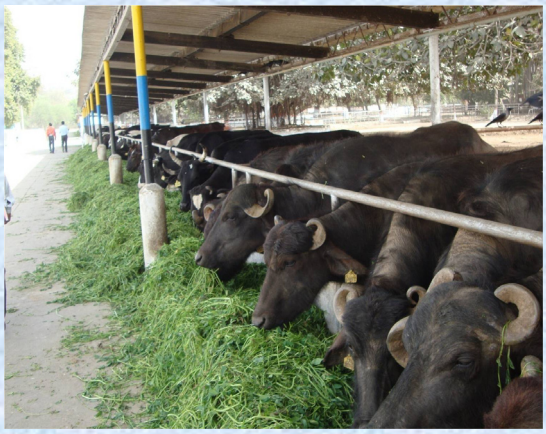
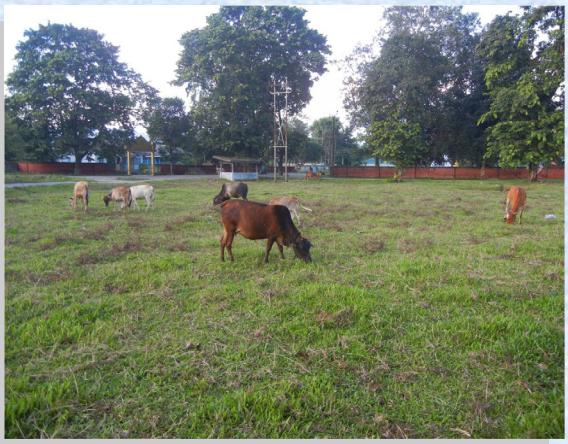
Extension Manual
on
FODDER PRODUCTION, CONSERVATION AND QUALITY IMPROVEMENT

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ICAR-National Research Centre on Yak
Dirang-790101, West Kameng District, Arunachal Pradesh
An ISO 9001: 2015 Certified Institute
In Collaboration with
Krishi Vigyan Kendra, Lohit
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CONTENTS

1. IMPORTANCE OF GREEN FODDER IN DAIRY FARMING

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Forage may be defined as the vegetative matter, fresh or preserved, utilised as feed for animals. Forage crops include grasses, legumes, crucifers and other crops cultivated and used for hay, pasture, fodder and silage. Forage is a broader term and are classified based on various features however, fodder are applied for cultivated plants. Fodders crops are cultivated plant species that are utilised as livestock feed. Fodder refers mostly the crops which are harvested and used for stall feeding. Fodder is an agricultural term for animal feed and fodder crops are those plants that are raised to feed livestock. At present, the country faces a net deficit of 61.1% green fodder, 21.9% dry crop residues and 64% concentrate feeds. The livestock is the sub-sector of agriculture sector which adds almost 32% of Agriculture output in India. In India, dairy farming is an allied sector of agriculture however, milk is a major product and one of the largest agricultural commodity followed by rice, wheat and other agricultural commodity. Dairy farming is contributing substantially to the livelihood options of small, marginal and landless farmers. Therefore, dairy farming is deeply intricate with crop husbandry and farmers' life since very beginning. Recently trends are transforming from agriculture dominance to enterprises and crops to livestock farming. Agricultural crops are depend on monsoon, however, dairy sector are less prone to climatic variation provides sustainable income and social security to the small, marginal and landless labourer. Hence, dairy farming has been designated one of the most important enterprise to reduce the poverty and social inequality in India as well as world. As agriculture depends on monsoon, dairy farming or milk production enterprise depended on feeds and fodder as this is the single largest recurring expenditure accounting for 70 - 75% of the cost of production of the dairy farm. Therefore, productivity and profitability in the milk producing animals to a large extent is determined by quantity and quality of feeds and fodder. Green fodder is a major part of feed of dairy animals. However, its availability and cultivation area are being declining very rapidly. Presently total deficit of green fodder is 50 percent of the total requirement and further increase during summer season. So, in this present situation of fodder scarcity, dairy sector is not expected to perform up to level of satisfaction. Therefore, in such a alarming situation, to aware farmers about importance and improve cultivation practice of fodder production especially in Namsai district of Arunachal Pradesh is an urgent need and real help for sustainable development of deprive tribal dairy farmers. As described earlier, fodder production is one of the most important activities in dairying contributing to the profitability of the business, hence, to promote profitable dairy farming successfully, promotion of fodder production is first and most important step.

Therefore, the importance of green fodder and its production techniques is being described in short.

Nutritional importance of Green Fodder:

Sun is the source of all metabolic energy. Plants have only capability to conserve the sun energy and made available to animal kingdom. Dairy animals and other ruminants consume plant only hence they are first consumer. All nutrients essential for life are present in air and soil. Plant assimilates entire nutrients and metabolized in the form of carbohydrate, fat, protein, available minerals and vitamins. Green plants also contain 75 to 90 percent of water. Therefore, green fodder is the important source of carbohydrate, fat, protein, available minerals and vitamins and water and can be considered as complete feed for adult dairy animals.

Feeding green fodder increases the availability of carbohydrate, fat, protein, available minerals and vitamins and water hence, feeding of optimum quantity of green fodder helps to increase the milk production.

One calf each year is basic of profitable dairy farming hence, good reproduction ensure better milk production. Green fodder contains comparatively higher amount of minerals and vitamins which ensure better productive health in dairy animals.

Green fodder feeding reduces the inter-calving period of dairy animals by providing essential minerals and vitamins to make animals in oestrus in time and thus increases the life productivity of dairy animals.

Feed nutrients presents in green fodder are more digestible, thus, it promote better growth and body weight gain in growing dairy animals and grow faster and attaining reproductive weight at early age increases the life productivity of dairy animals.

Green fodder contain secondary plant metabolites and some have medicinal properties and green fodder provides carbohydrate, fat, protein, available minerals and vitamins in balance quantity, therefore, dairy animals fed with ample amount of green fodder are less prone to diseases.

Secondary plant metabolites saponin increases meat shelf life. Tannins enhance meat colour and phenols increases antioxidation potential of milk.

Grass-based diets enhance quality of milk. Feeding of green grasses and fodder improve conjugated linoleic acid (CLA) isomers, trans vaccenic acid (TVA) , a precursor to CLA, and omega-3 (n-3) fatty acid on a g/g fat basis in milk. Grass-based diets improve the quantity of precursors for Vitamin A and E, as well as cancer fighting antioxidants compounds. Omega- 3 fatty acid is considered good for heart. Thus, green fodder feeding is important not only for dairy animal but human too.

Green fodder contains all essential minerals that promote strong and healthy bone and teeth.

Micro-organisms present in green fodder help in improving digestibility of crop

residues under mixed feeding system.

Green fodder is bulky in nature. Green fodder provides satiety to ruminant animals, which helpful to different rumen physiology and rumination.

Feeding green fodder during early age of dairy animals' causes fastening the development of rumen.

Economic importance of green fodder:

Concentrate is the costliest item of dairy farm. Green fodder provides an economic nutrient source which is highly relished by the animals. Leguminous green fodder contains moderate quantity of DCP (Digestive crude protein) and higher quantity of TDN (Total digestive nutrients) that can replace certain quantity of concentrate. For example concentrate containing 16 percent DCP (160g/kg) and 60 percent TDN (600g/kg) can be replaced by 5 times fresh Berseem fodder contains 3 percent DCP and 12 percent TDN. Berseem contain 3 percent DCP means 30g/kg or 30x5=150 g in 5 kg , TDN 12 percent means 120g TDN per kg or 120x5=600g in 5 kg. The market cost of one kg concentrate and five kg berseem would be Rs 25 and Rs 10 respectively. Though whole quantity of concentrate fed to the milk animal can replace from fodder, but, by replacing one kg concentrate from Berseem, farmers can save approximately Rs. 15.00. Therefore, feeding of green fodder reduces cost of milk production and improves the profitability of dairy farm.

Wastage of feed is wastage of money, energy, water and labour. Wastage of dry feed is more common; however, green fodder is tender and palatable and is less prone to wastage.

Feeding of green fodder fastening the growth of young ruminates. Grow faster and attaining marketing weight and reproductive weight at early age reduces cost of animal rearing and increases profitability of dairy farm.

Cultivation of green fodder is as profitable as cereals crops. In case of availability of fodder market, green fodder cultivation may be a profitable business. In the table (3) below, cost of cultivation and benefits analysis has been mention below.

Table 1 : Projected Demand, Supply and Deficits in the country (million tonnes)

Year	Supply		Demand		Deficit (%)	
	Green Fodder	Dry Fodder	Green Fodder	Dry Fodder	Green Fodder	Dry Fodder
2003	387.7	437.3	10006	560.1	61.51	21.81
2005	389.8	441.6	1021	568.0	61.83	22.12
2010	395.2	452.7	1057	588.2	62.63	22.91
2020	406.0	475.7	1134	630.9	64.26	24.57

Table 2 : Forage crops grown and their area and productivity in India

Metha (Fenugreek)	*Trigonella foenum-graecum*	5	20–35
Lobia (Cowpea)	*Vigna unguiculata*	300	25–45
Guar (Clusterbean)	*Cyamopsis tetragonaloba*	200	15–30
Rice bean	*Vigna umbellata*	20	15–30
Jai (Oat)	*Avena sativa*	100	35–50
Jau (Barley)	*Hordeum vulgare*	10	25–40
Jowar/Chari (Sorghum)	*Sorghum bicolor*	2,600	35–70
Bajra (Pearl millet)	*Pennisetum glaucum*	900	20–35
Makka (Maize)	*Zea mays*	900	30–55
Makchari (Teosinte)	*Zea mexicana*	10	30–50
Chara sarson (Chinese cabbage)	*Brassica pekinensis*	10	15–35

Table 3 : Cost: benefit analysis f different intensive forage production sequences

Crop Sequence	**Green Fodder Yield (tonnes/ha)**	**Cost of production (Rs/ha)**	**B:C ratio**
Berseem+Mustard-Hybrid napier+Cowpea	273.1	3810	**2.41**
Berseem+Mustard-Cowpea-Sorghum+ Cow-pea	171.0	3187	**1.55**
Berseem+Mustard- Sor-ghum+ Cowpea	172.1	2982	**1.94**
Berseem+Mustard-Maize+Cowpea-Sorghum+ Cowpea	180.5	3209	**1.67**
Oat-Sorghum-Turnip	190.1	3645	**1.48**
Oat- Bajra+Cowpea-Maize+Cowpea	148.1	2953	**1.38**

From the above table the future scope and profitability of fodder business can be easily access. The above table show that at present, the country faces a net deficit of 61.1% green fodder and 21.9% dry fodder however, regional deficits are more important than the national deficit, especially for fodder, which is not economical to transport over long distances. Namsai district is situated at very remote corner of the country where cow and other livestock is still reared in

extensive system due to lack of awareness and knowledge on profitability from dairying. Therefore, in the present time growing fodder for business purpose is not viable especially in remote place Namsai district of Arunachal Pradesh. However, cultivation and feeding of green fodder to the traditional reared cow may increase the milk production and ultimately the income of tribal farmers. Green fodder feeds to dairy animals on fresh basis thus it reduced the cost of storage.

