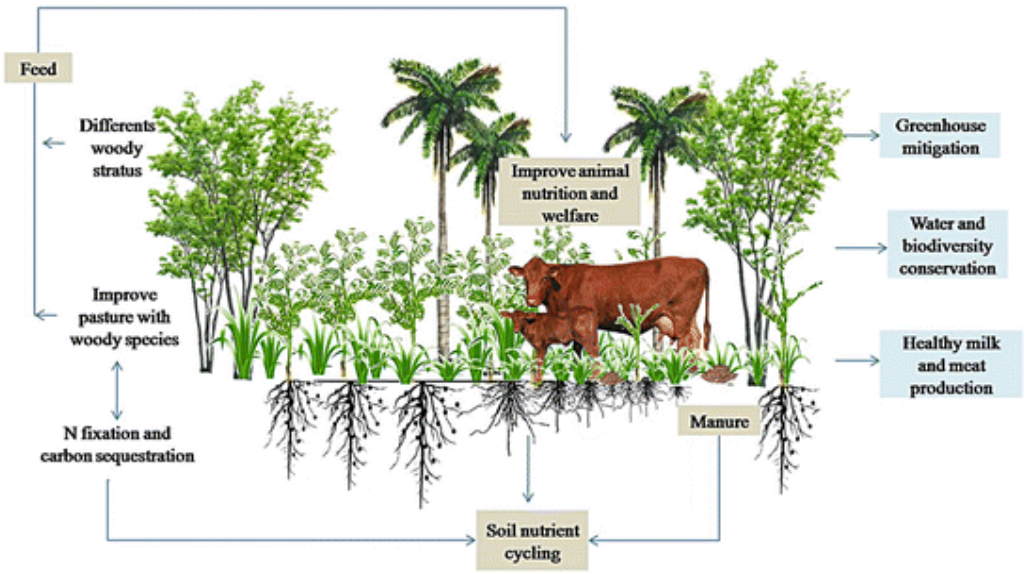

Fig. 1. Silvi-agro-forestry model for mitigating the green house gas

Classification of Agroforestry System (Nair, 1993)

1. **Structural Classification**

Structural classification is done on the basis of

A. Based on Nature of Components.

B. Based on the Arrangement of the Components.

A. Based on Nature of Components

I. Based on Presence.

II. Based on Dominance.

i. Based on Presence

a. Agri-silviculture (Crops and trees).

b. Silvo-pastoral (Pasture/ Animals and trees).

c. Agro-silvo-pastoral (Crops, Pasture/ animals and trees).

d. Others: Multipurpose tree lots, apiculture with trees, aquaculture with trees, etc.

ii. Based on Dominance of Components

Based on the dominance of components, it classified into the following categories.

a. **Silviagriculture:** Here, silviculture is the primary aim of land use. Trees constitute the major component while agricultural crops are integrated with them. e.g., Shifting cultivation, Taungya cultivation.

b. **Agrisilviculture:** Agriculture is the primary (major) component, and the trees are secondary. e.g., Multipurpose trees on farmland, hedge-row or alley cropping, intercropping of trees, home gardens.

c. **Silvipasture:** Trees constitute the primary (major) component of land use, with pastures as secondary. Most grazing in forests can be treated as Silvopasture.

d. **Pastoral silviculture:** Pasture is a primary component while the trees are secondary. e.g., Grazing land.

e. **Agrisilvipasture:** It is a combination of crops, trees, and pastures. Both crops and trees are dominant over the pasture.
f. **Silviagropasture:** It is a combination of trees, crops, and pastures. Trees are dominant over other components.

B. Based on Arrangement of Components

Arrangement of the component can involve the dimension of space and time. Based on the arrangement of components, the Agroforestry system can be classified as.

a) In space or spatial arrangement.
b) In time or temporal sequence.
c) Vertical stratification of components.

a). Space or spatial arrangement:

1) **Mixed dense:** Different components are arranged together with high density. e.g., Home garden.
2) **Mixed sparse:** Different components are arranged together with low density. e.g., Most systems of trees in pastures, Scattered trees on agricultural lands.
3) **Strip plantation:** Width of the strip to be more than one tree. e.g., Alley cropping.
4) **Boundary plantation:** Trees on edges of plots/ fields.

b). In time or temporal sequence:

1) **Coincident:** It occurs when different crops occupy the land together. e.g., Tea/ Coffee under a shade tree, pastures under trees.
2) **Concomitant:** When different components stay together for a certain period. e.g., the Taungya system.
3) **Intermittent:** When annual crops are grown with perennial ones. e.g., Rice under coconut trees or other MPTs, Seasonal grazing of cattle pastures under trees.
4) **Interpolated:** When different components occupy the space during different times. e.g., Home garden.
5) **Overlapping:** e.g., Black pepper in rubber.
6) **Separate:** When components occupy space at different times. e.g., Improved 'fallow' species in shifting cultivation.

c). Vertical Stratification of components:

1) **Single layered:** The major component usually grows in one layer or storey. e.g., Tree garden.
2) **Double-layered:** The major component is usually grown in two layers. e.g., Tea/ Coffee under a shade tree.
3) **Multilayered:** Different components are grown in different layers. e.g., Homestead agroforestry.

II. **Functional Classification**

A. Productive Agroforestry system:

This system refers to the production of essential commodities required to meet society's basic needs. It includes intercropping of trees, home gardens, plantation of trees in and around the crop field, production of animals and fishes associated with trees. Productive functions are as follows

+ Food.
+ Fodder.
+ Fuelwood.
+ Others woods.
+ Other products.

B. Protective Agroforestry system:

This system refers to protect the land, improving climate, reduce wind and water erosion, improve soil fertility, provide shelter, and other benefits. Protective functions are as follows:

- Windbreak.
- Shelterbelt.
- Soil conservation.
- Moisture conservation.
- Soil improvement.
- Shade (for crops, animals, and man).

III. **Socioeconomic Classification**

Based on socioeconomic consideration, the agroforestry system is classified as:

1. **Subsistence Agroforestry system:**
   Subsistence Agroforestry system aims at the basic needs of a small family having less holding and very little capacity for investment. There may be some marginal surplus production for sale. e.g., Shifting cultivation, Scattered trees in the farms, Homestead Agroforestry.
2. **Commercial Agroforestry system:**
   It refers to large-scale production on a commercial basis. The main consideration is to sell the products. e.g., Tea/ Coffee under a shade tree.
3. **Intermediate Agroforestry system:**
   It is an intermediate between commercial and subsistence systems. The system aims to produce items that are not only enough to meet the needs of the family but also earn money from the surplus that can be sold.

IV. Based on allied components

1. **Agroforestry-cum-sericulture**
   This is a very complex system of agroforestry. In this system, crops/ vegetables are grown along with tree species (silk host plants). The larval excreta are good manure for the crops/vegetables.
2. **Agroforestry-cum-apiculture**
   The land is managed for concurrent production of flowers, crops, and honey. Flowering plants often favor increase of parasites and predators of crop pests and thus an anti-regulatory biocontrol system. The main purpose of this system is the production of honey.
3. **Agroforestry-cum-pisciculture**
   It is a system under which silviculture of mangroves and fish is done simultaneously. In paddy field, fish can easily be reared by planting trees on field bunds or boundary. This system can be followed in high rainfall areas.
4. **Agroforestry-cum-lac culture**

In this system, crops are grown along with lac host plants. It is a very common in Chotta Nagpur plateau of Bihar.

Benefits of Agro forestry all fodder trees can be considered to be multipurpose, in that they provide many benefits to the farmer, the farming system, and the environment. The value of fodder trees in agroforestry systems.

For livestock

- Valuable source of high quality, protein-rich forage for subsistence and commercial production of livestock, including cattle, sheep, goats, rabbits, poultry, fish, and bees
- Able to supply foliage during dry periods when herbaceous species are not productive
- Being deep rooted, they are drought tolerant and thus are important components of adaptation strategies to climate change
- Living fences, around homesteads and fields
- Some species have important medicinal attributes for treating livestock health issues

For farming systems

- Source of nitrogen-rich mulch for cropping systems
- Enhance the sustainability of farming systems due to fertility enhancement, longevity, soil cover, and control of soil erosion
- Timber for trellises and stakes for climbing crops
- Source of fruit, vegetables, and medicines

For people and the environment

- Opportunity to intensify sustainable agricultural production
- Means to stabilize sloping lands against soil erosion, due to their deep-rooting habit and permanent soil cover
- Often an important source of timber, firewood, and charcoal, particularly for domestic consumption Habitat for wildlife
- As woody perennials, a sink for CO and contributor to climate change mitigation and adaptation
- Source of cash income when sold as forage or when seed are marketed
- A means to lower water table and to limit rise in salinity

