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Forage production for

livestock management and livelihood support

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Most often, livestock is the only source of cash income for subsistence farms and also serves as insurance in the event of crop failure. Forage crops are essential for livestock growth, health and productivity. There is 23% deficit in dry fodder and 11% deficit in green fodder. To meet the ever-increasing livestock fodder and nutrient demand, there is a need for developing forage production technologies. In this article, the forage production technologies for different agroclimatic conditions are discussed to increase fodder productivity in the country.

Keywords: Fodder beet, Fodder production, Forage, Hydroponic fodder, Moringa, Range grasses, Rainfed areas

FORAGES constitute the base of a complete food chain and are the source of protein and fat, *i.e.* meat, egg, milk and other dairy products through different livestock species. Feeding alone accounts for 60-70% of rearing cost, and timely availability of nutritious fodder from cheaper sources is crucial in maintaining the health and productivity. The major feed resources for livestock in our country include grasses, community grazing on common lands, crop residues and agricultural by-products, cultivated fodder, tree leaves from cultivated and uncultivated lands, and agro-industrial by-products. Crop residues, including fine straws, coarse straws, leguminous straws, and sugarcane tops, are the single largest bulk feed material readily available to farmers for feeding ruminants. The 20th Livestock Census (2019) has placed the total livestock population at 536.76 million, showing an increase of 4.8% over the Livestock Census 2012. Therefore, it is imperative to breed crop varieties for better yield, high nutritional value and tolerance to abiotic and abiotic stresses to meet the increasing demand for livestock in the country. Fodder production technologies can assist in achieving high crop yield under different ago-based systems. The salient features of forage crops are short growth period, closer spacing with dense stand to smother weeds, flexible crop duration to adjusted risk due to aberrant weather conditions, high persistency and regeneration, shy seed producer, wider adaptability with capacity to grow under stress conditions, high nutrient and water requirement under intensive cropping and multicut nature.

Forage production in rainfed areas

In rainfed condition, different aspects of rainfall like amount, duration, intensity and distribution are uncertain. In the absence of irrigation facilities, crop production depends on moisture conserved regimes. These uncertainties are highly unstable and lead to low productivity and poor income. The major constraints of forage production in rainfed areas are erratic rainfall, dry spells, poor soil quality, limited choice of crops and poor socio-economic conditions of the farmers with limited risk bearing ability. Forage crops and grasses are better suited for growing under moisture-stress situations. Besides, rain water-conservation techniques and soil fertility management are also required since the soils are not only thirsty but hungry also. Alternate land use systems like agroforestry having perennial forage trees, bushes and grasses are essential to provide sustainability to the forage production.

Soil and crop management techniques for forage production in rainfed areas

Bunding: To retain rainwater in the soil, at least 30 cm high bunds are needed. On light soils, grasses should be planted on bunds to make them stable. On sloppy lands, bunds are formed along the contour or across the slope.

Tillage: On sandy and other light-textured soils, cultivation should be limited to the extent essential for weed control and optimum tilth for seeding. Light cultivation with about 15 cm depth is enough. On heavy soils, deep ploughing once in three years helps to improve water infiltration. Cultivation should be done

across the slope on sloppy lands.

Manuring: An amount of 10-15 tonnes FYM or compost/ha should be applied every year along with appropriate doses of chemical fertilizers depending on crops under cultivation and season. Fertilizers are placed 2-3 cm below the seed line with the help of seed-cum-fertilizer drill or other equipment. Spray fertilization is also important in dryland areas.

Sowing: Crop should always be grown in rows to facilitate inter cultivation for checking weed growth and mulching to prevent water loss from the soil. The plant population should be about 25% less to ensure better utilization of limited moisture. Depending on the field conditions, ridge and furrow method and strip cropping can also be adopted.

Choice of forage species: Forages are better suited to moisture-stress situations since the duration of crop harvest can be adjusted. Pearl millet, sorghum, maize, barley, cowpea, clusterbean and field beans are ideally suited for drylands. Stay green types of these crops can also be utilized for forage after maturity of grains.

Weed control: Weeds should be checked from the very beginning through pre-emergence use of herbicides, clean and pure seeds, and inter cultivation practices to save the moisture and nutrients for crop plants only.

Mulching: Different types of mulches viz., live mulch, dust mulch could be used to conserve moisture in the soil especially in widely spaced row crops.

***Farm mechanization*:** Timely sowing, precise seed and fertilizer placement in the moist soil zone is crucial for successful crop establishment in rainfed regions. Since the sowing is to be completed in a short period of time, appropriate farm implements are necessary to cover a long land area before the seed zone dries. Farm mechanization ensures agricultural operations will be precise, time saving and cost effective. The important crop management practices of forage crops under rainfed conditions are given in Table 1.

Specific crop production techniques for rainfed conditions

Double cropping: In normal rainfall years, on medium deep soils, double cropping gives higher returns. In areas receiving more than 800 mm annual rainfall and soil moisture storage of 200 mm/m, double cropping is feasible. The most productive and remunerative double crop food-fodder sequences for forage are sorghum-gram, groundnut-wheat, sunflower-gram and sorghum-soybean.