Social importance of Green fodder production:

Agriculture and animal husbandry in India are interwoven with the intricate fabric of the society in cultural, religious and economical ways as mixed farming and livestock rearing forms an integral part of rural living. Few decades ago, contribution of agricultural sector in the Indian economy was more than one third however, at present it is steadily declining from 1/3rd to 1/6th. This decline trend is due to stagnant growth in agricultural crop and less return from crops. Agriculture are depends on rainfall, therefore, quantity and quality both are uncertain and ultimately provides less income to young youth hence nowadays agriculture is not an attractive livelihood source. Due to non-availability of employment source farmers and farm labourer are transmigrating from rural areas to urban areas in search of employment. Migration of farmer's family member and agriculture labourer is a big challenge for cities and policy makers. To reduce the migration problem, development of dairy and other livestock farming may be helpful up to a great extent. Livestock provides draught power, rural transport, manure, fuel, milk and meat which is limited to home consumption but it has ability to transform from mark of traditional to trade mark. Nowadays dairy farming becoming very popular among the well educated person and even technocrats. Therefore, development of dairy industry which depends on green fodder may play a great role to provide employment at home in rural areas.

2. AVAILABILITY AND CONSTRAINTS OF GREEN FODDER PRODUCTION IN NAMSAI DISTRICT

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Krishi Vigyan Kendra, Lohit, Namsai District, Arunachal Pradesh

Availability of Green fodder in Namsai District:

Undivided Lohit district has the highest number of cattle and third largest buffalo population in the state of Arunachal Pradesh. Namsai district bifurcated recently. Namsai district of Arunachal Pradesh is belonging to sub zone North eastern Himalayan region of Eastern Himalayan agro-climatic zone of India and computed a scarcity of green fodder about 40 percent. Topography of the land of Namsai district is plain with rich biodiversity of plant and forest. Most of the population belong to tribes and rearing livestock traditionally extensive system, therefore, productivity of dairy animals is very low. Vast forest land and poor quality community & pasture land's grasses is not enough to fulfil the nutritional requirement of milking animal. Due to low productivity of dairy animal and lack of awareness about economic importance of milk production as sustainable livelihood, dairy farming is not preferable work for tribal people. Namsai district has great potential of milk production from cow and buffalo, however, among several reasons lack of availability of quality feed and fodder especially green fodder is one of the most cause of under developed dairy farming in Namsai district. During personal interview, almost all dairy farmers realized that lack of feed and fodder is one of the major causes that prevent to adopt dairy farming as income generation enterprise. Farmers revealed that dry fodder is available only winter season after harvesting of rice crop and scarcity of green fodder exist over whole year. It can be concluded that scarcity of feed and fodder in Namsai district is up to great extent therefore, awareness about round the year green fodder production might be help to transform from present traditional dairying to organise and profitable dairy enterprise.

CONSTRAINTS AND SOLUTION OF GREEN FODDER PRODUCTION:

Most of the dairy animal of Namsai district is reared traditionally and they depend on forest, Government and community land. Constraints and their solution of green fodder production in the district are being discussed here.

1. Lack of awareness of scientific dairy farming and its economic importance:

Dairying and bovine rearing have been an integral component of India's agricultural and rural economy since time immemorial. It provides nutrition, draft power, organic manure, supplementary employment, cash and income. Livestock are now more valued as source of food and contributes over one-fourth to the agricultural gross domestic product and engage about 9% of the agricultural labour force. The livestock sector has been growing faster than crop sector due to ability of dairy sector as sustainable income generation capacity even in climatic calamity. In north east India where agriculture sector is not so mechanized, dairy animal is considered a 'power wheel of agriculture' and farmers are not aware income generation capacity of dairying. Productivity of indigenous cow and buffalo is low. However, in the era of health conscious food, people are demanding and ready to pay more for milk from indigenous dairy animal. Thus, neglected dairy animal may become "treasure" of the rural farmer. So, lack of interest in dairying farming and under-develop milk market is one of the major constraints that prevent farmers to cultivate green fodder.

To create awareness and impart scientific knowledge about dairy farming as an engine of agricultural and farmer's economic growth is the solution to promote green fodder production in Namsai district of Arunachal Pradesh.

2. **Lack of fodder crop and improve variety:**

Use of high yielding variety for main agriculture crop (Rice) is not common for farmers of Namsai district then what can expect for fodder crop. There are so many fodder crops in India but, mainly maize as a fodder crop is cultivated in Namsai district. Therefore, an urgent need to introduce new suitable leguminous, non-leguminous and perennial fodder crop with improve high production capacity dual purpose seed. Inadequate availability of quality fodder seeds is a major constraint. Fodder seed production is not remunerative in many of the fodder crops. State Governments may take initiatives to encourage farmers for taking up

the production of high yielding varieties by providing sufficient incentives to farmers for production of fodder seeds of high yielding varieties by way of assured procurement with a remunerative price and assistance of inputs. Emphasis should also be laid on availability of seeds of short duration and dual purpose crops, which can be used in emergency of drought / floods, for getting fodder in short period. The rich bio-mass of the Namsai district can be a potential area for providing fodder for livestock and dairy animal. However, a scientific approach is needed.

3. Traditional cultivation practices:

North east India is known for its tradition and culture. Use of traditional cultivation practice is also one of the cause of low production and availability of green fodder. Soil of Namsai district is sandy alkali soil. Due to high rainfall, soil is deficient in major and several soil micro-nutrients hence not support high growth and development of fodder. New agriculture land is fertile but application of fertilizer and manure in not common in regular used of soil. Due to low fertility status and traditional practices and high infestation of weed and forest brush, green fodder yield is very low. Productivity potential of most lands can be best utilized through not only crop rotation, but also adopting suitable crop combinations. Namsai district is very rich in horticultural crops and garden 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 substantially enhancing the availability of forage for the livestock. Demonstration on INM and improved cultivation practices will be helpful to improve the fodder production in Namsai district of Arunachal Pradesh.

4. Lack of irrigation facility during winter season:

Irrigation facility is an essential tool for round the year green fodder production. Though, Namsai district is a high rainfall zone during rainy season however, scarcity of water for agriculture purpose is very common during winter season. Rainy season crop are rain fed but due to lack of irrigation facility most of agricultural crop of winter season yields less than the national average, therefore, development of irrigation facility will be helpful to improve the productivity of crop as well as availability of green fodder.

5. Traditional feeding practices of dairy animal:

Feeding of Dairy animal totally depended on natural grass and vegetation. Due to leeching of soil nutrients during rainy season, most of the grasses of pasture and range are deficient in micro-mineral and less in protein content. Although, farmers assumed that grazing is sufficient for milking animals. Available dry roughage (rice straw as well as green fodder) is also fed without chaffing and cutting. Green fodder is available during rainy season abundantly however, treatment and conservation of green fodder is not practicing by the farmers. Dry fodder store in open place even during rainy season is prone to spoil and wastage and reduced the availability. To reduce wastage and improve the quality of dry fodder, optimisation of the use of crop residues through provision of appropriate feed supplement, treatment and conservation of green fodder should be done. Installing a community portable chaff cutters under self help group or with the help of state/ Central governments will be very helpful to save and store the dry fodder (rice straw) which is available one in year (after harvesting of rice crop (November and December). So, to improve the availability of green fodder and dry fodder round the year, farmers should be encourage to adopt intensive feeding system and suitable roughage treatment technology to ensure optimum nutrition of milking cow to improve the productivity as well as income of dairy farmers.

6. Un-organized grasslands / wastelands, and other community lands:

Namsai district has vast grassland/ degraded land where animals are allowed to graze. Due to unorganized continuous grazing by the animals and frequent flood most of grassland, pasture land have been degraded and grasses present are very poor in nutritional quality. Improvement of vast grassland, pastureland and degraded land under government scheme may be helpful to improve the green fodder availability in Namsai district. The forest department can also undertake silvi-pastoral plantations in degraded forest areas through the Joint Forest Management Committees for use of the communities grass and pasture land.

7. Conservation and Utilization of Crop Residues and unconventional fodder:

Burning of grassland and agricultural refuge in the fields is common practice, which reduce the roughage availability and harm the environment as well. To made best from waste, therefore, burning and destroying of grassland and crop residues must be control through awareness programme and government ban controls to prevent wastage or diversion of dry fodder. Farmers are well aware

about nonconventional green fodder. Farmers fed tree leaves to the milk animals. These tree leaves are containing good amount of crude protein and total digestive nutrients as well as medicinal value. However, its nutritional value is not explored so far. Nowadays, technology is available which can make valuable feed block by mixing crop residue and nonconventional tree leaves. This technology is called feed block technique. The availability of dry fodder can be enhanced by installation of low capacity Fodder block making units at each Primary Milk Cooperative / Panchayat level. Tractor mounted fodder block making units are now available, which can be operated in the fields to store surplus fodder / dry fodder. Agricultural residues can be densified with or without mixing it with easily available material like urea, molasses, butter milk, etc., for easy storage and use during the lean period. State Governments may promote use of crop residues and agricultural wastes / by-products as animal feed by enriching it through available technologies like treatment of straw with urea and molasses along with silage. Green topping of sugarcane and other crops should be saved for use as fodder.

8. Development of Fodder Banks:

Climate of Namsai district is variable and uncertain especially during rainy season. Flood condition is also very frequent during rainy season. Therefore, some time store feed may be drown away due to flood water. To save animal from such a disaster, fodder bank is necessary. The Milk Cooperatives and Panchayat may be assisted for keeping surplus fodder for use during crisis periods. Gaushalas may be encouraged and trained to popularize high-yielding fodder and forage crops and supported for creating fodder banks through silage or fodder blocks and enrichment of crop residues, etc. 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.

3. GREEN FODDER REQUIREMENT FOR DAIRY ANIMALS:

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Green fodder requirement depends on number of animals reared, type of animal and their lactation/physiological condition and feeding system followed on dairy farm. Number, type and physiology of animal are directly correlated with total green fodder consumption. Similarly, feeding system as *ad lib* vs. restricted green fodder also affects the green fodder requirement. Feeding green fodder *ad lib* quantity requires more green fodder in comparison to restricted green fodder feeding. Nutritional requirement and total feed consumption varied animal to animals therefore, calculation of green fodder requirement for each every single animal is laborious task. Therefore, requirement of green fodder is calculated based on Standard Livestock Unit.

An adult cow weighing 400 kg body weight requires 40 kg green fodder. An adult cow is one Standard Livestock Unit. Heifers 2 years and above is considered as 2/3 adult or Standard Livestock Unit. Calf one to two year old are 1/2 Standard Livestock Unit and a calf below one year old are 1/3 Standard Livestock Unit. The requirement of green fodder varied depending up on the availability of green fodder. In case of available green fodder, an adult cow can consume up to 60 kg of green fodder. Consumption of green fodder depends on dry matter content, hence; if green fodder is less succulent then consumption will be reduced and vice-versa. One of the most important principles for economic feeding of dairy animal is that they should be fed with sufficient quantity of nutritious and palatable fodder. However, dairy farmers of Namsai district are not aware about science of green fodder feeding. There is no any rule and principle for feeding of green fodder. Feeding of green fodder is far less than the standard quantity of fed to dairy animals on a standard farm. Sufficient availability of green fodder at farm is basic need for successful dairy farming; therefore, cultivation and calculation of green fodder requirement are being discussed here.

Category of Animal	Quantity of green fodder to be given for animals weighing			
	250 kg	300 kg	350kg	400 kg
Milch cows	25	30	35	40

A dairy farm having 15 standard Livestock Units including 10 adult cow, 3 heifers 2 years old and 2 calf one to two years old and 6 calf less than one years old may require following quantity of green fodder daily, monthly and annually.

15X 40= 600kg/day or 6.0 qts/day

15X 40X30 = 18000kg/day or 180 qts /month

15X 40X 365= 219000kg/day or 2,190 qt/annum

To produce the 2190 or 2200 quintals of green fodder following crop rotation may be used at one to one and half hectare land with well irrigation facility. Extra green fodder may be conserved as silage or hay and to be used during scarcity period.