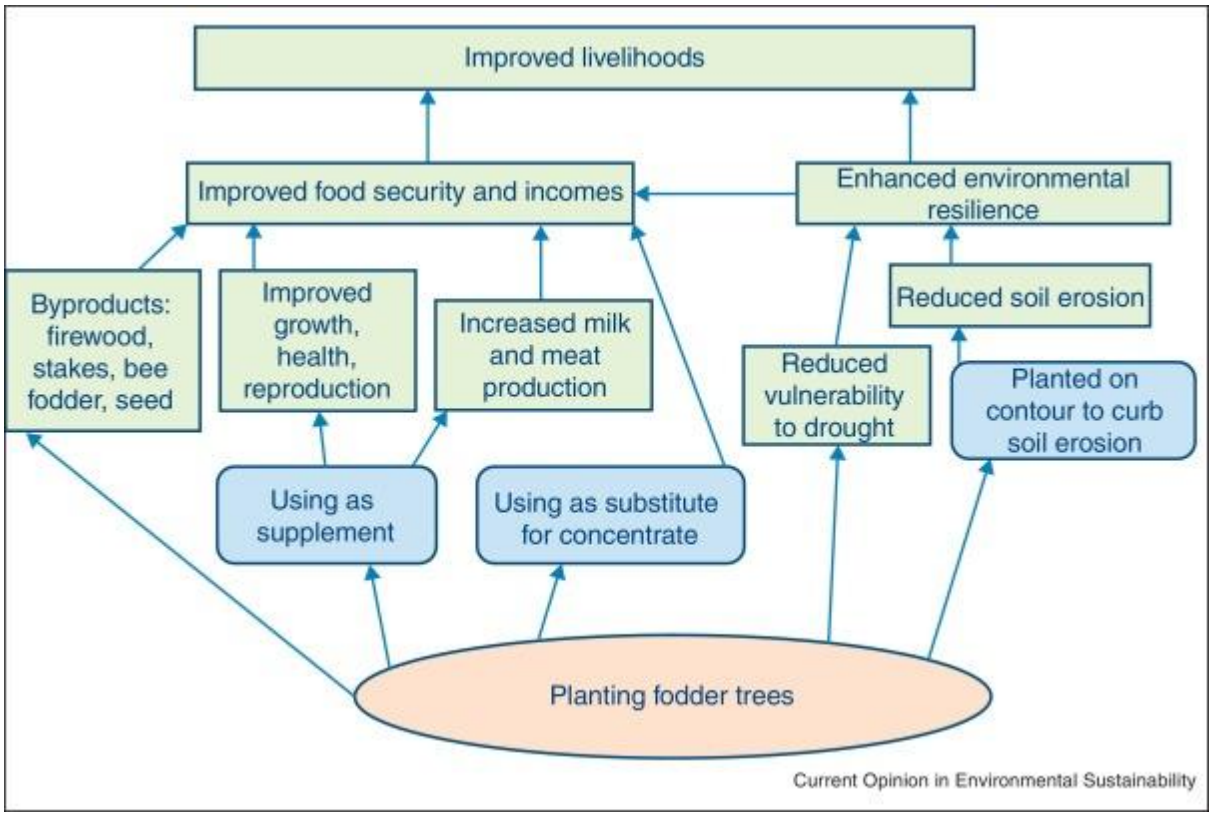

Fig. 2. Benefits of agro-forestry model (Franzel*et al*., 2014)

Disadvantages of Agroforestry

Although there are several advantages of agroforestry system, there are few disadvantages which include as follows:

- Prolific seeding habit of *L. leucocephala* resulting in weedy growth depresses the yield of arable crops
- Root and shade effect of trees on cultivated crops even 20 m in the case of babul (*A. nilotica*)
- Long gestation period-trees take several years to mature
- Harbour birds, pests and diseases that are harmful to food crops
- Agroforestry system requires more labor, which may cause scarcity at times in other farm activities
- Allelopathic effect of trees on crops, e.g. *Eucalyptus species*
- The fact that agroforestry system is more complex, less well understood and more difficult to apply, compared to single crop farms.

Key Challenges for Enhancing Fodder Trees' Benefits

Three key constraints limiting the uptake and benefits of fodder shrubs are as follows:

- **Species diversification:**

  There is a lack of species appropriate to different agroecological zones, particularly high altitude (42,000 m) and semiarid zones. In humid and subhumid zones, species are needed that provide more nutritious bio mass than some of the species in widespread use, such as *Calliandra*, and that are resistant to psylids (*Hetero psyllacubana*), jumping plant lice, which prevent farmers from planting *L. leucocephala*. More research is also needed on indigenous species. Efforts should be

made to integrate the huge amount of indigenous knowledge about indigenous species with scientific methods to screening and testing them.

- **Lack of functioning seed supply systems:**

  Emerging seed markets have facilitated adoption in some countries but are yet to emerge in other countries. Main constraints include policies of government seed centers, plant health regulatory agencies, and NGOs that distribute free seed. Decentralized, commercial models provide greater potential than government or NGO-led models.

- **Weak extension support:**

  Although fodder trees require relatively little land, labor, or capital, they are a knowledge-intensive practice as farmers need to acquire new skills such as nursery establishment, tree pruning, and seed collection. As weak as extension systems are in most developing countries, agroforestry extension is nearly non-existent.

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COMPLETE FEED BLOCK- ALTERNATIVE FEEDING METHODS FOR MILCH ANIMALS

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Complete feed block (CFB) is block made by hydraulic press machine using chaffed dry fodder and concentrate mixture to deliver all the essential nutrients in balanced manner to the milch animals.

Parts of complete feed block

It consists three parts and major portion is made up of roughage and next is concentrate mixture and small quantity of micronutrients. Roughages used for CFB is paddy straw, wheat straw, ragi straw, maize stover, sorghum stover, groundnut haulms, gram straw, sugarcane bagasse, sugarcane tops and tree leaves. Concentrate portion consists of cereal grains such as maize, sorghum, cumbu, ragi, broken rice and wheat grain and the oilcakes such as soyabean meal, groundnut cake, gingelly oil cake, coconut, mustard and sunflower cake and agro-industrial by products such as Deoiled Rice bran, wheat bran and gram husk and finally the micronutrients such as minerals and vitamin mixtures. Additives such as toxin binders, herbal extracts, probiotics, prebiotics can also be added to enrich the block to improve milk production, fertility and immunity of the animals.

Preparation of complete feed block

Roughage and concentrate feed are having different bulk density. Horizontal feed mixer is used to mix bulk density varied materials after adding binder such as maida powder, molasses and bentonite. Hydraulic press machine is used to press and make block according to our convenient size. The power operated feed block making machine can compress all kinds of feed materials to rectangular or square shape and of desired thickness and weight. The working pressure of machine can be up to 6000 PSI (413.68 bar) and its capacity to produce 30 to 40 blocks per hour depending upon the size of the machine. The bulk density of roughage based feed block produced by this machine may be 4 to 5 times more than the original feed. This machine is operated with 15 hp electric motor and other components are frame, power pack, hydraulic cylinder and electric control panel.

Benefits of complete feed block feeding to animals

1. Block can be fed to animals directly as concentrate mixture, roughage and micronutrients are balanced and mixed in proper ratio and there is no need for separate feeding of ingredients.
2. Nutrient digestion and utilisation from feed is efficient as concentrate and roughage are given simultaneously to assist the rumen microbes for better digestion.
3. Rumen microbes multiply efficiently as synchronization of energy and protein to built microbial biomass.
4. Ruminal acidosis or carbohydrate engorgement is avoided because of roughage is mixed with concentrate feed ingredients.

5. Milk fat is improved in milch animals after feeding feed block due to efficient fermentation and utilization of roughage to produce acetic acid which is major factor involved in milk fat synthesis.
6. Transportation is convenient as it is being dense block.
7. It saves feeding time and labour requirements as there is no separate feeding of concentrate and roughage feed.
8. Large quantity of feed can be stored in small space.
9. It can be stored in fodder bank and these feed blocks can be distributed to the areas affected with natural calamities such as flood and drought.
10. Concentrate ingredients present in the feed block is mitigating methane production in the rumen and thereby reducing global warming.
11. Feed additives, medicinal substances, herbal extracts and anthelmintic substances can be easily incorporated in these feed block.

    Daily Feeding of complete feed block improves body growth, milk production, milk fat level and better calving from the milch animals and thereby giving more profit to the dairy farmers.

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SILAGE AND ITS CHARACTERISTICS

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When green fodders are in plenty they are conserved as either silage or hay to feed the animals during summer or lean seasons.

Silage is defined as the green succulent fodder roughages preserved by controlled anaerobic fermentation with minimum deterioration in quality and loss of nutrients. The process of conserving green fodder as silage is called ensiling. Silo is the container used to prepare silage.

Benefits of silage

- ✓ Can be used as a reserved feed under extreme shortage conditions
- ✓ Under optimal storage conditions can be stored for 1 to 20 years
- ✓ Excess grown fodder can be preserved as silage to prevent maturation and *in situ* decay
- ✓ Field loss of fodder will be less
- ✓ It is less affected by the weather as it does not lie in the field open

Crops suitable for making good quality silage

- ✓ Soluble sugars/CHO's content: the green fodder should be rich in soluble sugars like 6 - 8% on DM basis or 3% on a fresh basis. Cereal fodders like maize, jower, bajra are ideal.
- ✓ Cultivated and natural grasses have low levels of soluble sugars. They can be ensilied with the addition of molasses @ 3 - 3.5%.
- ✓ Legume fodders have high levels of proteins and minerals which lead to poor quality silage. Hence legumes green fodders are mixed within a ratio of 3:1 with grasses/cereal fodders or in a ratio of 4:1 with dry forages for making better quality silage. In general, crops with thick stems are conserved in the form of silage while thin stemmed crops are conserved as hay.

Stages of harvesting and dry matter content:

- ✓ Crops should be harvested between flowering stage and milk stage. Immature crops should not be harvested as they are rich in proteins and low in sugars. Crops used for silage making should not have more than 35% DM. If the fodder is succulent containing more moisture then it is wilted in the field till dry matter content reaches about 35%.
- ✓ The crop that is used for silage making should be cut late in the day as sugars content increases as day progresses. Crops should not be cut when it is raining or very early in the morning when there is dew.

Wilting of crop or green fodder

After harvesting crops or green fodders, leave it for 4 – 5 hrs in the harvesting field itsel for wilting.

Chaffing

It is better to cut the green fodder into small pieces of about 1-2" or 4 – 5 cm before ensiling.

Rapid filling and compaction in the silo pit

- ✓ Filling should be quick to remove the air , delayed or slow filling may result in trapping of more air in the pit it which causes rapid oxidation of fermentation of sugars resulting in the liberation of heat.
- ✓ This heat draws more air from outside making the pit more aerobic. This aerobic condition is unfavorable for the growth of lactobacilli which are primarily responsible for bacterial fermentation. It is to be noted that the lactobacilli population should be established quickly for the rapid breakdown of fermentable carbohydrates(CHO) to lactic acid.