Intercropping: Intercropping is recommended in areas receiving 650-750 mm annual rainfall. In such areas, at least one of the component crops succeeds in producing economic yields; even during droughts or other adverse climatic abiotic or biotic extremes. In high rainfall areas, there are greater chances of success of both the component crops and the returns are higher than for a sole crop. Low rainfall years (early during withdrawal of monsoon), winter crops in sequence often fail and intercropping is more profitable over sole cropping.

Multiple cropping, which involves growing 3 to 4 appropriate annual forage crops as sole crops in mixed stands (graminaceous and leguminous) in a calendar year, significantly improves herbage quality and enhances forage productivity per unit area. One of its key benefits is the long-term maintenance of soil fertility due to the addition of root organic matter. The success of this system depends on various factors, including agro-climatic conditions, crop and soil management practices, and input availability. By selecting appropriate crops/varieties and adopting scattered sowing and harvesting schedules, regular supply of quality forage could be ensured. Food and fodder crops are also grown on same piece of land.

Leucaena + Trispecific hybrid + pigeonpea

Ratooning for food-fodder production: Ratooning for green fodder can be done in maize, sorghum, pearl millet. Pearl millet (BJ 104) ratooned at 5 weeks stage gave 155 q/ha green forage and 8.5 q/ha grain yield as against 10.5 q/ha grain yield under without ratooning. Similar results have also been obtained in case of sorghum and maize.

Alley cropping: Under rainfed conditions, alley cropping is an important alternate land use system

Table 1. Crop management practices for forage crops under rainfed conditions

Crop	Soil	Sowing time	Harvesting	GFY (q/ha)
Pearl millet	Well-drained sandy and sandy loams	Beginning of rains	60-65 DAS	300-350
Sorghum	Medium-textured with provision of drainage	Beginning of rains	65-75 DAS	250-300
Maize	Light to medium textured with good drainage	Beginning of rains	Tasselling stage - 50-60 DAS	200-250
Cowpea	Well-drained medium soils	Beginning of rains	Pod-formation Stage - 50-60 DAS	200-250
Guar	Sandy and sandy loams with adequate drainage	Beginning of rains	Flowering to pod formation 60-70 DAS	200-225
Field bean	Sandy loam and loams	Beginning of rains	80-120 DAS	150-200

to stabilize the productivity of crops and meet the multiple needs of farmers. In alley cropping system of grain sorghum with shrubs viz. *Sesbania* and *Leucaena* in row ratios of 6:1, 9:1 and 12:1, alley species produced 4 to 13 and 64 to 107 q/ha green forage in addition to maintaining the grain production of sorghum. Higher grain and stover yield of sorghum was obtained in alleys followed by farm boundary plantation and no trees association.

Association of perennial grass and legume bushes

Suitable ideotypes of perennial grass and forage-legume components reduces the necessity of repeated sowing and tillage, and economise on irrigation water use. In this system, an erect, leafy and compact BxN hybrid / guinea grass or trispecific hybrid and subabul or sesbania are grown together in alternate paired rows (2:2). These crops yields around 200 tonnes of nutritious green forage/ha/year. Such systems are less sensitive to fluctuations in soil moisture and are more suited to southern regions where both components grow throughout the year. The component crops of the system can be changed depending on input availability and yield indices of the crops in a region. Similarly, cultural management practices like crop geometry, spacing and planting patterns could be adjusted to facilitate appropriate farm machinery and effective utilization of irrigation water.

Grasslands and alternate land use system

Grazing based livestock husbandry continues to be important as around 50% animals depend on grazing spread over 12 mha. Grasses are suitable for soil and water conservation with quick reproduction by tillering and able to withstand grazing/mowing and harsh environments. The choice of suitable species vary with agro-climatic conditions. Some of the common grass species of forage importance are; Range legumes- *Stylosanthes,* white/ red clover, clitoria, hedge lucerne and range grasses- Tall Fescue, Sewan, *Chrysopogon, Dichanthium, Setaria, Cenchrus* and *Sehima.*

Contingency crop planning with fodder crops

In most of the rainfed regions, the short duration crops and varieties have replaced long duration varieties. When rainfall is inadequate after planting, mid season corrections such as interculture, thinning, additional application of the nitrogen after alleviation of the drought have shown to impart stability to crop production. During late onset of monsoon followed by normal rainfall, selection of late varieties and short duration varieties of pulses, oil seeds, and fodder crops are important strategies to overcome the drought situation. Under late and low rainfall conditions, leguminous crops and oilseeds showed promising results. To avoid risks from weather aberrations, intercropping is advisable so that the rainfall pattern is suitable to at least one crop and hence the risk of complete crop failure is averted.

Cenchrus setigerus

Non-conventional fodder sources

Besides the commonly used fodder crops including rangeland and pastureland grasses and legumes, a few other non-conventional fodders are now becoming quite popular. The details about a few of them are mentioned below.