Table: Round-the-year fodder production systems

Crop Sequence	**Green Fodder Yield (qts/ha)**
Berseem+Mustard-Hybrid napier+Cowpea	2731
Berseem+Mustard-Cowpea-Sorghum+ Cowpea	1710
Berseem+Mustard- Sorghum+ Cowpea	1721
Berseem+Mustard-Maize+Cowpea-Sorghum+ Cowpea	1805
Oat-Sorghum-Turnip	1901
Oat- Bajra+Cowpea-Maize+Cowpea	1481

4. FACTORS AFFECTING GREEN FODDER PRODUCTION

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As agricultural crop, fodder production too affected by several factors which should be known to dairy farmers for better production, productivity and availability of green fodder. The factors which affects the green fodder production can broadly classify in two categories 1: Genetic factor or internal factor of plant and 2: External factor

1: Genetic factor:

Factor which affect the plant character genetically are called genetic factors. Genetic factor passes from one generation to next generation or from parents to progeny and phenomenon called as inheritance or heredity. The basic of inheritance is chromosome. Chromosome is made up of DNA. *Small sections of DNA within the genome that code for proteins* and character are called gene. Gene is functional unit which regulate the development of a character and traits of plant as well as animal. Plant height, plant biomass, plant composition, flowering time and season, grain yields, age of maturity etc are the character related to plant productivity which directly control by genes. Thus, gene governs all the character express in the plant. Gene work within inner part of plant body therefore, genetic factor also called as internal factor. Among internal factor gene is major factor which responsible for faster growth, more height but less lodging with good nutritional constituents in the green fodder crop. Genetic makeup of plants differs from one crop to other and from one variety to other. Therefore, production potential, digestibility, early maturity, growth rate, better resistance to lodging, drought, flood & salinity tolerance, greater tolerance to insect & diseases, presence of anti-nutritional factor, and nutritional composition of green and dry fodder varied within the species and varieties. Using seeds with superior gene was the scientific aspect of the green revolution caused a big change in India's self sufficiency of food grain. Similarly high yielding variety of green fodder crops have superior gene responsible for higher production therefore, produced more fodder from less land. Thus, genetic factor is very important for green fodder crop as well as dairy animal but unfortunately farmers know about very less. so, from above sentence, farmers are advise to use of newly released fodder crop seed suitable

for Namsai district for better production of green fodder.

2: External factor affecting crop productivity:

External factor is very important for growing of a particular crop. Suitability of external factor is very important for the success of crop cultivation and variety performance. External factor includes several factor which have its own importance in successful cultivation of green fodder are a) Climatic b) Edaphic c) Biotic d) Physiographic and e) Socio-economic

A: Climatic factor:

Climatic factor is very important for growing of a particular crop. Climatic suitability is very important for the success of crop cultivation and performance of improved variety. Due climate difference, there are different type of crop and sowing time in different part of India. Climatic factor is not a single factor it includes several factor which have its own importance in successful cultivation of green fodder. **Climatic factors included 1. Precipitation, 2. Temperature, 3. Atmospheric humidity, 4. Solar radiation, 5. Wind velocity and 6. Atmospheric gases**

1. Precipitation

Water is one and far most requirement for crop production. Rainfall is major source of water for agriculture, hence rainfall one of the most important factor influences the vegetation of a place. Total precipitation in amount and distribution greatly affects the choice of a cultivated species in a place. Namsai district is a heavy and evenly distributed rainfall area during rainy season therefore, crops like rice in plains and tea are grown. In spite of high rain fall cultivation of fodder crop like sorghum, pearl millets and rice bean can be done. Low and uneven distribution of rainfall is common in winter season therefore, scarcity of green fodder is very common during winter season hence crop produced more with less water should be grown.

2. Temperature

The temperature of Namsai district varied from 18 to 35 degree centigrade in summer and rainy season however, 10 to 25 during winter season. The minimum, maximum (above which crop growth ceases) and optimum temperature of individual's plant is called as cardinal temperature. Temperature is a measure of

intensity of heat energy. The range of temperature for maximum growth of most of the agricultural plants is between 15 and 40°C. Temperature influences distribution of crop plants and vegetation by affecting seed germination, growth rate, flowing time and pollination. Physical and chemical processes within the plants are also governed by air temperature. Diffusion rates of gases and liquids changes with temperature. Solubility of different substances in plant is also dependent on temperature. Seed of fodder crop require a definite range of temperature for germination and based on suitability of temperature most of the rainy, summer and winter season crops can be grown, however, other factors need to address properly.

Crops	Minimum temperature °C	Optimum temperature °C	Maximum temperature °C
Rice	10	32	36-38
wheat	4.5	20	30-32
Maize	8-10	20	40-43
Sorghum	12-13	25	40

3. Atmospheric Humidity (Relative Humidity - RH)

Water is present in the atmosphere in the form of invisible water vapour, normally known as humidity. Relative humidity is ratio between the amount of moisture present in the air to the saturation capacity of the air at a particular temperature. Namsai district is a high rainfall area so, relative humidity is found higher than the dry part of the country. Humidity present in atmosphere influences the water requirement of crop by reducing or increasing the water requirement as well as absorption of nutrients from the soil. High humidity reduced evaporation of water from the soil and transpiration from plant. Lack of evaporation increase the turgidity of plant tissue and reduce the exchange of nutrients ion between root and soil. Thus, high humidity of a particular region affects crop production. So, before going to introduced new fodder crop and its varieties point should be taken care in the mind. Relative humidity of 40-60% is suitable for most of the crop plants. Very few crops can perform well when relative humidity is 80% and above. High humidity is also favoured the outbreak of pest and disease of plant.

4. Light

Sun light is the only source of energy and plant is only living thing that can capture the photonic energy used for biochemical reaction of life. Requirement of light in crop production started from germination to up to harvesting and even post harvest time. Light is helpful in seed formation, flowering, vegetative growth, nutritional composition, maturity of crop. The most important reaction photosynthesis can not happen in the absence of light. Photosynthesis is responsible for the synthesis of all bio chemical compounds is necessary for growth and development of seed as well vegetative parts. Light also affect physical process taking place in the soil, plant and environment by controlling and distribution of temperature. Light intensity or radiation essential for photosynthetic mechanism of plants is called as photosynthetically active radiation (PAR - 0.4 – 0.7µ). Photosynthetically active radiation is essential for production of carbohydrates and ultimately biomass. Duration of light is also important for green fodder as well as food grain crop. Flowering of plant is happening in the presence of definite light hours. The process is called as photoperiod. Based on photoperiod crop are classified as short day plant, long day crop and day neutral crop. Short day – Day length is <12 hours (Rice, Sunflower and cotton), long day – Day length is > 12 hours (Barley, oat, carrot and cabbage), day neutral – There is no or less influence on day length (Tomato and maize). Classification of crop based on light duration is very important for green fodder production. Maize is a day neutral crop so, it can be grown all round the year for fodder purpose. Namsai district have bright sun shine and very less foggy weather during winter season. The climate is suitable for growing *rabi* (winter) season sorghum. Thus, by acquiring knowledge on importance of light in green fodder production prevailing as well as new fodder crop can be grown in Namsai district of Arunachal Pradesh.

5. Wind velocity

Wind velocity is also important in agriculture. Wind velocity affect crop production by carrying moisture (precipitation) and heat. The moving wind not only supplies moisture and heat, also supplies fresh CO_2 for the photosynthesis. Some time high wind velocity cause lodging in fodder crop and grain shedding of mature crop. Wind movement for 4 – 6 km/hour is suitable for more crops.

6. **Atmospheric gases on plant growth**

CO_2, O_2 and Nitrogen are important for crop production. CO_2 is source of carbon used for photosynthesis and converted to carbohydrate, protein, fat and other compounds. O_2 is important for respiration of both plants and animals while it is released by plants during Photosynthesis. Nitrogen is one of the important major plant nutrient utilize to form building block protein. Atmospheric N is fixed in the soil by lightning, rainfall and N fixing microbes in pulses crops and available to plants.

B) SOIL FACTORS

Soil grown in land provides base and nutrition to plants. Agriculture farmer and dairy farmers should need to understand that sowing of crop seed is not enough to get maximum yield. Several characteristics of soil affect the plant growth and yields are Soil moisture, Soil air, Soil temperature, Soil mineral matter, Soil organic matter, Soil organisms and Soil reactions.

Soil moisture normally called as water present in soil at certain temperature and quantity. All moisture available in soil is not important for plant therefore, moisture available for plants or moisture that can be absorbed by the plant is more important. Available moisture will be more in clay soil than sandy soil. Soil of Namsai district is sandy soil; therefore, farmers should be careful regarding soil moisture for better fodder production.

Soil air is essential for seed germination and absorption of water by roots. Oxygen is required for respiration of roots and micro organisms for decomposition of organic matter. Leguminous fodder crop require more aeration to fix the atmospheric nitrogen. Sandy soil of Namsai district does not have problem of low aeration.

Soil temperature affects the germination of seeds and growth rate of root, absorption of water and plant nutrients, and thus, ultimately biomass of plant. Soil temperature is directly correlated to atmospheric temperature therefore, sowing of crop seed should be done based on atmospheric temperature.

Soil mineral content are directly related to available plant mineral nutrients as P, K, Ca, Mg, S, Mn, Fe, etc. Soil mineral content of soil is derived from the weathering of rocks from which soil form. Mineral deficiency in soil is common in India's soil. Sandy soil with high rainfall is more prone to mineral deficiency due to

high rainfall. Therefore, testing of soil sample periodically is advice to ensure optimum quantity of mineral in soil.

Soil Organic matter called as soul of soil, it supplies all the major, minor and micro nutrients to crops. Soil Organic matter improves the texture of the soil, increases the water holding capacity of the soil, increase activity and number of beneficial soil microorganisms. Soil Organic matter helpful to improve the availability of plant nutrients. Soil Organic matter is decomposed by soil organisms. Soil organism play vital role in decomposing and releasing of plant nutrients from soil organic matter. Fixation of nitrogen in the soil is also one of the activities of soil bacteria that can help to farmers to reduce the cost of cultivation. Soil reaction (pH) is the pH (hydrogen ion concentration) of the soil. Soil pH affects crop growth by influencing the availability of nutrients and the activity of microorganisms. A neutral soil pH level between 6.5 and 7.5 is best for growth of most of the crops. Based on pH soils are classified as acidic (<7.0pH), neutral (=7.0pH), saline and alkaline (>7.0pH). Low and high pH is harmful for the crop. Soil pH of Namsai district is in acidic in reaction and varied mild low to very low therefore, soil reclamation or growing of acid tolerance varieties will ensure better crop as well as fodder yield.

C) BIOTIC FACTORS

Living organism including plant and animals found in particular areas affects the production ability of crop called biotic factors. Heavy infestation of weed and pest in the fodder crop too affects the growth rate of main crop thus reduced green fodder yield. Some crops growing under mixed cropping has synergetic effect however, some can affect negatively. Presence of wild ruminant can also affect the production of green fodder. Therefore, all these things should also be taken care to obtain maximum green fodder yield.

D) Physiographic factors:

Physiographic factor means topography and situation of place where a particular crop is grown. The nature of surface earth as well presence of mountain or hill affect the crop production and its distribution. At higher altitude temperature reduces and growing of tropical green fodder will not be possible at low temperature. At steep slope cultivation practices is difficult and more prone

to soil erosion due to rain water. Therefore, topography is important for fodder cultivation.