Steps in silage making

- ➢ Select the crop that is to be ensiled when it has 30 - 35% DM. In case the crop has less than 30% DM, it is allowed to dry for 3 – 4 hrs in the field so that dry matter content would increase to 30 - 35%.
- ➢ Generally, crops are harvested and ensiled when the ears start coming.
- ➢ Select days of the week when the weather is fair and not rainy.
- ➢ It is always better to chop the fodder first since packing is better. Thus, the loss of nutrients is minimized with chaffed fodder. Further, filling and removal of silage is easy.
- ➢ After chaffing and ensuring that DM is around 35% the silo is filled with fodder.
- ➢ The fodder should be evenly filled in a silo pit. Trampling should be done with either men or tractors or bullocks depending upon the size of the pit. At the top of the silo, the fodder should be packed 3 - 4 feet above ground level.
- ➢ From all the sides it should be covered with long paddy straw or poor quality grasses and then covered with wet mud and dung to seal the material preventing the entry of air and water. The layer of straw/grasses may be about 4 – 5". The silage would be ready in 2 months after covering.
- ➢ Salt and urea @ 1% are added to cereals and grasses to improve the palatability and nitrogen content.
- ➢ To preserve grasses as silage, molasses is added at 3 - 5% to improve sugar content and quality of silage.

Structures and materials required for the silage preparation

1. Silo 2. Green fodder or material to be ensiled 3. Additives 4. Other items

Silo

Silo is an air-tight structure designed for the storage and preservation of high moisture feed in the form of silage. There are different types of silos like tower silos, bunker silos, bag silos, pit silos, etc. pit silos are more common in India. They require very little input/technology in their construction and preparation. The size of the pit silo depends on the farm area, fodder availability/ number of animals maintained. Preparation of the silo pit is an important procedure in silage making. Any lacunae in the preparatory steps may lead to large-scale spoilage and poor conservation. The steps involved in silo pit preparation are as follows:

1. The size (dimension) of the silo should be decided based on the number and kind of animals to be fed daily, the length of feeding period and the amount of forage available for ensiling. It is advisable to construct a silo pit deeper than ten feet as it would promote compactness. It is not advisable to keep the opened silo pit with enriched and ensiled

fodders beyond twenty days. Therefore the estimated requirement of enriched and ensiled fodders should be preserved in multiple silo pits rather than in one pit.

2. One cubic meter of space is required for 400 kg fodder. The pits are dug 2.4 to 3.0 M deep, with variable sizes.

Number of adult cow	Diameter of silo in meter	Height of silo in meter	Tonnes of silage
12	3.05	7.93	39.4
20	3.66	8.23	56.4
30	4.27	9.14	84.6
50	5.49	10.68	141.0
100	6.10	11.89	282.0

3. Silo pit must be located on the elevated ground, preferably at the highest spot on the farm to avoid water seepage.
4. It should be conveniently located and accessible in all kinds of weather, from the standpoint of both filling and feeding.
5. Silo should be sufficiently deep, which ensures better packing and provides less surface area to the total area exposed. It should not be shallow. The depth depends upon the water table in the locality.
6. The sidewalls should be straight and smooth in order to prevent the formation of air pockets, which may retard the normal microbial fermentation.
7. The walls should be impermeable to water, so that water can't gain entry into silo pit, walls may be made of cement or brick and mortar.
8. The walls should be strong and rigid to withstand the pressure, which develops inside the pit as fermentation takes place.
9. Adequate provisions should be made for the escape of surplus juices, either by a drain or by a gravel bottom.

Green fodder or material to be ensiled

Each cow can be fed about 15 kg of silage per day. Hence multiplying 15 kg into number of cows maintained and again multiplying number of days to be fed gives the quantity of green fodder required to ensile.

Additives

To regulate the microbial activity various additives can be used during ensiling. They may be grouped as

Fermentation stimulants – Culture of lactic acid producing bacteria, soluble carbohydrate sources. Bacterial cultures like *Lactobacillus acidophilus, Torulopsis species, Bacillus subtilis.* These cultures act as a preservative and help in rapid fermentation.

Fermentation inhibitors – Inorganic acids, sterilants (antibiotics, Sodium metabisulphite, Formaldehyde) and organic acids. Especially propionic and formic acids (@ 1 per cent) are used in sufficient quantities as the crop is being filled into the silo to bring the pH value immediately to about 4.0 to 3.5.

Others – Urea, limestone, poultry manure, etc.

Common additives used in silage making

- **Molasses:** Two per cent
- **Urea:** One per cent
- **Salt:** One per cent
- **Limestone (calcium carbonate):** 0.5 to 1.0 per cent to **maize silage** to increase acid production

Other items

Water, Vessel to mix urea and molasses, Mug to sprinkle and polythene sheet to cover pit silo. Chaff cutter for fodder chaffing.

Silage making steps

This involves the following steps.

A. Preparation of forage

The crops which can be used for silage making are generally harvested at the proper stage of maturity, cut to proper length, control the moisture content, add an additive or preservative when needed, fill rapidly, distribute forage uniformly in the silo and seal the silo.

The crop for silage making is generally harvested at the flowering stage when it has the maximum amount of nutrients. Silage materials containing less than 25 % dry matter (more than 75 % moisture) will form very sour silage juices during storage, incurring a considerable loss of nutrients. Thus, plants for silage making should be allowed to mature till the dry matter content attains 35-40 per cent.

Silage material should be cut to a proper size in order to fit it in a silo and ensure good quality of silage. The length varies from a fraction of an inch to over an inch in length.

Moisture content of silage material beyond 60 - 65 % is not desirable. In such a condition, it will be costlier to handle, susceptible to decay and loss of juices and nutrients. Due to high acidity, a large amount of silage near the wall is spoiled. Fresh grass should be wilted for 3 to 4 hours on a good sunny day.

B. Addition of additives

Additives are those materials that are mixed with silage material to improve the quality. Some important functions of the additives are given below.

1. They supply nutrients.
2. Provide fermentable carbohydrates.
3. Furnish additional acids which are essential for proper fermentation.
4. Inhibit the growth of undesirable types of bacteria and moulds.
5. Reduce the amount of oxygen present in silos.
6. Reduce the moisture content of silage if it is too high.
7. Absorb some acids which might otherwise be lost in seepage.
8. Increase nitrogen content of the silage.

Example: Urea, Salt, Molasses, Limestone, Sodium meta bisulfite and acids (organic and inorganic acids) eg. Formic and propionic acid @ 1 per cent level.

C. Filling the silo

The material should be trampled, especially well near the walls of the silo. It is believed that keeping the center higher than the outside while filling the upper part of the silo loosens the tendency of the silage to draw away from the wall as it settles. To avoid a large amount of spoilage at the top, the silage should be leveled off and trampled thoroughly from the lower few meters.

The filling of the pit should be completed within the least possible time say one or two days. To create favourable anaerobic conditions inside the silo, adequate compression of the material through trampling is essential. It helps in driving air pockets from the silo which may otherwise spoil the silage.

D. Covering and sealing the silo

It is essential to keep off air from the silage materials of silo. An anaerobic atmosphere in the silo is essential for proper fermentation of silage. Therefore, the silo, should be covered with wet straw, sawdust or other materials and plastered with 15-30 cm thick layer of clay soil. If possible, put a plastic sheet before plastering with soil. After covering, weights such as paving slabs, concrete posts, concrete cylinders and wooden logs should be kept for better compression.

E. Opening the silo

The silage is ready within three months' time beginning from covering of silo. In the case of tower and trench silos, excavation should begin from the entire top surface and in the case of bunker silos, silage can be taken out from the front side. After opening it becomes necessary to fill the pit completely.

Important conditions for success in silage making

- ✓ The plant material for ensiling should have a moisture content of 65-75%
- ✓ Excluding air in the silo pit
- ✓ Encouraging a rise of temperature to 30-38ºC

Why exclusion of air from the silo is needed

- ✓ To minimize the loss of nutrients due to respiration
- ✓ To initiate the growth of lactic acid producing bacteria rapidly
- ✓ To prevent the development of undesirable aerobic bacteria which produce a lot of heat at the expense of nutrients that they oxidize.
- ✓ Aeration promotes the activity of mould, which spoils the silage and makes it unpalatable.

Fermentation in silo /changes in the silo pit

The conversion of fresh forage into silage progresses through four phases that are normally completed within 21days of ensiling. A 5^{th} phase may occur if improper silage production practices cause undesirable or abnormal silage fermentation.

Phase I: Aerobic or plant respiration phase, immediately after the silo pit is filled with chopped green fodder and packed airtight, the plant cells continue to respire and utilize all the oxygen present in the pit and leave out CO_2. At the same time, the aerobic bacteria present on the stems and leaves of plants begin to grow. These processes consume readily available CHO's stored in the plant and produce CO_2, water and heat. This CO_2 released will create

anaerobiasis and also check the mold growth. The heat produced by aerobic bacteria causes an initial rise in silage temp to 80-100 °F. the respiration phase usually lasts 3 – 5 hrs depending on the oxygen supply present.

Phase II: Action of Enterobacter species of bacteria or **acetic acid production**, this phase begins when the supply of O_2 is depleted and anaerobic bacteria that grow without O_2 begin to multiply. The acetic acid bacteria convert plant CHO's to acetic acid and traces of propionic acid and butyric acid. This acidifies the forage to pH of about 5.0. the lower pH causes the acetic acid bacteria to decline the number as they can't tolerate an acidic environment. The early drop in the pH also limits the activity of plant enzymes that break down proteins to NPN compounds like free amino acids. This phase of the fermentation process continues for 1 - 2 days.

Phase III: Action of lactic acid producing bacteria (Lactobacillus and Streptococcus spp) or the **initiation of lactic acid production,** the increased acidity of forage mass enhances the growth and development of lactic acid producing bacteria that convert plant CHO's to lactic acid, acetic acid, propionic acid and CO_2. The increased production of lactic acids checks the production of acetic acid and propionic acid. During this phase, fodder settles down and there is a chance of seepage if the forage is high in moisture. This phase of the fermentation process continues for 3 - 6 days.

Phase IV: Peak lactic acid production. In this phase, lactic acid production reaches a peak and stabilizes the pH to within the region of 3.8 – 4.2 and this phase lasts for 15 - 20 days. At this pH the crop is preserved. The bacterial fermentation is checked when once the desired level of lactic acid is produced which reduces the pH to 4.0 - 4.2. At this pH the activity of all other bacteria ceases. When pH falls to 3.7 even the activity of lactobacilli stops and the silage is preserved in stable conditions as long as anaerobic conditions prevail. A well-prepared silage will have a typical brown or golden yellow colour and it develops a characteristic flavour and aroma.