Azolla: *Azolla* is a small floating fern. The genus *Azolla* has seven species of aquatic ferns. It has symbiotic relationship with blue green algae, *Anabaena azollae*, which fixes and assimilates atmospheric nitrogen. Due to easy cultivation, good nutritive value and high biomass yield, it is now gaining popularity among the livestock keepers. *Azolla* is a good source of protein and contains almost all essential amino acids and minerals apart from appreciable quantities of β-carotene (vitamin A precursor) and vitamin B12. Azolla on a dry weight basis contains approx. 75% organic matter, 25% protein, 15% crude fibre, 10% amino acids. Up to 15 to 20% of azolla can be included in the diet of dairy cows as a replacement to concentrate.

Azolla

Thornless cactus: Thornless Cactus (*Opuntiaficus-indica*) commonly known as fodder cactus is potential forage resource in arid/semi-arid areas. These are good for areas with low and erratic rainfall, frequent drought along with long and dry spells and poor soil. Thornless cactus has higher water use efficiency (WUE) because it is CAM (Crassulacean Acid Metabolism) plant. Cactus fodder is rich in vitamin A and water soluble carbohydrates. It is highly digestible with 70% dry matter digestibility. Large size, fleshy and 6 months old cladodes are cut, chopped in small pieces of 2-3 inches size and fed to animals. About 10-15 kg chopped thornless cactus may be fed to animals per day mixing

them with dry fodder. It has good acceptability and palatability both by small ruminants and cattle.

Fodder cactus

Fodder beet: Fodder beet (*Beta vulgaris*) is one of the highest yielding forage crops and is a good source of renewable energy. The crop has a potential to produce the green fodder (root + foliage) of 150 to >200 t/ha in about 4 months. The crop has very high water use efficiency. It has 4-6% crude protein in roots and 12-14% in fresh leaves.

Fodder beet

Moringa: Moringa (*Moringa oleifera*), popularly known as drumstick, *sahjan*, and *munga* is a multipurpose tree cultivated for food, medicinal, industrial and fodder purposes. It is a perennial tree and has a potential to provide 'round the year' high quality green fodder up to 70-100 t/hectare in 4 to 5 cuttings. Moringa fodder is a rich source of nutrients for dairy animals. It is a fast-growing deep-rooted plant tolerant to drought conditions. It is highly nutritious, palatable potential fodder resource. Other than protein (approx. 16-20%) and minerals, it is a good source of vitamins.

Sugarcane top: Sugarcane top is generally known to be a major by-product of the sugarcane crop. It consists of 3 distinct parts – the green leaves (blades), the bundle leaf sheath and variable amounts of immature cane. It is widely fed to livestock in sugarcane growing areas. It is rich in energy and low in CP content.

Hydroponics fodder production: In view of seasonal and regional imbalances in fodder in the country, hydroponics as a soil-less fodder production technique is increasingly getting popular. It can provide fodder round the year and the fresh fodder is highly succulent and relished by the animals. Within 11-13 days, the nutritious fodder is ready which is rich in carbohydrates, minerals, and vitamins. The system is highly water efficient and can provide round the year green fodder. In a trial conducted at three locations, a seed density of 300g/sq. ft. was better and it produced 4.2-5.8 kg green weight containing 8-7-9% dry matter with 1-15% crude protein.

SUMMARY

Forage crops are essential for livestock growth, health and productivity. These crops are flexible in growing period which enables these to fit in most of the rainfed production systems. The fodder crops are characterized by short growth period, adjustable crop duration, grown in closer spacing, high persistency and regeneration capacity with multicity nature and wider adaptability with capacity to grow under stress conditions. In association of perennial grasses and legume bushes, high yielding perennial grasses with fodder bushes are grown which provide 4-6 cuttings of nutritious fodder. The crop management practices vary to great extent under different growing conditions and agro-climatic situation which is very clearly reflected in the productivity too. The productivity of grasses is often high under warm and humid climate, whereas sub-tropical climate with chilling winter is suitable for oat berseem and rye grass. *Azolla*, Thornless Cactus, Moringa, Sugarcane top, and fodder beet are non-conventional fodder sources being grown in few pockets. Under harsh climates with poor soil conditions, range species like *Stylosanthes, Clitoria*, Hedge Lucerne, Tall Fescue, Sewan, *Chrysopogon, Dichanthium, Cenchrus* and *Sehima* can be grown.

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Water

- Even though households are relatively low consumers of water, population growth and expanded water use have outweighed the effect of water saving technology and behavior.
- Less than 3% of the world's water is fresh (drinkable), of which 2.5% is frozen in the Antarctica, Arctic and glaciers. Humanity must therefore rely on 0.5% for all of man's ecosystem's and fresh water needs.
- Man is polluting water faster than nature can recycle and purify water in rivers and lakes. More than one billion people still do not have access to fresh water.
- Excessive use of water contributes to the global water stress. Water is free from nature but the infrastructure needed to deliver it is expensive.

- See more at: *http://www.unep.org/wed/theme water.asp#sthash.ki5vg3lB.dpuf*

Courtesy: United Nations Environment Programme website - http://www.unep.org/wed