E) Socio-economic factors

Socio-economic factor is also important for cultivation and availability of green fodder. In India, 80 percent livestock are reared by marginal and landless farmers possess no land to very small land holding. Therefore, landless dairy and livestock farmer can not cultivate green fodder due to lack of land. Similarly, economically improved farmer are not interested in dairy farming. Areas where piggery is more common green fodder cultivation not be a popular activity. So, depending on the profitability and popularity of enterprise green fodder production and availability may be affected.

F) Agricultural factor:

Under the same climate and soil, agriculture practices adopted by the farmers affects fodder yield significantly. Agriculture practices includes selection of crop, crop rotation, mixed cropping, multiple cropping, date of sowing, depth of sowing of seed, spacing between line and plant, management of pest and disease, irrigation time, weed control and time and method of fertilizer application, cutting time and height of cutting of fodder crop (Non-monitory factors), land preparation, type, quantity, & treatment of seed, irrigation frequency and method, quantity of fertilizer and intercultural activity (monitory factors). Production and availability of green fodder is greatly affected by all above said factors. So, to improve the production and availability of green fodder due importance should be given to all the points.

5. CLASSIFICATION OF GREEN FODDER:

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Krishi Vigyan Kendra, Lohit, Namsai District, Arunachal Pradesh.

Fodders crops are cultivated plant species that are utilised as livesto ck feed. Fodder refers mostly the crops which are harvested and used for stall feeding. Classification of green fodder crop is very important to know type, cultivation and nutritional properties. Green fodder is classified based on season of cultivation, nutrient density, plant type and crop duration.

Classification of green fodder on the basis of season of cultivation:

Particular crop grown in a particular season, therefore, called seasonal green fodder crop. Based on season of cultivation, green fodder is classified as Kharif season green fodder crop, Winter season green fodder crop and summer season green fodder crops.

Green Fodder		
Kharif (April - September)	**Rabi** (October –December)	**Summer** (January - March)
Eg. Maize, Bajra, Sorghum, Cluster bean, Field bean	Eg. Lucerne, Oats, Barley	Eg. Cowpea, Cluster bean, Field bean, Bajra, Sorghum, Maize

Classification of green fodder on the basis of type of crop:

Based on botanical characteristics green fodder crops are divided into two classes legume and non-legume crops. To make balance ration both legume and non-legume crop of green fodder is essential.

Leguminous green fodder	**Non-Leguminous green fodder**
Cowpea, Cluster bean, Field bean, Rice bean, Lucerne, Berseem , Stylosanthes etc	Maize, Bajra, Sorghum, Oats, Barley, Deenanath grass, Hybrid Napier etc

Classification of green fodder on the basis of duration of crop:

Green Fodder crops has different growing period. Some crop grow all over year, however, some has seasonal growing period. Therefore, green fodder crops classified as annual green fodder and perennial green fodder crop. The above class are further classified in subclasses as mention below-

Cereal - Annual	**Grasses**		**Legume**	
	Annual	**Perennial**	**Annual**	**Perennial**
Maize, Sorghum	Deenanath grass	Hybrid Napier, Guinea grass	Cowpea, Berseem	Lucerne, Stylosanthes

6. PACKAGE AND PRACTICES OF SEASONAL GREEN FODDER CROPS SUITABLE IN NAMSAI DISTRICT

6.1: IMPROVED PRODUCTION TECHNOLOGY OF FODDER MAIZE

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Maize is one of the most important fodder crop in India and world. Maize is one of the major fodder crop of rainy and summer season grown in India and in Namsai district. In Namsai district maize is only crop grown for fodder purpose. Maize is widely cultivated from 50' N to 40' S and from sea level to 3300 m altitude. It requires 600-900 mm rainfall in the growing season. In Namsai district maize grown for dual purpose as staple food for human consumption and quality feed and fodder for ruminant animals. Maize is generally grown in the areas with rainfall of 50-150 cm, but it is also grow well in higher rainfall area of Namsai district, however, yield are poor due to traditional package and practices adopted by the farmers of Namsai district.

Botanical and nutritional Description

Maize belongs to non-leguminous group of green fodder crops therefore, containing less protein than the leguminous green fodder though, it can grow all the season (Except extreme cold) due to less sensitive to daylight. Maize has moderate nutritional value and graded as maintenance ration.

Nutritional composition of green Fodder (% Dry matter)									
Crop	Crude Protein	Fi-ber	NFE	Ether Extract	DCP	TDN	Total Ash	Cal-cium	Phos-phorus
Maize Grain	10-6	2.2	82.1	3.3	5.8	76.0	1.8	-	-
Maize Green fodder	6.7	35.9	47.0	2.0	4.1	67.7	8.1	0.5	0.2
Maize Husk	8.1	15.6	72.5	1.5	4.5	75.3	2.1	0.3	0.0
Maize Cobs	0.38	48.6	53.3	0.05			0.45		

Soil and Land Preparation:

Maize is grown on a variety of soils, but well drained and fertile sandy loam soils are best suited. Land should be prepared well by ploughing/hoeing. Plough the field twice with an iron plough and three or four times with country plough to obtain good tilth. Good land preparation reduces weed infestation and improves germination of seed.

Manures & Fertilizers:

Apply NPK fertilizers as per the soil test recommendations as for as possible. If soil testing is not done, follow the normal recommendation of NPK/ha mentioned below. Application of FYM or compost at the rate of 10 to 15 t/ha is good for better green fodder yield. The quantity of NPK has been mentioned in the table below. Total quantity of FYM, phosphoric and potash fertilizer and half dose of nitrogen should be incorporated n the soil as basic dose of fertilizer land preparation. Application of bio fertilizer and PSB along with 25 kg zinc sulphate per ha is beneficial to increase the green fodder yield. Half dose of nitrogen should be applied at 30 to 40 day after sowing of seed as top dressing. A combination of organic and inorganic fertilizer gives better yield. Vermi-compost at 5 t/ha + 75% recommended dose of fertilizer for intercropping of maize and cowpea produces green fodder yield of 105 t/ha/yr (3 crops/ year) which is sufficient to maintain 7 adults and 3 young cattle.

Nutrient	Requirement (Kg/ha)	Form	Fertilizer (Kg/ha)	For one Bigha (Kg/ha)
N	**60**	**Urea**	**132**	**18**
P_2O_5	**30**	**SSP**	**186**	**27**
K_2O	**30**	**MOP**	**82**	**7**

FYM (GOBOR) or compost should be applied during land preparation preferably 10 day before expected day of sowing. The entire quantity of SSP, MOP and half of the total urea is to be applied at final land preparation or in furrows and covered with soil.

Time of sowing:

Maize is mostly grown as Kharif crop i.e. sowing in June – July in other part of country. However, miaze sowing should be done before June during rainy season and October- November in Rabi (winter) season in Namsai district. In summer season, sowing should be done in the month of February to March. Maize as fodder crop can be grown throughout the year at 20 to 30 day interval except during heavy rainfall time. Seeds should be dibbled at a depth of 3-4 cm in rows 20 cm apart and at a distance of 10 cm from seed to seed within the rows. For fodder purpose broad casting is common method of sowing, however, quantity of seed should be used 10 percent higher than the recommended quantity.

Seed Rate:

For fodder purpose require 60-65 Kg seeds/ha. Seeds should be treated with Bavistin @ 2g/kg of seed to prevent seed born fungus diseases.

Improved Varieties:

Improve and newly released variety of maize gives higher fodder as well grain yield. All varieties (composites, synthetics and hybrids) developed for grain production can also be used for dual purpose fodder as well as grain production. Maize has very less number of fodder varieties are **African tall, Vijay composite, Moti, composite, varieties- Ganga – 5, J-1006 and Jawahar** are some important fodder variety.

Intercropping: Fodder Maize can be intercropped with Cowpea at 3:1 ratio and harvested together to provide nutritious fodder.

Weeding and intercultural operation:

To produce maximum green fodder yield field should be free from weeds especially after sowing of seed. Excessive weeds should be removed either by manually or by using chemical. Manual control of weed at large area is not economic therefore, application herbicide Atrazine @ 0.25 kg/ha as pre-emergence on 3-5 DAS using Backpack/ Knapsack/ Rocker sprayer fitted with a flat fan nozzle using 500 litres of water/ha followed by one hand weeding on 30-35 DAS. If leguminous green fodder crop is sown as mixed crop as intercrop, do not use Atrazine. Spraying of Pendimethalin @0.75 kg/ha as pre-emergence on 3-5 DAS are advice.

Irrigation and Drainage:

Maize fodder field should be irrigated whenever require particularly during dry winter spells. Provision of drainage is to be made for removing excess water during rainy season.

Harvesting:

Harvesting should be done at 75 days after sowing of the crop (cob is in the milky stage) to get good quality fodder. Only one cut is recommended. To obtain continuous soft and green fodder, whole area under maize crop should be sown at certain interval of period.

Green Fodder Yield:

An average fodder yield of 40 to 50 tonnes per hectare can be obtained

6.2: SORGHUM: A NEW FODDER CROP FOR NAMSAI DISTRICT

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Sorghum is fast-growing, warm weather annual plant that can provide plenty of feed in summer and rainy season. Sorghum is indigenous of Africa continent, though it is being cultivated in India before recorded history. Sorghum crop as fodder and grain purpose is grown mainly in western UP, Haryana, Punjab, Rajasthan, Gujrat, MP, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. Sorghum is a major fodder crop of rainy season and fulfils over two third of the fodder demand during rainy season in other part of country. Sorghum is a new crop in Namsai district however, experiment under prevailing climatic condition shown that it can grown here with good forage yield and plant growth. Scarcity of fodder is a major hindrance of dairy farming in Namsai district. Namsai district, however, has good potential of scientific dairy farming, milk production and its marketing which may help to improve the economic condition and poverty eradication of rural farmers of Namsai district. In the Namsai district very limited number of fodder crop has been grown, therefore, to reduce the scarcity of green fodder sorghum a new fodder crop introduced and cultivation practices are being explained here.

Botanical and nutritional Description

Sorghum belongs to non-leguminous group of green fodder crops

therefore, containing less protein than the leguminous green fodder. Sorghum is a rainy season crop however, other winter season variety is also available and grown during winter season under clear weather area having moderate winter temperature. Clear winter and moderate temperature of Namsai district during winter is suitable for growing of winter season sorghum, however, field study is necessary. Sorghum has moderate nutritional value and graded as non-maintenance ration.

Nutritional composition of green Fodder (% Dry matter)									
Crop	Crude Protein	Fiber	NFE	Ether Ex-tract	DCP	TDN	To-tal Ash	Cal-cium	Phos-phorus
Sorghum Green fodder	7.7	32.3	49.6	1.7	3.4	54.0	8.1	-	-

Soil and Land Preparation:

Upland soil free from water submerge condition is suitable for sorghum cultivation however, most suitable soil is sandy loam soil. The land preparation should be started from February mid. One deep ploughing and 3 to 4 times harrowing and planking are sufficient. The land should be made free from weed before sowing. Good land preparation reduces weed infestation and improves germination of seed. Finally preparation should be completed by planking.

Manure & Fertilizers:

Sorghum is very responsive to use of the fertilizers. Application of farmyard Manure (FYM) 20tonnes / ha and 100 kg N and 60 kg phosphorus (P_2O_5) and 60 kg potassium/ha for multi-cut sorghum and 80 kg N and 60 kg phosphorus and 60 kg potash/ha for single cut sorghum is recommended. Application of 25 kg/ha zinc sulphate and micro-mineral increases green fodder yield. Apply NPK fertilizers as per the soil test recommendations as for as possible. If soil testing is not done, follow the normal recommendation of NPK/ha mentioned. A combination of organic and inorganic fertilizer gives better yield. Total amount of FYM, phosphorus, potash and half amount of nitrogen should be applied at the time of field preparation. Remaining amount of nitrogen should be applied in two equal split doses as top dressing after 30 days of after sowing.