Phase V: Due to unfavourable conditions or if rain is allowed to enter the silage (or) if the lactic acid concentration is inadequate, due to reasons such as high moisture and high protein content or low sugar content in the green fodder, the proliferation of other bacteria like clostridia occurs. These bacteria consume acids formed in previous fermentation stages and produced butyric acid. These proteolytic clostridia also break down the proteins into amines and ammonia which paves the way for decomposition of the silage leading to poor quality silage with foul and undesirable smell and decreases feed intake.

Characteristics of Silage

Quality of silage	pH	Taste	Butyric acid	Lactic acid	Ammonical nitrogen to Total N_2 %	Colour	Other qualities
Very good silage	3.5 - 4.2	Acidic, pleasing	Nil	1-2%	<10 %	Green or brownish	No moulds, no proteolysis
Good silage	4.2 -	Acidic	Trace	0.5-1.0 %	10-15%	Green or brownish	No moulds, no proteolysis

	4.5						
Fair silage	4.5 - 4.8	Acidic	Little	0.5%	15-20 %	Tobacco brown to dark brown	Slight proteolysis, some moulds
Poor silage	> 4.8	Less acidic	High	< 0.5%	> 20 %	Blackish	Proteolysis, bad smell, high mould

Flieg index

It's the commonly used method to evaluate silage quality and determined by the relative amount of lactic acid, acetic acid and butyric acids, expressed as % of total acids in silage.

Colour of the silage

When the temperature in the silo is moderate the silage tends to be yellowish in colour or brownish green and sometimes even golden in colour. This is due to the action of organic acids on chlorophyll, and converting chlorophyll to brown magnesium-free pigment, pheophytin. Silage is dark brown or black when the temperature in the silo is high.

Colour of the silage	Interpretation
Very dark olive /dark olive	Weather damaged or wilted legume, with limited fermentation
Light green to green	Normal colour cereal, grass, maize silage
Light amber brown	Late harvesting or low DM content
Brown to dark brown	Overheating, inadequate compaction or aerobic spoilage

Physical appearance

Plant structures of which silage is made like stems and leaves should be completely recognizable in silage. Severe petrifaction is indicated by completely destroyed structure. A viscous, slimy appearance indicates the pectolytic micro organism's activity.

Characteristics	Interpretation
Rotten silage	Air leakage results in DM loss causing a decline in silage quality
Very wet with discharge	Poor fermentation
Very dry with discharge	High DM content

Aroma

Good silage usually has a mild, slightly acidic and fruity smell, resembling that of cut bread and tobacco due to the lactic acid. A rancid and nauseous smell denotes the presence of butyric acid and signifies failed silage. A musty smell is a sign of deficient compaction and the presence of oxygen.

Characteristics	Interpretation

Mild, pleasantly acidic	Normal lactic acid fermentation
Very little smell, but slightly sweet aroma	Heavily wilted silage with little fermentation
Sweet, fruity smell	Yeasts have an active role in fermentation with high ethanol levels
Sour vinegar	Low DM, low sugar forages
Rancid, putrid	Poor fermentation- clostridia producing high butyric acid

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DEMONSTRATION AND HANDS-ON TRAINING ON PREPARATION OF SILAGE

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Stepwise procedure to ensile fodder crops

*(Source: **Monograph on Sugarcane tops** (2010) by Dr. V. Balakrishnan, Professor and Head, Dept. of Animal Nutrition, Madras Veterinary College, Chennai-7)*

1. Ensure that the sidewalls, as well as floor of the silo pit, are smooth, if not plastered.
2. Assess the quantity of green fodder required to fill the silo pit. Around 7 – 10 kg of green fodder can be preserved in 1 cubic feet silo pit. Quantify the volume of silo pit by measuring the length, width and height and add 20 per cent extra green fodder quantity for making dome at top of silo pit.
3. Calculate the quantity of urea, common salt and molasses at the rate of 1, 1 and 2 per cent (on air dry basis), respectively for the quantity of green fodder to be ensiled. If molasses is not available, jaggery can be substituted at 1 per cent and dissolve it in a minimum quantity of water.
4. Use little quantity of water to dissolve urea and mix it with entire quantity of molasses/jaggery.
5. Chop the wilted green fodder to the length of 4 – 5 cm using either chaff cutter or manually by sickle.
6. Spread the chopped green fodder on the floor of the silo pit to a layer thickness of 6 inches.
7. Convert the height of the silo pit to inches and divided by six and use this factor to apportion the volume of urea molasses mixture. For example, if the height of the silo pit is 15 feet, it will be 180 inches. Dividing by six results in 30. Now apportion the urea molasses mixture to 30 portions.
8. Evenly sprinkle 1 portion of urea molasses mixture to chopped green fodder spread on the silo. Similarly, sprinkle one portion of the total quantity of common salt.
9. Compress manually to ensure compactness.
10. Spread chopped green fodder over the previous layer on the floor of the silo pit to a layer thickness of 6 inches.
11. Repeat steps 8 and 9.
12. Repeat steps 10, 8 and 9 until chopped green fodders are filled up to the brim of the silo pit.
13. Now repeat steps 10, 8 and 9 to form a dome shape over the silo pit. Dome shape facilitates outward drainage of rainwater and thus preventing seepage into silo pit.
14. Spread the polythene sheet over the dome shaped green fodder to cover completely as well as to extend to about three feet on all sides of the silo pit.
15. Cover the soil to about three feet above the dome and plaster with mud to form a smooth surface.

16. Open the silo pit after 30 days and discard the top layer of green fodders, if soiled.
17. Good quality ensiled green fodder will be brown in colour, with sweet fruity odour without mold infestation.
18. Remove the required quantity of ensiled green fodder for feeding and cover the top with the polythene sheet. Evacuate the entire quantity of ensiled green fodder at the earliest possibility, but not exceeding 20 days.

* Similarly 12.5 kg silage can be prepared in 600 gauze polythene bags (60 cm breadth and 1 meter height).

Amount of silage can be fed:

- ✓ Dairy cows : 15 – 20 kg/day
- ✓ Mature calves : 4 – 5 kg/day

Precautions

- ✓ Urea should be dissolved thoroughly and sprinkled evenly.
- ✓ As compression creates desired anaerobic condition, extra care is required to thoroughly press the chopped green fodder.
- ✓ Excessive mold indicates spoiled silage and therefore should be discarded.
- ✓ If urea is used as an additive in the ensiling process, it should not be fed to calves less than 6 months of age.

Harvesting of fodder crops and wilting

Chopping of fodder crops

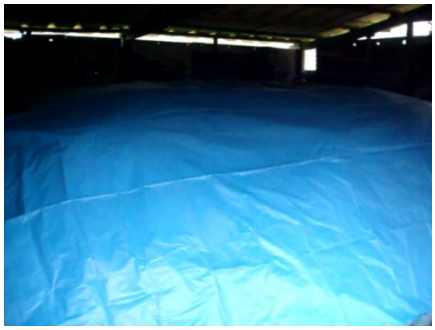
Preparation of silo pit (3 x 3 x 4 meter)

Filling of silos

Addition of additives (Urea, salt and jaggaery/molasses)

Spreading of unwanted grasses before sealing the silo pit

Covering the silo pit with polythene sheet **Plastering silo pit (dome shape) with clay**



Allow for 30 days and open the silo pit and observe silage quality for feeding the animals

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AZOLLA AND HYDROPHONIC FODDER CULTIVATION TECHNIQUES

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Introduction

Azolla is prominent among aquatic plants because of the presence of photosynthesis and nitrogen fixation in the leaves, as well as because of its growth habits, it looks to have a greater potential than tree leaves as a source of protein minerals and vitamins for animals. Azolla is a tiny aquatic fern found in tropical, subtropical, and temperate fresh water ecosystems. Azolla is an aquatic fern with a short, branching, floating stem and roots that dangle in the water.

The leaves are alternately oriented and each has a thick aerial dorsal lobe with green chlorophyll and a thin floating ventral lobe without colour. They have a symbiotic association with the blue green algae *Anabaena azollae*, which fixes atmospheric nitrogen, allowing the plant to acquire the nutrient. Azolla is a plant with a high yield. Its biomass can be doubled in 3 to 10 days depending on the conditions, and its yield can be 8 to 10 times that of fresh matter. Azolla, in exchange supplies a carbon source as well as an appropriate habitat for algae growth and development. It is because of this unique symbiotic interaction that azolla is such a great plant with a high protein content. Among its species, the water fern, Azolla, which forms a group with the blue green algae *Anabaena azollae*, is likely the most promising in terms of culture, productivity, and nutritive value.

The water fern Azolla comes in several varieties, including *Azolla pinnata, Azolla maxicana, and Azolla nilotica*. Among them, *Azolla pinnata* is a significant variety that can be grown simply and with a low initial expenditure. It is most widespread in the tropics and subtropics. It grows in the stagnant water of drains, canals, ponds, rivers, and marshy lands. Because of the presence of symbiotic algae in the leaves, *Anabaena azollae* growing in the hollow of azolla leaves can fix a significant amount of atmospheric dinitrogen. For centuries, Azolla has been utilised in Asia as a green manure fertiliser for rice fields and as a supplement in livestock diets. Some azolla strains may fix up to 1 to 3 kg of nitrogen per hectare per day, and its yearly production as a green azolla for animal feed is 730 tonnes per hectare. It develops in aquatic environments and mostly draws nutrients from water. Plant roots adhere to the soil and take nutrients from it in shallow water.

Research study and promotion of azolla as a livestock feed has increased since it has a greater protein content (19 to 30 per cent) than most green fodder crops and aquatic

macrophytes, as well as a more beneficial essential amino acid composition for animal nutrition. Azolla contains a high concentration of protein, essential amino acids, vitamins, growth promoter intermediaries, and minerals such as calcium, phosphorus, potassium, ferrous, copper, and magnesium.

The chemical composition of the azolla is Dry matter (DM) - 91.78 per cent, Organic matter (OM) - 74.50 per cent, Crude protein (CP) - 22.25 per cent, Crude fiber (CF) - 11.19, Ether extract (EE) - 2.45 per cent, Nitrogen free extract (NFE) - 38.61 per cent, Total ash (TA) - 25.50 per cent Acid insoluble ash (AIA) -7.9 per cent (Mangesh*et al.,* 2018). Because of its high protein content and low lignin concentration, it is easily digested by livestock. Azolla, as a good protein source, can be used to supplement cattle feed. Azolla can be combined with concentrates or given to livestock directly. In animal nutrition, a high total ash content is a limiting factor. Azolla is an excellent source of feed for cattle, sheep, goats, pigs, rabbits, and poultry as an alternative to a concentrate feed and fodder to enhance the livestock and poultry production.

Benefit of Azolla in Livestock Production and Paddy Cultivation

- 1 kg azolla equals to 1 kg of oil cakes (It costs only 75 paise to produce 1 kg of azolla).
- Consumption of azolla increases milk production by 15 to 20 per cent. In milk the fat percentage is increased by 10 per cent and non-fatty nutrients by 3 per cent.
- It can be used for feeding poultry and ducks, which may gain more weight (10 to 12 per cent).
- If azolla is fed to the pigs along with salt, the weight of the pig will increase and the quality of meat will be good.
- Rabbits prefers to feed on azolla. There will be no mosquito problems at the azolla rearing site.
- As azolla spreads across the surface of water, it can reduce the evaporation of water by 11 per cent. If grown in paddy fields, it takes nitrogen from the air and gives it to paddy, reducing the need for urea in rice fields.
- If you start growing azolla on 4 cents of land while sowing paddy slips, you will have azolla per acre in 20 days. This will save a lot of money on fertilizer. When the water drains, the plants wither and provide the nitrogen that the soil demands.

Factors required for growth of Azolla

Temperature

Azolla is a very tolerant plant and optimum temperature 18 to 28^{o}C will be an ideal one.

Humidity

Azolla grows well when the humidity of the air is 85 to 90 per cent. Drying up when humidity drops to 60 per cent.

Wind speed

The fast wind brings the azolla in the beds to one side. This greatly affects the growth of azolla.

Light Sources

Light affects the photosynthesis and regulates the nitrogenase activity in azolla. Azolla plants are best known to grow under less sunlight instead of extreme sources. Under high sunlight intensities azolla fronds turn brick red. In the case of low light intensities, these sources of light could cause the azolla plant to suffer or die.

Sunlight *and* Photoperiod

High sunlight during the day during summer turns azolla brown.The ideal photoperiod for azolla plants is about 20 hours. For the 20 hours photoperiod, 380E/m2/s of illumination should be fine.

Soil

The alkaline and acidity of soil will interfere with the growth. The growth of azolla is mainly affected in alkaline soil. The growth of azolla varies according to micronutrients.

Acidity of water

Acidity of water refers to the pH values needed for an optimum azolla cultivation. Azolla are known to be able to survive in pH levels ranging from 3.5 to 10. They cannot thrive in acidic soils with pH levels lower than 3.5.

Minerals

Just like the cultivation of any other plant, the azolla requires just as many minerals and nutrients for its growth. The nutrients required might be available to the plant in the water or it can be extracted from the soil if the water is shallow enough. Also, molybdenum and cobalt are important minerals to have. These are required for Anabaena and its nitrogen fixation.

Nitrogen

During the growth of azolla, one must be careful as to how the levels of nitrogen are maintained. This is because the levels of nitrogen play an important role in determining its nitrogen fixation rates and its growth.

Phosphorus

This is the most important nutrient for **azolla production**. A deficiency in phosphorus can be determined by the deep red colour of the plant and the sudden lengthening of the roots.

Ingredients required for Azolla production

- Brick - 30-40 stones
- Silpauline sheet - 2.5 m long, 1.5m width for 6 feet x 3 feet azolla pit
- Red soil - 30 kg
- Fresh dung - 3 kg
- Super phosphate - 30 g (or)Azofert - 20 g
- Water - 10 cm height
- Azolla seed - 500 g
- Urea gunny bag - required numbers

The site of azolla pit should be near to tree shade (direct sunlight should not be more than 3 hours a day).

- The size of the azolla pit – 6feet x 3 feet.
- Remove the grass and weeds and clean the area around the azolla pit.
- The area should be levelled without being potholed.
- Spread urea gunny bags around the area to prevent grass and weeds from growing.

- Place the bricks in cross section position around the top of the prepared azolla pit. Then, spread the Silpaulinesheet (**Polythene tarpaulin** - which is resistant to the ultra violet radiation in sunlight) on it.
- Spread 10 to 15 kg of red soil on the Silpauline sheet in equal quantities.

- Pour about 6 to 9 pots of water until the water level is 10 cm high from ground level.

- Spray fresh dung 2 kg and 20 g of azofert (or) 30 g super phosphate in 10 liters of water.

- Add 500 to 1000 g of clean azolla seeds and sprinkle lightly over the water.

- Provide shade for the azolla pit, if necessary

- Take 500g to 1 kg of azolla daily and rinse it with water.
- Milch cow: 1.5 – 2 kg; Goat: 300 - 500 g
- Chicken: 10 – 15 g
- In 1:1 ratio,azolla can be provided along with concentrates.
- It can be given raw or processed (dried) or mixed with concentrate feed and fodder

Harvesting

Weight of the azolla seeds triples within 3 days of sowing and the azolla will grow well in 15 days and be ready for harvest.After 15 days, we can harvest 500 grams to 1 kg per day from 6 feet X 3 feet dimension azolla pit.

Other precautions

- Stir the azolla and other content added to pit daily with a rod.
- The amount of water at any time should be 10 cm. Pour 2 kg of fresh dung and 20g of azofert (or) 10 g of super phosphate water every 5 days.
- Replace one-third of the water from azolla pit every 10 days with clean water. Similarly, One-third of the soil should be replaced once a month with new and clean red soil.
- Remove all inputs added to the azolla pit except azolla seeds once in 6 months and apply fresh one following the same procedure for better azolla production.

Hydroponic Cultivation

It is a soil-free fodder production method that allows fodder to be grown for livestock such as cattle, buffalo, horses, pigs, sheep, goats, and poultry. It takes very little land, water, and labour. It is a kind of hydro culture and is a technique of growing plants using solutions rich in mineral nutrients without soil. Terrestrial flora could be grown with their roots in the mineral solution only, or in an inert medium like gravel or per litre. Plants mature in hydroponics in an inactive growing medium with an impeccably controlled pH, with nutrients given to the roots in an extremely soluble form. This permits the plant to carry its food with a very little exertion in contrast to the soil when the roots must grab the nutrients and obtain them.

Hydroponics is a scientific method of growing plants/crops in water in a controlled environment without the use of soil. Water is enriched with well-balanced nutrients in hydroponic technology, which is necessary for plant growth and productivity. When it comes to growing green fodder for livestock/animals, hydroponic technology alleviates the strain on the soil. Water, nutrients, and sunlight are the most important inputs to a hydroponic system. Fodder crops such as barley, oats, maize, and sorghum can be grown in hydroponic systems to produce high quality nutritious green fodder for livestock/dairy animals. Apart from increased dairy productivity, hydroponic green feed improves the health of dairy animals.

The model hydroponic cultivation unit (Fig – 1) in market is made up of 8 rows, each with a holding capacity of 4 trays which can produce 8 kg of fodder from 1.65 kg of maize seed. The biomass of hydroponics contains, the entire fodder, root, and seed which can be consumed by the livestock with no waste. Maize, sun hump, horse gram, jowar, and other seeds that can be cultivated into hydroponic fodder.

The sustainable technology like hydroponics would be the key driver of the dairy industry future. Using hydroponic technology to produce the quality green fodder would be a revolutionary step in the country's green fodder production if certain problems in hydroponics cultivation been properly addressed or modified in future by research and development divisions.

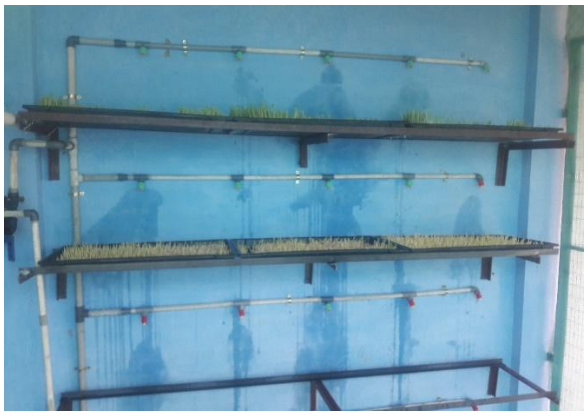
Procedure

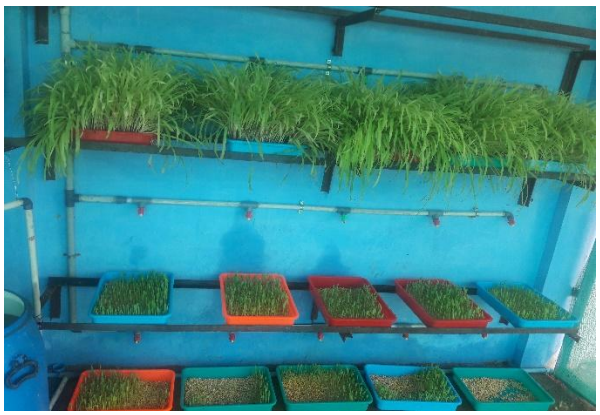
- The select seeds with high sprouting quality and moisture less the 12 per cent
- Place the seeds in to tub / tank and add water
- Wash the seed by stirring with stick and drain the water
- Add water and soak the seeds for 24 hours
- Pack the soaked seeds in to gunny bags

- Place these gunny bags under shade (avoid keeping near / under direct sun light)
- Sprinkle water once in every 3 hours on to the gunny bags
- Allow the seeds to sprout in the gunny bag itself for one day
- Transfer the sprouted seeds from the gunny bags on to the trays and spread them evenly upto a height of 1/2 inches within the tray
- Rack the trays in to the lower section of the machine (i.e) in to the day 1 row.
- Switch on the sprinklers attached to machine every two hours for sprinkling water daily.
- Change / shift the trays to next row on every other day
- After completion of 8th day (i.e.) 8th row the fodder can be utilized for feeding farm animals.
- Usually, the growth period is 8 days in which the fodder grows to a maximum height of 25 - 35 cm.