Sowing Time:

Depending on soil moisture and atmospheric temperature, sorghum can be sown from March to end of July. Delayed sowing may cause decrease in green fodder yield due to high rainfall during month of July and August. Sowing should not be done during the time of high rainfall. Line sowing 20x10 cm give better green fodder yield, sowing by broad casting method require 10 percent higher seed rate than the recommended to maintain green fodder yield. The seed should be sown at the depth of 3 to 4 cm. Sowing seed at deeper place reduces germination percentage. Planking is necessary after sowing of seed.

Seed rate and Seed Treatment:

20 to 25 kg/ha seed should be used. In case of hybrid variety seed sowing in line only 10kg/ha are recommended. Before sowing seed should be treated with carbendazim (bavistin) @ 2g for one kg seed for better germination and disease prevention. Sowing in line (30X10 cm) will improve fodder yield.

Suitable Varieties:

Name of the Variety	**Green Fodder yield (qt)**	
	Single cut	**Multi-cut**
CSH-24MF		**600**
Pant Chari-6		**450-500**
Pant Chari-5		**450-500**
CSV-21F	**400**	
SSG 59-3 (Meethi Sudan)		**750**

Intercropping:

Sorghum can be intercropped with Cowpea at 3:1 ratio and harvested together to provide nutritious fodder. In forage sorghum, the mixed cropping is also practiced with fodder legumes, viz., Pigeon pea, cowpea and cluster bean, in 2:1 ratio to improve fodder yield and quality.

Irrigation and Drainage:

Under normal rain distribution irrigation is not required. In case of drought, irrigation at 15 days interval is desirable. Provision of drainage is to be made for removing excess water during heavy rainfall. Irrigation facility is necessary for growing of winter season sorghum to minimize the water scarcity particularly during prolong dry winter spells.

Plant Protection:

Use of any insecticide and pesticide is not recommended for fodder crop.

Sorghum crop growing for grain purpose prevention from diseases and pest is necessary. Seed treatment before sowing is easiest method of control of seed born disease.

Harvesting:

Sorghum fodder is ready for first cutting in about 6 weeks after sowing of seeds. Fodder should be cut 10- 15 cm above the ground level. Subsequent cutting should be done after 30 to 40 days interval in multi-cut fodder varieties. Single cut varieties harvested at 50% flowering to full bloom contains higher amount of nutrients and its digestibility. Harvested fodder should be feed to dairy animals after chaffing in chaff cutter. Sorghum fodder should be cut after receiving of sufficient amount of rain. Prolong dry season causes toxicity in sorghum fodder called HCN. HCN is present in sorghum especially during early stages up to 40–50 days and below 50 cm plant height. Proper care has to be taken during harvesting for avoiding HCN poisoning. Sorghum fodder is suitable for silage and hay making.

Besides green fodder and stover, sorghum is fifth most important cereal crop of the world. Therefore, sorghum can be grown as dual purpose crop in Namsai district during both rainy and winter season. However, extensive study needs to be done on practices and packages for the cultivation of sorghum as food millets.

Laddu made from sorghum's roasted seed

Growth of plant of winter season sorghum

6.3: OATS: NUTRITIOUS FODDER OF WINTER SEASON

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Oat (*Avena sativa*) is important non-leguminous green fodder crop of winter season cultivated all over the country and world. Cultivation of Oat in Namsai district is successfully demonstrated on farmer's field under rainfed conditions. Oats are grown and use as grain as well as forage and fodder, straw for bedding, hay and silage. Thus, oat is important not only for livestock but humen being too. Food uses of oats include oatmeal, oat flour and oat flakes for use as breakfast cereals and ingredients in other food stuffs. Oats are one of the most nutritious grain cereals, high in protein and fibre. The protein of rolled (flakes) oats is generally greater than that found in other cereal grains. Many of the vitamins and minerals found in oats are combined in the bran and germ. Most of oat food products use the entire groat, making it a nutritious cereal grain.

Botanical and nutritional Description

Oat is winter season fodder crop belongs to Gramineae family and non-leguminous green fodder crops but, quite nutritive containing on an average 7.6

per cent crude protein at 50% flowering stage and about 14.6 percent at very early stage of growth. Under adequate irrigated conditions, it may give three cuttings starting from January when green fodder is scarce.

Nutritional composition of green Fodder (% Dry matter)									
Crop	Crude Protein	Fi-ber	NFE	Ether Extract	DCP	TDN	Total Ash	Cal	phos
Oat Grain	10.0	12.7	65.8	6.55	7.8	78.4	4.7	0.1	0.1
Oat Green fodder	9.9	26.6	50.5	2.2	7.1	69.7	10.8	-	-

Soil and Land preparation:

Oats are better adapted to variable soil types and can perform better on acid soils than other small grain cereals crops. Optimum pH for oat is varied from 5.5 to 6.5. Soil of Namsai district is acidic in nature, therefore, oat can perform better under improved soil and agriculture practices. Oat require good land preparation, therefore, one deep ploughing and 5-6 ploughing by the cultivator or harrow makes soil free from weeds and suitable for germination. Soil should be free from stone and good tilth improves seed germination.

Manure and fertilizer application:

In Namsai district, fertilizer application is not a common practice, therefore, farm yard manure available at farmer's home about 25 tones should be apply to ensure good growth and fodder production. Along with manure basal dressing of 40 kg N and 40 kg P_2O_5 per ha should be done at the time of land preparation and 30 kg N should be applied as top dressing each after first and second cutting. Application of 54 kg urea, 125 kg SSP and 33 kg MOP per hectare as basal dose and 34 kg urea after first cutting (60-70 days after sowing) as top dressing is essential. 50% recommended dose of fertilizer+ vermicompost @ 2.5t/ha + FYM @ 2.5t/ha should be applied if oat is grown in fodder based cropping sequence.

Sowing time:

The crop should be sown from mid September to mid December. Good amount of moisture should be available during sowing.

Seed rate and method of sowing

Seeding should be done in rows 20 cm apart at seed rate of 100 kg per hectare. The seeds should be treated with Vitavax or bevestin 2 g/kg seed to ensure freedom from covered smut disease. Sowing of oats in lines 20 cm apart and with broadcasting of pea gives higher green as well as dry fodder yield under rainfed conditions.

Suitable Varieties:

Under good irrigation and nutrient management use of newly released and improved variety of oat gives better yield. Therefore, among the following varieties mention below may be used for fodder production. Kent variety of oat is an early variety coming to flowering in about 125 days. It has moderate tillering and plant height with medium sized leaves. The seed crop matures in about 180 days. On an average, it gives 360 qunitals green fodder per hectare.

Name of the variety	Year of release	Developed by	Suitable for the Reason
Kent			Whole country
HJ 114			Assam
OS 7	1981	CCS HAU, Hisar	Whole country
UPO 94	1981	GBPUA.&T, Pantnagar	Whole country
Bundel Jai 822	1989	IGFRI, Jhansi	Entire country
UPO 212	1990	GBPUA.&T, Pantnagar	Entire Country
OL 125	1995	PAU, Ludhiana	Entire Country
Bundel Jai 99-2	2002	IGFRI, Jhansi	North-east
Bundel Jai 99 1	2007	IGFRI, Jhansi	North-east

Irrigation:

A pre-sowing irrigation is important for the proper germination of the crop. Lack of moisture during growth period is one of the major cause of low yield of green fodder of oat. In absence of irrigation facility oat cultivation will not be successful. Mild rainfall during winter season as expected in Namsai district oat can be grown successfully as rainfed crops. If the soil is dry, first irrigation is to be applied immediately after sowing, second at maximum tillering (45 days after sowing) and third immediately after the first cutting. Three to four irrigations are sufficient. In case of multiple cuttings, field must be irrigated after each cutting.

Harvesting of green fodder:

For single cut plots, optimum time of harvesting is the fifty percent bloom stage. For multiple cuttings, the first cutting is taken about three months after seeding and subsequent cutting at an interval of 40 days. Multicut variety should be cut at the height of 8 to 10 cm above the ground level to maintain good growth in subsequent cutting.

Green Fodder Yield:

An average fodder yields of 220 to 300 quintals per hectare and an about 5 quintals grain/ha can be obtained from oat fodder crop. For seed production crop should cut only once.

Seed Production:

Oats seeds can be obtained by allowing the crop for seed setting after the first cutting. One fifth of a hectare produces seeds sufficient for sowing one hectare.

6.4: SCIENTIFIC CULTIVATION PRACTICES OF COWPEA AS FODDER

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Traditionally Cowpea is extensively grown in Namsai district for vegetable and pulse purpose. Use of Cowpea as fodder crop is not common however, after harvesting pod, farmer's use vegetative part for the feeding of cow and goats.Cowpea is an annual leguminous fodder crop. It is one of the most suitable fodder crop for areas of Namsai district. It remains soft and succulent at all stages of growth. It can be grown without irrigation in areas with high water table.

Botanical and nutritional Description:

Cowpea (**Vigna unguiculata)** is member of Leguminosae family has 2n = 2x = 22 chromosomes (diploid). Cowpea is day neutral, highly self-pollinated crop, although significant out crossing can also occur due to large bees like bumble bees. Cowpea cultivated all over the India with four cultigroups (1) *unguiculata*-major group, (2) *biflora orcatiang* with small erect pods grown in south- east Asia, (3) *sesquipedalis*-yard long bean grown in Asia, (4) *textiles*-grown in west Africa, for textile fibres obtained from peduncles. The wild and weedy types include, *V.*

pubescense, V. dekindtiana and *V. cylindrical.* Cowpea can be an annual or perennial, bushy, trailing or climbing herb. Stems are 1 to 3 m long, glabrous or slightly hairy. Leaves are trifoliate, inflorescence auxiliary having a few to several flowers. Pods are linear and cylindrical. Cowpea as vegetable is extensively cultivated in Namsai district, however, farmers should be make aware about fodder production potential.

Cowpea is a nutritious green fodder and has been classified as productive green fodder. Feeding cowpea green fodder increase the milk yield and improved the fertility of soil by fixing the atmospheric nitrogen in to the soil.

Nutritional composition of green Fodder (% Dry matter)									
Crop	Crude Protein	Fiber	NFE	Ether Extract	DCP	TDN	Total Ash	Calcium	Phos-phorus
Cowpea (Breakage)	20.5	10.9	57.8	7.8	16.3	66.9	7.1	0.5	0.3
Oat Green fodder	28.1	26.6	33	3.0	20.2	62.1	9.1	1.4	0.3

Soil and Land preparation:

Cowpea is better adapted in the soil of Namsai district and can also be grown in variety of soil types *viz*. red loam, black clay loam, coarse gravel, sandy loam, light sandy soils. It is also grown in sloppy land in hilly tracts and heavy loam soils. It is more tolerant to heavy rainfall than any other pulse crop. It suffers from water stagnation and heavy drought. It thrives well between 21 to 35°C. The crop is usually grown as dryland *kharif* crop and can also be grown as pre monsoon and late monsoon crop. It is also grown as second crop during winter season after rice in southern parts of country.

Land should be prepared well by repeated ploughing. First ploughing by mould board plough followed by 2 to 3 harrowings is sufficient to prepare the land well. Land should be prepared two times. After first ploughing field should be given rest for ten days to germinate the weed's seeds. At the time of second and final land preparation manure and seed should be broadcast. Thus, preparing field in this way reduced the weed intensity.

Manure and fertilizer application:

Cowpea does not require much fertilizer however, if nitrogen deficiency is found in the land initial dose of fertilizer is essential. In Namsai district, fertilizer application is not a common practice, therefore, farm yard manure available at

farmer's home about 10 tones should be apply to ensure good growth and fodder production. Application of micro-nutrients fertilizer especially molybdenum and sulfur is necessary to optimize the nitrogen fixation activity of bacteria. So, basal dose as mention below is essential for higher green fodder yield. Half the nitrogen

Nutrient	Requirement (Kg/ha)	From	Fertilizer (Kg/bigha)
N	20	Urea	6
P_2O_5	40	SSP	35
K_2O	20	MOP	5

is applied as basal dose and half for top dressing.

Sowing time:

March - April is the most optimum time for sowing. Fodder cowpea can be profitably grown as a summer crop in rice fallow of sandy loam soils where water is not available to raise a subsequent crop. It can be considered as a complementary crop in the rotation sequence of rice- cowpea because of the leguminous organic residues available for fertility enrichment.

Seed rate and method of sowing:

Seed rate recommended is 40 to 50 kg/ha for a broadcast crop and 15 to 40 kg/ha for drill sown crop. It can be broadcasted or drilled in lines. For seed crop, line sowing is preferred. For drilling, spacing of 30 to 40 cm between rows and 6 to 15 cm between plants is recommended.

Seed treatment:

Cowpea is leguminous fodder therefore, before sowing of seed should be treated with rhyzobium culture.

Suitable Varieties:

Under good irrigation and nutrient management use of newly released and improved variety of cowpea gives better yield. Assam Agriculture University has recommended following varieties for Assam and adjoining areas are **Cowpea : No 10, No 42/1, EC 4216.** Besides these some other varieties **UPC – 287, UPC-4200, Bundel Lobia-1, Bundel Lobia-2** and **UPC- 625** may also be tried.

Irrigation:

Irrigation for monsoon season crop is not necessary however, post rice

crop need to be irrigated if sufficient moisture are not available.

Weed Management:

One hand weeding or hoeing 30-35 days after sowing or application of weedicide pendimethalin @ 1.0-1.5 kg a.i/ha immediately after sowing helps in control of weeds.

Harvesting of green fodder:

Cowpea should be harvested at 50 % flowering stage 60 to 70 days after sowing. Cowpea is leguminous fodder and feeding in large quantity may cause bloat in cow as well as other ruminants. Therefore, cowpea should always feed with sufficient amount of dry roughage.

Green Fodder Yield:

An average fodder yield of 20 to 30 tonnes per hectare can be obtained.

6.5: SCIENTIFIC CULTIVATION PRACTICES OF RICEBEAN AS FODDER

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Rice bean is an important fodder crop of north east region however, very few know about fodder production potentials. Therefore, however, farmers should be made aware about fodder production potential and nutritional importance of ricebean. Most of the cultivation practices for rice bean are similar to cowpea hence important practices are being describing under several headings.

Sowing time:

March - April is the most optimum time for sowing. As fodder crop it can be grown round the year in Namsai district rice bean.

Seed rate and method of sowing:

Seed rate recommended is 25 kg/ha for a fodder purpose. It can be broadcasted or drilled in lines. For seed crop, line sowing is preferred. For drilling, spacing of 30 to 40 cm between rows and 10 to 15 cm between plants is

recommended.

Seed treatment:

Cowpea is leguminous fodder therefore, before sowing seed should be treated with rhyzobium culture.

Suitable Varieties:

Assam Agriculture University has recommended following varieties for Assam and adjoining areas are **K-1, Bidhan rice bean-1, Bidhan rice bean-2 and Shyamalee-1.**

Irrigation:

Irrigation for monsoon season crop is not necessary however, winter season crop may not grow well in absence of irrigation.

Weed Management:

One hand weeding or hoeing 30-35 days after sowing or application of weedicide pendimethalin @ 1.0-1.5 kg a.i/ha immediately after sowing helps in control of weeds.

Harvesting of green fodder:

Rice bean should be harvested at 50 % flowering stage 70 to 80 days after sowing. Feeding should be done similar to cowpea fodder.

Green Fodder Yield:

An average fodder yield of 25 to 30 tonnes per hectare can be obtained.

7. PACKAGES AND PRACTICES OF PERENIAL GREEN FODDER CROPS SUITABLE IN NAMSAI DISTRICT

7.1: SCIENTIFIC CULTIVATION PRACTICES OF HYBRID NAPIER

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Napier grass is also called as elephant grass due to its tallness and vigorous vegetative growth. Hybrid Napier (*Pennisetum purpureum*) is an inter-specific hybrid fodder crop produced by hybridization between Napier (African grass) and Bajra (Indian pearl millets). Hybrid Napier is more succulent, leafy, fine textured, palatable, fast growing and drought resistant than Napier to combine these qualities with its high yielding potential. Compared to Napier grass, Hybrid Napier produces more tillers and numerous leaves. It grows faster and produces more biomass but the stems are hard and the plants less persistent. The tillers are more numerous and grow faster. Hybrid Napier is one of the most important forage crop grown in the country and most popular crop grown in North East India including

Assam and Arunachal Pradesh in particular. It is highly palatable, higher in nutrient contents and high yielding. Hybrid Napier requires more nutrients and demands more water for its fast growth rate. Therefore, this crop suits agro climatic situation of North east India although, not popular in Namsai district of Arunachal Pradesh. Thus, the cultivation practices are being explained here in brief.

Botanical and nutritional Description:

Hybrid Napier grass grows throughout the year in the tropics. The optimum temperature is about 31°C. Light showers alternated with bright sunshine are very congenial to the crop. The hybrid once planted supplies fodder continuously and regularly for a period of three years. Hybrid Napier is a triploid grass, so does not produce any seeds. It produces high number of tillers and numerous leaves. It grows fast and produces high herbage but the stems are hard and the plants less persistent. The leaves are large and green, the sheaths are softer and the margins less serrated and hence the herbage is palatable. It is juicer and succulent at all stages of growth. It is less fibrous and more acceptable. It can withstand drought for a short spell and regenerates with rains but is susceptible to frost.

The oxalate content of some of the varieties may be high. It can be mitigated if harvested at longer intervals (45 to 60 days). Nutritional properties of the napier fodder has been given below

Nutritional composition of green Fodder (% Dry matter)									
Crop	Crude Protein	Fiber	NFE	Ether Extract	DCP	TDN	Total Ash	Cal cium	Phos-phorus
Hybrid Napier	10.3	24.9	46.2	3.2	-	-	15.2	-	-

Soil and Land preparation:

Hybrid Napier can grow on a variety of soils. Light loams and sandy soils are preferred to heavy soils. Prolong waterlogged and flood condition harmful for the crop. Fertile land rich in organic matter yields higher green fodder. Hybrid Napier can tolerates pH ranging from 5 to 8. Thus, Hybrid Napier is most suitable in upland field of Namsai district.

Hybrid Napier requires a deep, thorough weed free and compact seedbed. Three or four ploughings followed by disc harrowing is ideal. Land should be prepared well by repeated ploughings. First deep ploughing by mould board plough followed by 2 to 3 harrowings is sufficient to prepare the land. Namsai

district is a high rainfall area therefore, planting on ridge and furrow makes easy water drainage during rainy season.

Manure and fertilizer application:

Hybrid Napier is high nutrient demanding crop and application of manure and fertilization enhance the growth of plant and green fodder yields. Farm yard manure @ 8 to 10 t/ha or 1.0 – 1.5 tonnes/biga, and P2Os 50 kg/ha, 40 kg N/ha and K2O @ 30 kg/ha each may be applied at the time of land preparation as basal dose of fertilizer and manure. A combination of organic and inorganic fertilizer gives better yield. However, soil may be tested for selecting exact dose of fertilizers. FYM (GOBOR) or compost should be applied during land preparation. Nitrogen fertilizer @ 40 kg/ha should be applied as basal and rest of nitrogenous fertilizer should be applied @30 kg/ha after each cut. Vermicompost is growth enhancer manure therefore, it may be applied @ 2.5 t/ha. The same quantity of manure and fertilizer are needed and to be applied every year.

Nutrient	Requirement (Kg/ha)	Form	Fertilizer requirement	
			(Kg/ha)	(Kg/bigha)
N	120	Urea	265	35
P_2O_5	50	SSP	310	45
K_2O	30	MOP	48	7

Sowing time:

April to June is the most optimum time for transplanting of rooted slips or stem cuttings.

Seed rate and method of sowing:

Seed rate (number of rooted slips or stem cuttings) recommended is 4000 number/ha with spacing of 50 X 50 cm distance.

Suitable Varieties:

Under good irrigation and nutrient management use of newly released and improved variety of Napier gives better yield. Assam Agriculture University has recommended following varieties for Assam and adjoining areas are **NB 21, IGFRI-6 and CO-2.**

Irrigation:

First irrigation should be given immediately after planting. Subsequent

irrigation will depend upon amount of rainfall received.

Weed Management and inter culture activity:

Early interculture once or twice is necessary before the plants establish and grow vigorously. Subsequent, interculture activity should be done as and when necessary. Earthing is helpful to prevent lodging of crop and drain off excess water during rainy season.

Harvesting of green fodder:

The first cut is taken 9-10 weeks after planting. Subsequent cuts are taken after four to six weeks or when the plant attains a height of 1.5 m. Annually at least six to eight cuts are possible. In order to encourage quicker regeneration from the basal buds, stubbles of 10-15 cm is left out at the time of harvesting.

Green Fodder Yield:

Under good cultivation practices and nutrients management an average fodder yield of 80 to 150 tonnes per hectare can be obtained.

7.2: SCIENTIFIC CULTIVATION PRACTICES OF FORAGE GRASS SETARIA

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Setaria (*Setaria sphacelata*) is one of the most important forage grass grown in the country. It is highly palatable, good in nutrient contents and high yielding.

Improved varieties :

Kazungula, Narak

Soil type :

Setaria grass can be grown in different types of soil but well drained soil rich in organic matter is best suited for the crop.

Land preparation :

Land should be prepared well by repeated ploughing. Stubbles should be removed and lavelled well. Prolong waterlogged and flood condition harmful for the crop. Fertile land rich in organic matter yields higher green fodder. Setaria grass can tolerates pH ranging from 5 to 8. Setaria grass requires a deep, thorough weed free and compact seedbed. Three or four ploughings followed by disc harrowing is ideal. Land should be prepared well by repeated ploughings. First deep ploughing by mould board plough followed by 2 to 3 harrowings is sufficient

to prepare the land. Fodder land should be levelled well to prevent from water stagnation and flood condition.

Time of Planting **:** April – June is the optimum time for planting.

Spacing **:** 50 X 50 cm

Seedling requirement **:** 40,000/ha (5000/bigha)

Manures & Fertilizers : A combination of organic and inorganic fertilizer gives better yield. Compost or FYM (Gobar) @5 t/ha should be applied. Fertilizers should be applied as follows –

Nutrient	Requirement (Kg/ha)	Form	Fertilizer (Kg/ha)	Fertilizer (Kg/bigha)
N	120	Urea	262	35
P_2O_5	50	SSP	312.5	44
K_2O	30	MOP	50	7

However, soil may be tested for selecting exact dose of fertilizers. FYM (GOBOR) or compost should be applied during land preparation. Nitrogen fertilizer @ 40 kg/ha should be applied as basal and rest of nitrogenous fertilizer should be applied @30 kg/ha after each cut. The entire quantities of phosphatic and potassic fertilizer along with farm yard manure should be applied as basal dose. Vermicompost may be applied @ 2.5 t/ha.