The environmental factors for optimum growth of hydroponicsfodder are: temperature between 19 to 22 ºC, humidity between 40 to 80 per cent (optimum being 60 per cent), light (2000 lux in intensity) between 12 to 16 hours and aeriation for 3 minutes after every 2 hours (Starova Jeton, 2016).

Model Hydroponic Cultivation Unit (Fig – 1)






Low-Cost Model Hydroponic Cultivation

Benefits and advantages of Hydroponics

There are many advantages of hydroponic farming especially growing green fodder.

- Water saving
- Utilization of minimal land
- Less labour requirement
- Less time to grow green fodder
- Round the year production
- Increased nutritious value
- Natural green fodder supply
- Minimal loss of green fodder
- Faster growth and high yield
- Conservation of water and nutrients.
- No more use of fertilizers, pesticides, and other chemicals.
- It can be grown anywhere as it requires very less space for growing and involves a soil-free condition.

- It minimizes the loss of nutrients and has a lot more accurate control over the nutrients required by the plants.

Hydroponics in dairy and livestock business

The hydroponic system allows growing green fodder at a wider temperature in the range of 15 to 33°C and humidity range at 70 to 80 per cent without fungal growth. Hydroponic technology is environmentally friendly. Hydroponically grown fodder is free from contamination. Hydroponically grown green fodder saves water and labor cost. Hydroponically grown fodder is highly nutritious. The green fodder from the hydroponic system improves animal/livestock health and reproductive efficiency. Feeding highly nutritious fodder will result in higher milk yield in dairy animals. One kg of un-sprouted seed yields 8 to 10 kg of hydroponics green forage in 7 to 8 days (Anonymous, 2015; FAO, 2015; Yvonne Kamanga, 2016).

The crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and Ca content increased, but organic matter (OM) and non-fibrous carbohydrates (NFC) content decreased in the hydroponic green forage compared with the original seed on a dry matter basis (Mehta and Sharma, 2016).

Hydroponic fodder is a rich source of vitamin A, vitamin E, vitamin C, thiamin, riboflavin, niacin, biotin, free folic acid, anti-oxidants like β-carotene (Naik *et al.,* 2015) and minerals (Fazaeli*et al.,* 2012)

Composition of Hydroponics maize fodder

The average dry matter (DM) content of the maize seed was 95.08 per cent whereas the hydroponic maize fodder was 25.00 per cent. The decrease observed in the DM may be due to the decrease in the starch content of the hydroponics fodder. (Adebiyi *et al.,* 2018)

Proximate composition of Hydroponics maize fodder

Parameter	Percentage (%)
Dry matter	25.00
Crude protein	13.75
Ether extract	3.55
Crude fibre	14.77
Ash	3.33
Nitrogen free extract	60.72

The disadvantages associated with hydroponics are

- It is a supplement to traditional growing methods which requires high technical knowledge and training before starting the process.
- It is a time-consuming process.
- Cost of cultivation is relatively more in hydroponics fodder production when compared to conventional fodder cultivation. The feed cost per kg milk was higher when animals were fed maize fodder grown in a high-tech hydroponic system, owing to the higher cost of hydroponic fodder production [INR 4.0 to 4.50/kg] than green fodder grown in traditional farming [INR 1.50/kg](Reddy *et al.,* 1988; Naik *et al.,* 2014).
- A number of studies reported that sprouting resulted in 7 to 47 per cent loss in dry matter from the original seed after sprouting for a period of 6 to 7 days of growth, mainly due to respiration during the sprouting process (Sneath and McIntosh, 2003; Dung *et al.,* 2005; Fazaeli*et al.,* 2012; Putnam *et al.,* 2013).
- Non availability of quality seeds for hydroponic cultivation.

Conclusion

Agriculture and livestock farming contribute more to India's economy as a developing country. To address the existing problems in the livestock sector and bring India's livestock production status up to par with developed countries, the country's green fodder deficit should be addressed in livestock production.In this situation, azolla and hydroponics will be effective tools for overcoming the fodder deficit if certain disadvantages in their production systems are properly addressed.Azolla is the most cost-effective and efficient feed additive for livestock and poultry which as a greater protein content (19 to 30 per cent) than most other green fodder. With regard to hydroponics, the high initial investment in fully automated commercial hydroponic systems, as well as the high labour and energy costs associated with maintaining the desired environment in the system, significantly increases the net cost of hydroponic fodder production. Such systems do not work in developing countries.The production system, cost of production and availability of quality seed should be addressed and further study has to be carried out to have effective production system. Furthermore, hydroponic fodder production is most likely best suited to semi-arid, arid, and drought-prone regions of the world that face chronic water shortages or lack irrigation infrastructure.In future, because of limited irrigation facility it may forces to implement the azolla cultivation and hydroponic technology in the production of green fodder.

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ANTINUTRITIONAL FACTORS IN PRESENT IN GREEN FODDER AND ITS MANAGEMENT

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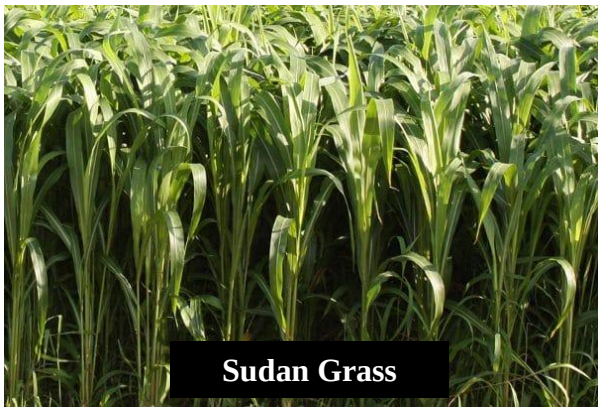
The anti-nutritional factors (ANF) can be defined as those substances generated in natural food substances by the normal metabolism of species and by different mechanisms (e.g., inactivation of some nutrients, diminution of the digestive process or metabolic utilization of feed) which exert effects contrary to optimum nutrition. ANF interfere with feed utilization and affect the health and production of animal or which act to reduce nutrient intake, digestion, absorption and utilization and may produce other adverse effects.

The common anti-nutritional factors present in the green fodder

S. No	Anti-nutritional factors	Name of the fodder
1.	Nitrate	Sudan Grass, Pearl millet, Oats
2.	Oxalates	Guinea Grass, Bajra and Napier Grass Hybrid, Setaria Grass, Kikyu Grass, Buffel grass
3.	Saponins	Lucern
4.	Tannins	Fodder tree/Shrubs
5.	Cyanogens	Sorghum, Sudan grass, Jhonson grass
6.	Mimosine	Subabul
7.	beta-N-oxalylamino-L-alanine (BOAA)	Lathyrus

1. Nitrate

Nitrate is the form of nitrogen that the plant roots take up from the soil, and is transported to the leaves. Excess nitrates accumulate in plants when they are stressed. Drought or hot dry winds put forage under water stress often resulting in nitrate accumulation. Damage caused by hail or frost impairs photosynthesis resulting in excess nitrates. Cool cloudy weather can also cause the problem. During initial growth, much of the nitrate taken up by the plant is used for root and shoot development. At this stage, the roots are able to take up more nitrate than is required and it accumulates in the stems and leaves of the plant. As the plant develops, the leaves of the plant are able to convert more nitrate into plant protein, therefore less "surplus" nitrate is found in the plant as it matures. Some of the fodder crops such as Sudan grass, pearl millet and oats can accumulate nitrate at potentially toxic levels. Most of the nitrate accumulates in stem, followed by leaves and very little in the grains.

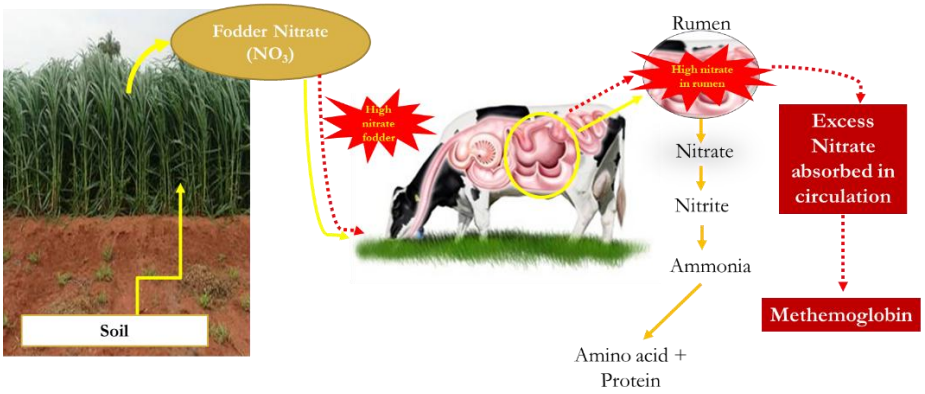


Nitrate poisoning is better described as nitrite poisoning. When livestock consume forages, nitrate is normally converted in the rumen from nitrate - nitrite - ammonia - amino acid to protein.

Level of Nitrate in forage (DM Basis) and potential effects on animals (John Andrae, 2008)

Nitrate Content (ppm)	**Effect on animals**
0-1000	This level is considered safe to feed under all conditions.
1000-1500	This level should be safe to feed to non-pregnant animals under all conditions. It may be best to limit its use to pregnant animas to 50 per cent of the total ration on a dry basis.
1500-2000	Feeds are fed safely if limited to 50 per cent of rations total dry matter.
2000-3500	Feeds should be limited to 35-40 per cent of total dry matter in the ration. Feeds containing over 2000 ppm nitrate nitrogen should not be used for pregnant animals
3500-4000	Feeds should be limited to 25 per cent of total dry matter in ration. Do not use for pregnant animals.
>4000	Feeds containing over 4000 ppm are potentially toxic. Do not feed

When forages have an unusually high concentration of nitrate, the animal cannot complete the conversion and nitrite accumulates. Nitrite is absorbed into the blood stream directly through the rumen wall and converts haemoglobin (the oxygen carrying molecule) in the blood to methaemoglobin, which cannot carry oxygen. The blood turns to a chocolate brown colour rather than the usual bright red. An animal dying from nitrate (nitrite) poisoning actually dies from asphyxiation, or lack of oxygen. Factors affecting the severity of nitrate poisoning are the rate and quantity of consumption, type of forage, energy level or adequacy of the diet.



Precaution

Nitrates are more likely to accumulate in annual forages than in perennial crops. Nitrates are a concern immediately following a period of drought or wet, dull weather. The risk of nitrate toxicity can be reduced, but not eliminated, by taking the following steps:

- Dilute the nitrate content of the total ration by feeding a combination of low and high nitrate feeds.
- Feed the ration in two or three meals per day rather than just one meal per day.
- Allow cattle to adjust to low levels of nitrate before increasing the nitrate content of the ration.
- Ensure that livestock are being fed a balanced ration for the level of production that is expected.

Most feeds that contain nitrate can be fed to cattle if managed properly with balanced diet.

2. Oxalates

Oxalate is an anti-quality nutrient which under normal conditions is confined to separate places. However, when it is processed and/or digested, it comes into contact with the nutrients in the gastrointestinal tract. After released, oxalic acid binds with nutrients, rendering them inaccessible to the body. If feed with excessive amounts of oxalic acid is consumed regularly, nutritional deficiencies are likely to occur, as well as severe irritation to the lining of the gut. Strong bonds are formed between oxalic acid, and various other minerals, such as Calcium, Magnesium, Sodium, and Potassium. This chemical combination results in the formation of oxalate salts. Oxalates react with calcium to produce insoluble calcium oxalate, reducing calcium absorption. This leads to a disturbance in the absorbed calcium: phosphorus ratio, resulting in mobilization of bone mineral to alleviate the hypocalcaemia. Prolonged mobilization of bone mineral results in nutritional secondary hyperparathyroidism or osteo dystrophy fibrosa. Young plants contain more oxalate than older plants. During early stages of growth, there is a rapid rise in oxalate content followed by a decline in oxalate levels as the plant matures. The distribution of oxalate in plants is uneven. Several researchers reported that oxalate content is highest in leaf tissue, followed by stem tissue.

Guinea Grass-கினியாப்புல்

Napier Grass

Buffel grass

Precaution

Dietary oxalate can be degraded by rumen microbes into CO_2 and formic acid. Ruminants adapted to diets with high oxalate content can tolerate oxalate levels that are lethal to non-adapted animals. Moreover, it has been shown that the transfer of rumen fluid from animals in Hawaii to Australian ruminants resulted in complete elimination of the toxic effects of mimosine and the bacteria involved in such effects have been identified. Evidence also exists that rumen microbes can be genetically manipulated.

3. Saponins

Hedge lucerne(குதிரைமசால்)

Saponins are glycosides containing a polycyclic aglycone moity of either C27 steroid or C30 triterpenoid (collectivelytermed as sapogenins) attached to a carbohydrate. Saponins are characterized by a bitter taste and foaming properties.These are glycosides characterized by bitter taste, foaming in aqueous solution and haemolyse RBC. Their toxicity is related to their activity in lowering surface tension in ruminants. The important forages which cause saponin poisoning of livestock are Lucerne, soybean etc. The saponin content of the leaves is twice as much as that of the stems and will decline as the plant becomes older. Poultry are more susceptible than Pigs. 0.4- 0.5% saponin in the feed decreases feed consumption, egg production and body weight loss in birds. Saponins are degraded by rumen microbes and hence, no growth depression takes place. However, upon excess feeding of green Lucerne, saponins lower the surface tension of ruminal content leading to accumulation of gas in the digesta. This condition is known as bloat or tympany or tympanitis. Symptoms include listlessness, anorexia, weight loss and gastroenteritis. In non-ruminants(chicks and pigs), retardation of growth rate, due primarily to reduction in feed intake, is probably major concern.The adverse effect of saponins can be overcome by repeated washing with water which makes the feed more palatableby reducing the bitterness associated with saponins. Saponins are among several plant compounds which havebeneficial effects. Among the various biological effects of Saponins are antibacterial and anti-protozoal**.**

Precaution

The concentration of saponins can be overcome by repeated washing with water which makes the feed more palatableby reducing the bitterness associated with saponins. Add other legumes and roughes in ration along with siris leaf(which are toxic to animal).

4. Tannins

Tannins are water soluble phenolic compounds with molecular weight greater than 500 and hydrolysable tannins and condensed tannins are two different groups of these compounds which differ in their nutritional and toxic effects. Tannins have a property of binding to protein to form reversible and irreversible complexes due to the existence of an number of phenolic hydroxyl groups. They occur almost in all vascular plants. Hydrolysable tannins and condensed tannins are two different groups of these compounds. Generally, tree and shrub leaves contain both types of tannins. The condensed tannins have more profound digestibility-reducing effect than hydrolysable tannins, whereas, the latter may cause varied toxic manifestations due to hydrolysis in rumen. Tannins may form a less digestible complex with dietary proteins and may bind and inhibit the endogenous protein such as digestive enzymes. The tannin protein complexes are astringent and adversely affect feed intake and all plants contains phenolic compounds but their type and concentration may cause negative animal responses. When herbivore forage on tannin rich plant, tannin protein complexes can reduce the digestion of forage protein. Tannins directly affect digestibility of cell wall by binding with microbial enzyme in the rumen. The reduced digestibility of cell wall compounds restricts the digestible energy that animal gain from forage plants.

Precaution

The concentration of condensed tannins above 4 per cent has been reported to be toxic for ruminants as they are more resistant to microbial attack and are harmful to a variety of microorganisms. Physical methods like soaking and drying and heat treatment before feeding of forage can reduce the toxic level of tannin. Several studies indicate that tannin-rich leaves, in combination with concentrate rations, could be fed to animals without any adverse effect. This happens because animals consume protein in excess of their requirement from the concentrate and therefore, the anti-nutritional effects of tannins were masked. Moreover, these studies do not show the utilization of tree leaf proteins for which they are mostly fed.

5. Cyanogens

Cyanogens are glycosides of a sugar or sugars and cyanide containing aglycone. It can be hydrolysed by enzymes to release hydrogen cyanide (HCN) by enzymes that are found in the cytosol. Damage to the plant occurs when the enzymes and glycoside form HCN. The hydrolytic reaction can take place in the rumen by microbial activity. Hence, ruminants are moresusceptible to CN toxicity than non- ruminants. The HCN is absorbed and is rapidly detoxified in the liver by theenzyme Rhodanese which converts CN to thiocyanate (SCN). Excess cyanide ion inhibits the cytochrome oxidasewhich stops ATP formation, and further tissues suffer energy deprivation and death follows rapidly.

Prussic acid (HCN) Concentration in forages (Denekew and Tsega, 2009)

HCN Concentration in (ppm)		**Potential Effect on Livestock**	**Remarks**
Dry Matter	**Fresh Harvested**		
0-500	0-100	Forage is generally safe and should not cause toxicity.	Safe to Use
500-1000	100-200	Potentially toxic and forage should be fed at a restricted rate in the diet.	Dangerous

>1000	>200	Very dangerous to livestock and will usually cause death.	Toxic/ Poisonous

The lethaldose of HCN for cattle and sheep is 2.0-4.0 mg per kg body weight.The lethal dose for cyanogen would be 10-20 times greater because the HCN comprises 5-10 per cent of theirmolecular weight. For poisoning, forage containing this amount of cyanogens would have to be consumed within afew minutes and simultaneous HCN production would have to be rapid. HCN level will be high in young seedlingsrather than in matured seedlings. The forage prussic acid percentage of the second cut wassignificantly lower than the first cut, probably due to degradation of the acid and a higher metabolic activity of theplant due to higher temperatures during growth processes which can reduce the prussic acid accumulation, these lowamounts of FPAP (Forage Prussic Acid Percentage) are not toxic to animals.

Sorghum

Jhonson grass

Precaution

As levels of HCN is found high in younger sorghum crop which are found unwanted and out of place *i.e* grown under energy stress condition and crop not get proper irrigation. Thus, try to exclude fodder from such plant. Further, Post-harvest wilting of Cyanogenic leaves may reduce the effect of cyanide toxicity. Sorghum, Sudan and Johnson grass must be kept for drying at least six hours before its use. Fodder HCN concentration >200 ppm in fresh green fodder and>1000 ppm in dry fodder drying, ensiling or allowing the forage to mature will reduce prussic acid concentration. Retest the plant sample before feeding.

6. Mimosine

Mimosine, a non-protein amino acid structurally similar to tyrosine, occurs in a few species of Mimosa and all species of closely allied genus Leuceana. Concern has arisen because of importance of *L. leucocephala*in which the level of mimosine in the leaf is about 2-6% and varies with season and maturity. In non-ruminant animals, mimosine cause poor growth, alopecia, eye cataracts and reproductive problems. Levels of Leucaena meal above 5-10 % of the diet for swine, poultry and rabbits generally result in poor animal performance.The main symptoms of toxicity in ruminants are poor growth, loss of hair and wool, swollen and raw coronets above the hooves, lameness, mouth and oesophageal lesions, depressed serum thyroxine level and goitre. Some these symptoms may be due to mimosine and others to 3,4 dihydroxypyridine, a metabolite of mimosine in the rumen. Reduction in calving percentage due to Leucaena feeding has also been noted.