Intercultural operations:

Intercultural operations in the form of light hoeing are necessary at 30-35 days of planting and also after each cut to facilitate better growth of plant. Top dressing of nitrogenous fertilizer should be done after the inter culture activity.

Number of cuttings:

First cut is to be taken at 60-65 days after planting and subsequent cut at an interval of 45-60 days.

Green forage yield :

Setaria produce a green forage yield of 800 – 1000 q/ha

Setaria grass ready for cutting

8. MORINGA PLANTATION FOR GREEN FODDER

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Drumstick or moringa is local tree found abundantly in Namsai district and fruits (pod) are used for vegetable purpose not only in Namsai district but all over India. Drumstick tree called *Sajna* in Assamees and Sahajan in Hindi. Use of drumstick as fodder for dairy cow is not a common practice in Namsai district and India however, lopping of stem and leaves for small ruminant goat are common. Cow too are very relish to eat leaves of drumstick whenever available. Indian Drumstick has vigorous vegetative growth, highly digestive, very nutritious and has medicinal value. Feeding of drumstick leaves as fodder to the dairy animals has been found to improve the milk production and body weight gain capacity and

therefore, National dairy Development Board (NDDB) takes step to popularize drumstick as fodder crop all over India. Drumstick is common plant in Namsai district, several potential benefits, moringa cultivation on large scale is ignored so far. To benefit the farmers as well as improve the milk production of dairy animals in order to get high economic returns, therefore, information on its scientific cultivation as fodder is being described here.

Botanical and nutritional Description:

Botanical name of drumstick is Moringa oleifera classified *to k*ingdom: Plantae, Division: Magnoliphyta, Class: Magnoliopsida, Order: Brassicales, Family: Moringaceae, Genus: Moringa, Species: M. oleifera. Flowering season of drumstick tree is winter December- January and provide vegetable up to rainy season. The Moringa tree is grown mainly in tropical and sub tropical regions and well adaptive to harsh and drier environments of the arid/semi-arid zones as well as in the hills and uplands of the humid parts during summer. Drumstick tree is slender and grows to a height of 10 meters. The branches are droopy. The flowers are bluish white and occur in bunches. Seed pods are long, slender and triangular, resembling drumsticks. Seeds are triangular in shape and have wings. The tree trunk is soft.

Drumstick tree leaves and soft stem are very nutritious. Green leaves and soft stem contains high quality protein, fat, minerals and vitamins. Drumstick leaves contain about 18 percent dry Matter, 16 to 18 percent crude protein, 3.5 percent fat, 60 percent NFE and 12 percent Crude fibre and 8 percent Ash. Beside this, it contain 3.69 percent calcium, 0.33 percent phosphorus, 0.42 percent magnesium, 1.58 percent potassium and 0.21 percent sodium, 397 ppm iron, 80 ppm manganese and 44 ppm zinc. Drumstick leaves contains essential amino acids including metionine, Valine, Leucine, Phenylalanine, Threonine, Tryptophan, Isolucine, Lysine, Tyrosine and Histadine better than the berseem.

The medicinal properties of Moringa Oleifera or drumsticks are very well explained in texts of ayurveda and recently modern science has also proved. Phytochemistry of drumstick compounds are reported as antimicrobial, anti-inflammatory, anti-spasmodic, anti-tumour, anti-oxidant, anti-pyretic, anti-ulcer, anti-epileptic, diuretic, cholesterol lowering, renal, anti-diabetic and hepato-protective activities due to presence of many constituents as alkaloids,

flavanoids, anthocyanins etc. so, feeding of drumstick as fodder will be beneficial for dairy animals.

Soil and Land preparation:

Sandy loam and loam soil are best for Moringa tree cultivation. Moringa tree are adapted to various soil types and it can grow in marginal land and erosion prone land. Good land preparation is necessary for quick development of roots. One deep ploughing by disc harrow is necessary. Main land preparation should be started after 10 to 15 days of first land preparation. After deep ploughing 3 to 4 harrowing and planking is sufficient for sowing of seed.

Manure and fertilizer:

Good growth can only be ensured by good nutrients availability. Therefore, application of 5 to 10 tonnes of compost or farm yard manure and 150 kg/ha N, 60 kg/ha Phosphorus and 40 kg/ha Potash is essential. Application and spraying of 10 kg zinc improved the productivity of green fodder. All manure, phosphorus, potash and zinc and 30 kg Nitrogen should be applied as basal dose in soil at the time of land preparation. Remaining amount of nitrogen should be applied equally after each cutting as top dressing. Addition of a balanced fertiliser or compost to infertile soil enhances root development.

Variety:

Drumstick can propagate easily from seeds or cuttings which can flourish quickly even under poor soil conditions and start flowering eight months after planting. Use of stem cutting for propagation is found to be good for vegetable purpose however, seed is most suitable for fodder purpose. Local adoptive tree seed can also be used as fodder crop. However, improved variety as **PKM-1 and PKM-2** gives better yield under good management condition.

Seed Rate:

Drumstick require 100kg/ha seed for fodder crop or 1 kg/100square meter area.

Sowing of seed and Treatment:

Sowing time for drumstick is Aril to June after initiation of monsoon. Drumstick seed are hard therefore, before sowing seed needs treatment. Soaking of seed under water for 8 to 10 hours to soften the outer coat is help to improve and quick germination of seeds. Soaked and dried seed are treated with

trichoderma or corbendazium powder @ 5g/kg seed to prevent fungal disease. For intensive production of leaves, plants should be sown 30X10 cm line and plant spacing.

Irrigation:

Sufficient moisture is necessary for good germination of seed. Therefore, irrigation just after sowing is recommended for drumstick fodder crop in dry areas. Under evenly distributed rainfall, irrigation not require however, during winter season every fortnight irrigation help to improve the fodder yield. Regular irrigation keeps the soil moist which promotes growth.

Weed management:

During early age of plant field should be free from weeds. One to two manual weeding are sufficient. Use of 1 to 1.5 kg pendimethalin/ha after sowing is helpful to control the weed.

Harvesting and feeding precautions:

Drumstick fodder is ready for harvesting after 90 days after sowing of seeds. Second cutting should be done every 60 day of interval. First cutting gives 30 to 40 tonnes/ha green fodder and annually 100 to 120 tonnes per ha. The vigorous and re-growth nature of moringa plant can produce 3-5 new shoots after each cutting and up to six cutting can be obtained annually. Drumstick fodder contain more protein therefore, feeding should be done with precaution. Drumstick fodder should be chaffed in chaff cutter first and mixed with molasses, sugarcane, young elephant grass, sweet (young) sorghum plants, or whatever else is locally available straw (Rice or wheat bhusa). The high protein content of moringa leaves must be balanced with other energy feed. Care must be taken to avoid excessive protein intake as too much protein in a cattle feed can be fatal. 15 kg drumstick fodder with chaffed rice or wheat straw has been found to be sufficient for lactating animals.

9. SILAGE: A CONSERVED GREEN FODDER FOR LIVESTOCK DURING SCARCITY

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Adequate supply of feeds and fodders is crucial to the growth of livestock sector. Feeding of livestock in India including the North Eastern Region largely depends on crop residues and their by-products with the grazing lands. Cultivated fodders plays important roles of green fodder for livestock is negligible in these states and farmers virtually do not allocate any land for fodder cultivation in this region; though all over about 2.5 per cent of the gross cropped area in the country is allocated to fodder crops only 0.16 per cent of gross cropped area has been estimated to be allocated for fodder cultivation in NE states. Therefore, the farmers largely depend on common grazing lands like permanent pastures, wastelands, fallows, excluding current fallows etc. however, during scarcity like peak winter, heavy draught/flood there occurs lots of problem for feeding animals due to shortage of fodders. The problem is further compounded by lack of availability of locally produced feeds as the feed requirement for both human and animals in the NER is generally met through import from other states, which makes it costly and is often beyond the affordability of the farmers. Till date several technologies have been developed by Animal Nutritionists on forage conservation for feeding livestock during scarcity and popularized worldwide. Most areas of the country especially the NE states, endower with lots of unconventional feed staffs including some tree foliages (Ghosh, 2009), which could be explored as animal feed for feeding livestock during scarcity using suitable methods of conservation like ensiling, preparation of CFBs etc.

Feeding silage is becoming a common practice in most part of the world including India especially during the lean season. Several workers have studied the performances and nutrient utilization in growing as well as milch cow fed on silages. Pachuri and Rekib (1992) observed higher TDN intake in ensiled sorghum silage group compared to the non-siled sorghum group. The digestibility of crude protein and total carbohydrates was observed to be higher in animals fed ensiled sorghum silage as compared to the un-siled sorghum silage fed group which might

be due to higher microbial growth in the rumen on providing roughage as silage (Singh *et al.*, 1995). Radotra and Upadhyay (2005) recorded the better nutrient utilization and milk production efficiency in crossbred (Sahiwal x Red Sindhri) cows fed ensiled sorghum stover in comparison to feeding stover as such which results an economic milk production. Maize silage was also found to be the best feeding strategy for both lactating and growing yaks living in high altitude especially during severe winter whenever all the greenery become covered with snowfalls (Medhi *et al.*, 2015).

Ensiling forages and its importance:

Ensiling is a forage conservation techniques by which we can preserved green forages through controlled or induced anaerobic fermentation retaining its moisture content and its product is called as Silage. Two main conditions to be fulfilled for production of good quality silages are

1. Achievement of anaerobic condition
2. Discourage the growth of undesirable microbes such as *Clostridia* and *Entertobacteria*.

The container used for silage making is known as silo. Different types of silos are now available namely Tower silo/upright silo, Air tight/gastight/sealed/oxygen limiting silos, Pit silos, Trench type, Bunker type etc. Among these Trench and Bunker type are commonly used in our country. To prepare good quality silage there must be some specific characteristics of silo like:

1. Side walls should be straight and smooth to prevent the formation of air pocket,
2. The silo should be of adequate depth but above the water table (trench & pit)
3. The walls should be strong and rigid in order to withstand the pressure of fermentation.
4. Silo pit should be easily approachable both from the field and farm.
5. Silo pit should be adjacent to the chaffing shed.
6. Silo may be made up of brick, cement, stainless steel or kachcha (clay & dung @1:1)

Quality of crop/ forages for silage making: In general crop with thick stems are conserved as silage. But any crop having sufficient soluble carbohydrates and

moisture to produce sufficient quantities of lactic acid may be use for silage making. The most commonly used silage crop in India are maize, sorghum, sudan grass, bajra, hybrid napier etc. But maize and sorghum is best crop for silage making. Leguminous crop like Berseem, Lucern cowpea etc is not suitable for silage making because legumes are more highly buffered than non leguminous fodders. But after mixing with non leguminous fodders (*graminaceous*) or with molasses at suitable combination good quality silage can also be prepared from leguminous fodders. Suitable combinations are-

Maize:	Cowpea	1:1
Berseem:	Paddy straw	1:5
Berseem:	Dry grass	1:5
Berseem:	Sorghum straw	1:5
Berseem:	Oats	1:1
Lucern:	Wheat straw	2:1
Legume:	Molasses	100:3.5-4
Legume:	Mixture of grasses & cereal fodders	1:3

Steps of silage making: To get a good quality silage one should take care at every stage of ensiling. Steps of good silage making are as follows:-

1. Harvesting of forages: Crop should be harvested at the stage when it contain maximum nutrients. Single cut crop should be harvested at half bloom stage and multi-cut forages can be harvested at 55-60 days after sowing for first cut and after 25-30 days for subsequent cuttings.