Subabul tree

Precaution

A solution to a mimosine problem could be the development/selection of low mimosine containing cultivars. However, low mimosine types are found to be unproductive and low vigour. The approach is to feed leucaena mixed with other feeds. Use of Leucaena fodder may be restricted to 30% of green forage in the case of cattle and buffalo, and 50% for goats. The effect of Leucaena and mimosine can be reduced by heat treatment by supplementation with amino acids or with metal ions such as Fe^{2+}, Al^{3+} and Zn^{2+}.

7. BOAA

β-N-oxalyl-L-α,β-diaminopropionic acid (β-ODAP or BOAA), a naturally occurring amino acid, possesses potent neuro-toxic activity and has been shown to be responsible for outbreaks of neuro lathyrism following consumption of *Lathyrus sativus***.** β-ODAP occurs naturally as two isomeric forms with the α-form being approximately 5% of the total. According to toxicological studies, this isomer is less toxic than the major, β-isomer.


Lathyrus sativus

The level of β-ODAP indry seed varies considerably according to genetic factors and environmental conditions. *L. sativus* grown in nutrient solutions that are zinc-deficient or rich in ferrous iron produced seed with elevated levels of β-ODAP. β-ODAP is biosynthesized during the ripening of the seed and is further increased during germination. The ingestion of ODAPcauses neuro-lathyrism, a neuro-degenerative disease that damages upper motor neurons, causing irreversibleparalysis of the lower limbs and sometimes death in humans and animals. In Ethiopia, other studies reported ODAP content in seeds varying from 5.4 to 8.9 g/kg DM or 2.0 to 4.5 g/kg DM. The green parts and the straw contain lower concentrations of ODAP: 1.9 to 3.4 and 1.3 to 2.1 g/kg DM respectively.

Precaution

Do not use in large amount and tender fodder. Water soaking or hot water soaking for few hours reduced the toxicant.It is advised to feed lathyrus to the big animals with straw and other dry feed Bhusa.

Sources

Birendra Kumar, NiketaTirkeyand Sanjay Kumar. 2017.Anti-Nutrient in Fodders: A Review. *Chem Sci Rev Lett.*, 6(24), 2513-2519.

Denekew, Y.; Tsega, W.2009. Evaluation of b-ODAP content in forage, grain and straw of Lathyrussativus in North West Ethiopia. Liv. Res. Rural Dev., 21 (article #212) Grassl. Sci. 52:161-166.

John Andrae. 2008. Preventing prussic acid poisoning. Forage Leaflet, 13,Clemson University.

Ramchandra R., RainaDoneriaand MK and Gendley. 2019. Antinutritional Factors in Feed and Fodder used for Livestock and Poultry Feeding". Acta Scientific NutritionalHealth 3(5): 39-48.

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CURRENT SCENARIO IN FODDER AVAILABILITY, DEMAND AND GOVERNMENT SUPPORT FOR THE FODDER PRODUCTION

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Introduction

Livestock plays a crucial role in the country's rural economy as a key source of additional income, risk mitigation strategy and subsistence, particularly for small landholders and landless rural poor. According the study, it indicates that farmers had low level of knowledge on fodder production. Due increased pressure of land by vagaries of nature, land degradation, conversion of land into real estate, the availability of grazing land is declining. The desired growth of agriculture sector can be accomplished only through enhancing overall productivity of the livestock sector. This would necessitate a consistent and sufficient supply of high-quality feed to sustain the livestock population. The need of the hour, therefore, for the development of the livestock sector is to address the country's current fodder shortage by implementing appropriate measures to increase the production of crop residues, green fodder, and agricultural by-products. One of the key issues that the Indian livestock business is currently facing is ensuring an adequate supply of reasonable quality feed and fodder.

Current status of fodder availability and demand in India

Green fodder availability and demand

Estimation of green fodder was made from the resources like forage crops, grasses from forest, pastures and grazing lands, cultivable wasteland, etc. The data on area under fodder crops, both irrigated as well as unirrigated, forest, pasture and grazing lands and cultivable wasteland were collected from Land Utilization Statistics published by Government agencies and other unpublished reliable sources.

Green fodder availability and demand In South Zone and India (estimated)

In South Zone, comprising of Andhra Pradesh (including Telangana), Karnataka, Kerala and Tamil Nadu, there is an overall deficit of 43.9% in green fodder availability. All the four states in south zone are deficit in green fodder with maximum in Andhra Pradesh (62.9%) and Tamil Nadu (36%). On allIndia basis, there is an overall deficit of 11.24%ingreen fodder availability in the country. Total green fodder availability is 734.2 mt against requirement of827.19mt. (Roy*et al.* 2019)

Dry fodder availability/requirement in India (estimated)

Availability of crop residue for fodder was calculated based on the major utilizable cereals, pulses and oilseed crops, harvest index, production, and utilization pattern for each state as done in earlier studies as well as based on information taken from subject matter specialist in the study area.

Fodder availability and demand in Southern region and India (estimated)

In South Zone, comprising of Andhra Pradesh including Telangana, Karnataka, Kerala and Tamil Nadu, major source of dry fodder availability is food grains crop residue followed by forests and other sources (including groundnut and sugarcane) and kitchen/horticultural/ top feed/ farm waste. There exists an overall deficit of 27.00% of dry

fodder in south zone and except Kerala all other states in the region are deficit in dry fodder (Roy *et al.* 2019). On all India basis, there is an overall deficit of 23.4% in dry fodder availability in the country. Total dry fodder availability is 326.4mt against requirement of 426.1 mt.

Concentrates availability and demand in India (estimated)

Based on study and analysis we found that 85.78 million tonnes of concentrate is required at national level, however, at present the estimated annual availability of total concentrate feed is only 61 million tonnes (Anonymous, 2018) which makes a deficit of approximately 24.78 million tonnes or 28.9% of the demand(Roy *et al.* 2019). On the whole the statistics show that there is deficit of 11.24% for green fodder and 23.4% for dry fodder.

Different methods estimation of fodder availability and demand

Forecasting of animal feed resources need information about the feed requirement s of different livestock in terms of dry matter, crude protein and total digestible nutrients and availability of various feed ingredients like green fodder and dry fodder and concentrates along with their nutritive values. To match the requirements with availability for the present and future, projection have to be made for the further. Keeping in view these issues in focuses the pre requisite data was collected from different sources.

Livestock aspects

- Livestock census
- Nutrient requirement of different categories of animals in terms of dry matter, crude protein and total digestible nutrients

Feed resources aspects

- Animal feed resources include various agro industrial byproducts like crop residues, oil cakes brans, chunnies and greed fodders
- Data collected pertains to area under crop and yield per hectare in respect of major crops of interest for livestock like rice, wheat, oil seeds etc along with rainfall, deviation from normal rainfall.
- Annual production data in respect to various agro industrial byproducts like mahua cake, sal seed cake *etc* estimate of their products from the published from the literature

Miscellaneous data

- Data related to number of combined harvesters used by farmers over the years from input survey
- Amounts of oil cake d exported every year

Government schemes

National Livestock Mission (NLM) is Encouraging establishment of fodder processing units to reduce the demand supply gap, increasing availability of fodder and feed to substantially reduce the demand – through strengthening the fodder seed supply chain and availability of certified fodder seeds and promoting applied research in prioritized areas of poultry, sheep, goat, feed and fodder. The NLM scheme will have separate component of sub-mission on Feed and Fodder Development: This Sub-Mission aims towards strengthening of fodder seed chain to improve availability of certified fodder seed required for fodder

production and encouraging entrepreneurs for establishment of fodder Block/Hay Bailing/Silage Making Units through in centivisation.(NLM Guidelines.pdf)

Assistance for quality Fodder seed production

Under this activity, fodder seed chain i.e. breeder, foundation and certified quality fodder seed production will be incentivized.

Entrepreneurial activities in feed and fodder

The private entrepreneurs, SHG, FCOs JLG, FPOs, Dairy Cooperative societies, section 8 companies will be incentivized for the value addition such as Hay/Silage/Total Mixed Ration(TMR)/ Fodder Block and storage of fodder by providing 50% percent capital subsidy towards project cost to the beneficiary for Infrastructure development related to hay/silage at village level/ Fodder blocks making units for procuring machinery like bailer, block making machines, TMR machines/equipment, Forage harvester /reaper, Heavy duty Power operated Chaff cutters and any other PHT equipment as per the requirement/need.

Constraints faced by farmers in fodder production

Studies conducted by different researchers were indicated. It is described mainly input resources availability, lack of quality seeds, poor knowledge of farming community on latest fodder production technologies were the major constraints.

S.No.	Constraints faced by farmers in fodder production	
	Dry land farmers	**Wet land farmers**
1	Inadequate reliable input suppliers in the local market	Inadequate credit facilities for purchasing necessary inputs
2	‘Inadequate credit facilities for purchasing necessary inputs	Lack of on farm trial and trainings on latest fodder crop cultivation methods
3	High cost of inputs	Lack of on farm trial and trainings on latest fodder crop cultivation methods
4	Scarcity of Improved fodder seeds	Scarcity of water for fodder crop irrigation
5	Poor knowledge on latest know-how of cultivated fodder crops	Lack of knowledge about conservation of excess fodder
6	Lack of knowledge about unconventional fodder sources	Lack of knowledge about unconventional fodder sources
7	Water scarcity for fodder crop cultivation	Lack of knowledge about presence of anti-nutritional factors in unconventional

Source: Meena *et al.* 2017 & Pawar *et al*. 2019

Role and responsibility of Veterinarian in fodder production

Assessing the fodder available would helpful to the veterinary practioners in following way:

- To improve production potential of livestock of the village
- To manage the fodder scarcity during natural calamities

- To prepare fodder available and demand plan in well advance
- It helpful to implement the fodder related disseminate technologies to farming community
- As making arrangements such linking the farmers with reliable input fodders resources, updating the knowledge with regard to fodder production
- Production and sale of fodder seeds on partnership basis
- Production of Fodder seed of old varieties need to be replaced with newly notified
- varieties/hybrids
- Create awareness among farmers about new varieties through live demonstrations/ village awareness programme / extension mechanism
- Developing Entrepreneurs on fodder production.

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