2. Chaffing of forages: It is better to chaff the long fodder before filling the silo. Because chaffed forages can be compressed to a greater extent and it helps in better airtight packing of silo. More over more plant surface area will be exposed to micro-organism which helps in optimum lactic acid production.

3. Mixing of legumes and non-legume forages: Legumes are good sources of protein and poor sources of carbohydrate. On the other hand non-legumes are poor source of protein and good

source of carbohydrates. So by mixing them at proper ratio good silage can be prepared.

4. Mixing of additives: To achieve good quality silage in terms of lactic/acetic acid contents and their palatability some additives like molasses 3.5-4% in liquid or dehydrated form, urea/lime stone 0.5%, common salt 1% of the green weight of forages, some organic acids, bacterial cultures etc. It improves the quality of silage by increasing lactic acid and acetic acid production and increase palatability of silage. Sometimes some feed staffs like wheat bran, crushed maize, starch, dextrose, whey and yeast can also added.

5. Filling of silo: Filling of silo should be rapid and it should not take more than two days. During filling forage should be compressed properly so that neither there is any air pocket inside the silo. Never fill a silo when it is raining.

6. Sealing of silo: Sealing of silo should be airtight to prevent the entrance of atmospheric air. Top of the silo should be cover by any type of insulator like mud, loose earth, or plastic. For bunker and trench silo sufficient load should be apply on the top to facilitate compactness.

7. Removal of silage: After a period of 4-6 weeks the silage is ready for feeding. After the removal of silage the open end of the silo should be covered to prevent the contact of the remaining silage with air. The silages should be fed to the animals as soon as it possible.

Quality of silage:

Depending upon the type of silos used, fodder quality, time taken for its filling etc the quality of silages varies and they can be classified as follows-

1. **Very good silage:** silage having acidic taste and odour, free from butyric acid and moulds, no sliminess (contain sticky liquid and unpleasant to touch) nor proteolysis, P^H 3.5-4.5 and ammonical nitrogen less than 10% of the total nitrogen. Lactic acid content is 1-2%. Uniform in moisture and green or brownish in colour, the taste is pleasant, no bitter or sharp.
2. **Good silage: silage** having acidic taste and odour, traces of butyric acid (less

than 0.2%), P^H 4.2-4.5 and ammonia-cal nitrogen 10-15% of the total nitrogen, other points are same with very good silage.

3. **Fair silage:** silage that contain butyric acid, slight proteolysis, some moulds, P^H 4.8 and above and ammoniac nitrogen 15-20% of the total nitrogen. Colour of this type of silage is tobacco brown to dark drown.
4. **Poor silage: I**t has a bad smell due to high butyric acid and high proteolysis. The silage may be infested with moulds, less acidity and P^H is above 4.8. The amount of total ammonia cal nitrogen is more than 20%.Colour of the silage is blackish and not suitable for feeding

Useful tips on making good silage

a. Harvest at the right maturity stage when the nutrient are optimum in the forage or grain.
b. Avoid stop and start during silo filling. Fill and seal silo within 24 hours if possible.
c. Good consolidation is a must. Compact in thin layer and build up until the clamp is filled up.
d. Using a thin layer of plastic before the upper thick layer will help to vacuum seal of the silo and reduce losses on the top.
e. Depending on the type of bacteria in the standing crop, you can get a good fermentation without additives.
f. Adding additive will however give you the extra assurance to improve the feeding value of the silage. It is advisable to delay the choice of additive until you have some idea of what the condition is going to be at ensiling. Where it is not possible to delay your order, always select an additive that will not only help to reduce nutrient loss but will give some element of aerobic stability.
h. When legumes are ensiled, the use of additive is very important because of their low sugar content and the fact that they have high buffering capacity.
i. With crimp cereals, avoiding nutrient loss and improving aerobic stability should be your top priority in your additive selection criteria.
k. At feed out, a clean silo face is very important. And, avoid covering back the face after opening as this can create a micro environment for spoilage organisms.
l. Mycotoxins problems are real and trying to control it at feed out is very

expensive. Hence, necessary preventative measure to be taken at the time of ensiling.

Advantages of ensiling:-

1. Silage can be prepared from green fodder when the weather is not suitable for hay making.
2. Surplus green fodder abundantly available in rainy season can be preserved as silage for feeding during lean season.
3. Silage can be preserved from plants having thick stems which are not suitable for hay making.
4. Weeds can also be utilized along with main fodders .Ensiling destroy weed seeds and help in weed control.
5. It increases the palatability of some unpalatable organic waste products and can be use as animal feed.
6. Organic acids produce during ensiling are similar to those occur in digestive tract of animals and can be utilize by animals easily.
7. Lesser loss of carotenes in silage making than hay making
8. Ensiling increase voluntary intake of coarse fodder.
9. Fear of loss due to spontaneous fire sometimes experienced in hay is not there.

Feeding schedule: Good quality silage can be fed to adult yaks on *ad libitum* basis for maintenance of yaks however, supplementation of some concentrates may necessitate if it use for high yielding dairy animals.

Conclusion: The feeds and fodder shortage during scarcity is great problem in all over the country like India especially during harsh winter in highland areas, affected areas experienced with some natural calamities like flood, draught etc. However, Most areas of the country especially the NE states, endower with lots of unconventional feed staffs including some tree foliages which could be explored as animal feed for feeding livestock during scarcity using suitable methods of conservation like ensiling, preparation of CFBs etc and the silage making technique have been found most economic and beneficial for different types of livestock including the highland animals.

10. QUALITY IMPROVEMENT OF ROUGHAGE

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UREA TREATMENT OF DRY FODDERS FOR LIVESTOCK

Dry roughage (paddy straw) has very less nutrients but, gives satiety from hunger, therefore, it is very important for ruminant nutrition point of view. As dry fodder, only rice straw is used to feed the dairy animals in Namsai district of Arunachal Pradesh. Rice straw containing high amount of crude fibre (40%) and oxalate that not only very hard to digest but drain some digestible nutrient (Calcium) from the body of the animals. In Namsai district dry fodder availability including paddy straw and maize clover for livestock is not adequate and the gap between the requirement and availability is widening. Hence, feeding of fibrous crop residues fails to even fulfill the maintenance requirement of the animal. Different methods have been employed for improving the quality of fibrous crop residues and making them suitable for the feeding of livestock. Alkali treatment is noteworthy where caustic soda, lime, ammonia, urea or urine may be used for the purpose but have some serious limitations at the farmer's doorstep like cost, toxicity, lack of trained staff etc. However, the use of urea is comparatively safe and has the distinct advantage of universal availability, less risk and low cost as compared to ammonia or alkali treatment.

The urea treatment technology is simple and has great potential for adoption at farm-gate level for enhancing the utilization of poor quality roughages.

Mechanism of action:

Urea treatment of straw and stover works on the principal of ureolysis and alkali action on the cell through dissolving the structural carbohydrates especially the hemicelluloses band, swelling of the plant matter in an aqueous environment, reducing the physical strength of cell. Urea treatment of straw leads to an increase in intake, digestibility and energy availability as well as milk production and body weight gain to the host animal through enriching the straw for its protein content.

Process of Urea treatment:

Simple steps of urea treatment are given below

1. Chaffing/thrashing of crop residue/stover by chaff cutter to 1-2" size

2. Collect/store the chopped straw at a safe and dry place till further use
3. Weigh 100kg straw for urea treatment.
4. Make the urea solution by dissolving 4 kg urea into 40 liter water.
5. Spread the straw layer on polythene or tarpaulin sheet.
6. Fill the urea solution in a container and spray over straw layer uniformly.
7. Fill the urea treated straw immediately in an airtight bag and close it properly.
8. Ensure the complete air tightness of bag and keep it for at least 2 weeks
9. Open the bag; remove top 1-1 ½ inch layer and offer the straw to livestock.

Many times it happened that remaining residues in farm are burned without using their potential in dairy farming. Waste of crop like wheat straw, Rice straw, Gram straw can be used as feed of animals but it needed treatment. Reason for treatment of crop residues.

It is tasteless. Some crop residues are having micro spines which cause injury to soft tissues in the mouth of animals. Its energy as well as protein value is inferior. Some of them are deficient in minerals. It has seen that wheat straw or rice straw are available in abundant quantity as crop waste & many farmers used to burn it as traditional practice, so it is necessary to use it as a feed for animals after having treatment of following ingredients.

S NO.	Ingredients	Quantity
1	Wheat straw / rice straw/maize stovers etc.	100 kg
2	Urea	1.5 kg (1.5%)
3	Mineral Mixture	1 kg (1%)
4	Salt (Big Granules)	1 kg (1%)
5	Jaggery (If not available, waste flour in flour mill can be used)	3 kg (3%)
6	Water	30 to 40 litre

The above materials should be used in following method.

- Dissolve urea in correct concentration (as above) in water (1.5 kg urea in 30-40 litres of water)
- Then also add Salt, Mineral mixture & Jaggary (or Flour) in urea dissolved water to become concentrate single solution. The solution are used to treat the straw or clover.
- Make a layer of 6 inches of wheat or rice straw and sprinkle concentrates

solution on it equally. Again mix this layer thoroughly & make a heap. Once again make a layer of 6 inch of this wheat straw and sprinkle the concentrated solution.

- Make a heap & press it with the help of hand so that all air will expel out form heap. Then cover it with plastic paper for 2 hours.
- Then use it for feed to animals.

Facts for urea/ammonia treatment

- Urea provides readymade protein source for animals.
- Salt & mineral mixture provide essential mineral for animals which are lacking in crop residues.
- Jaggery or flour provides taste to straw as straw is tasteless.
- Water soften the spine as well as harder part in straw so it is easy to fed on it & may not cause any injury to soft tissues in mouths of animals. Care to be taken for urea treated straw
- Do not exceed the urea concentration for wheat straw more than 1.5 % for 100 kg of straw. If it will increase then there may be danger of urea poisoning to animals.
- Care to be taken to dissolve each granules of urea in water thoroughly.
- Use this urea treated straw immediately after 2 hours of treatment. Do not store treated material for more than 8 hours.
- Daily use fresh treated straw for animals & for each animals use this straw 4-6 kg only for high producing dairy animals .If the animals are not in production then it is physible to use 7-8 kgs of treated wheat straw for feeding animals.

Mix treated wheat straw in chaffed green as well as dry fodder so that animal can not use its selective behavior of feeding.

UREA TREATMENT OF PADDY STRAW WITHOUT USING JAGGERY.

Benefit:

1. Treated paddy straw has enhanced nutritive value than the untreated paddy straw.
2. Treaded paddy straw is liked by cattle.
3. Increase palatability.
4. Intake will increase

5. Maintained the health quality.

Items:

1. 100 kg paddy straw
2. 40 liters of water
3. 4 Kg. Urea.
4. Polythene sheet
5. Water cane
6. Bucket etc.

Procedure:

1. Polythene sheet should be spread over on the selected site.
2. The one fourth paddy straw will be spread over the polythene sheet
3. The water urea solution will be sprinkle over the paddy straw and mixed properly.
4. Then next one fourth paddy straw will be spread over and again urea solution will be sprinkle till completion of the straw.
5. The treated straw will be airtight and kept for 21 days.

Precaution:

1. The calf of below six month will not be fed with treated straw.
2. The pregnant cattle are also not being fed with treated straw.
3. The fungal growth straw should not be taken for UTPS
4. The treated straw will be fed after exposure of air for at least 10 minute.
5. The starting quantity of UTPS should be regulated from lesser quantity to higher in periodic manner.

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