Strategies for Maximizing Forage Yield and Nutritional Quality in the North Western Himalayan Ecosystem

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Livestock industry holds significant potential for growth, offering rapid economic benefits and playing a crucial role in the economic and social development of any region. However, livestock sector is constantly facing shortage of fodder at national and regional levels. Under deficiency scenario, farmers, resort to feed low quality dry fodders such as paddy straw, maize stover, dried grasses or costly concentrates to their livestock. Improving the availability of high-quality fodder and forage is challenging due to intense competition from other commercial ventures and food crops. In this situation, a practical solution is to increase the productivity of fodder crops per unit area and time. To maximize the yield and quality of fodder crops, it is essential to follow well-defined agronomic package of practices that include proper seeding rates to optimize plant density and resource use, adequate fertilization with essential nutrients, efficient water use through proper irrigation scheduling, timely weed control and harvesting at most suitable stages.

Selection of crops and suitable varieties

It is advisable to grow diverse crops like grasses and legumes, perennial and annual in order to harvest higher yields and more nutritious fodder. Selecting the right forage crops, especially perennials and legumes, can also enhance the resilience of cropping systems to climate change. Similarly, identification of suitable genotypes offers an excellent opportunity to meet the nutritional fodder requirement of livestock. Improved varieties offer advantages in higher yield, better quality, biotic and abiotic stress resistance etc. Suitable fodder crops for various regions of NW Himalayan region are given in Table 1.In the sub-tropical parts, the scarcity of green fodder during lean periods can be mitigated if the fields that are vacated after the harvest of rabi crops such as wheat, potatoes, mustard etc. or the lands that are kept fallow are sown with quick growing multiple fodders such as maize + sorghum; maize/sorghum + cowpea or cowpea alone during mid-March at a gap of two weeks intervals as staggered sowing. This will enable green fodder supply from mid-May to mid-July (summer lean period). In the temperate region, maize, sorghum or maize/sorghum + cowpea/soybean/ricebean followed by oat/annual rye grass or oat/rye grass + berseem/shaftal will provide higher quantities of good quality fodder for immediate feeding or can be preserved for use during lean periods. Sowing of perennial forage grasses like orchard grass, tall fescue, rye grass, *Phalaris* and legumes like red clover, white clover and sainfoin during mid-October to mid-November will help to provide the fodder during extended period of time.

Fig. 1 Annual *kharif* fodder crops suitable for the Himalayan region including pearl millet, cowpea and sorghum at Forage Garden of IGFRI, Regional Station, Srinagar

Optimum time of sowing

Temperature is crucial for rabi crops such as oats, rye grass and berseem while as irrigation availability is key for *kharif* crops. In the sub-tropical plains, fodder availability is plentiful during the peak months of fodder growth in *kharif* and *rabi*, however, there are two distinct lean periods for fodder supply i.e. May to mid-July and October to December. Similarly, in temperate areas forage is typically abundant from April onwards and sowing of *kharif* fodder crops is also initiated in April. However, there is a severe deficiency of green fodder from November to April. In such a scenario three options can be explored (i) scattered/adjusted sowing of *kharif* crops (ii) cultivation of perennial forages which provide fodder during the extended periods (iii) cultivation of short duration autumn crop. Therefore, green fodder supply throughout the year is actually planning green fodder supply during the scarcity period, which can be achieved by planning crop calendar to ensure higher fodder production and squeezing the deficits.

Table 1 Suitable forage crops and varieties for NWH region (IGFRI FRDP-2021)

Crop	Varieties	Potential GFY (t/ha)
Sub-tropical zone (altitude <500-800 m)		
Berseem	BL-180, Wardan, BL-1, BL-2, UPB-110, JHB-17-1, 17-2	70-100
Oat	JHO 2015-1, SKO-225, SKO-96, Bundel Jai-99-1 (JHO-99-1), Bundel Jai-99-2 (JHO-99-2), Bundel Jai 2004, JHO 851, UPO-94, RO-11-1, Palampur-1, Kent, Pant Forage Oat-3 (UPO-06-1), Pant Forage Oat-4 (UPO-06-2)	35-40
Chrysopogon	Bundel Dhawalu Grass-1	25-30
Heteropogon	Bundel Lampa Grass -1	25-30
Guinea grass	RSDGG-1, CO (GG) 3, Bundel guinea 2	45-50
B N hybrid	Swetika-1 (Hybrid Napier-3), DHN-6 (Sampoorna), BNH-11, PBN 342, NB37, CO-5,CO-6, DHN-15	150-250
Guinea grass	Bundel Guinea-1,2,4, DGG-1	60-125
Sorghum	MP Chari, CSH-13-R Hybrid, CSH-20, Pant Chari 6, 7 and 8	40-100
Pearl millet	AVKB-19, Giant Bajra, CO-8, Gujarat Forage Bajra-1, NDFB-3	40-45
Cowpea	Bundel Lobia, 1,4, GFC-2, GFC-3, UPC-287, UPC-622,625	25-30
Intermediate zone (altitude (800-1500 m)		
Oat	JHO 2015-1, OS-424, SKO-225,SKO-90, SKO-96, Sabzar,SKO-20, Kent, Palampur-1, JHO-99-1, JHO-99-2	30-40
Maize	African tall, Pratap Makka, J-1006, SFM-1	40-50
Setaria	S-25, Nandi, Setaria-92, S-25, S-18, PSS-1	30-40
Tall fescue	Hima-14, EC-178182, Hima-1, Hima-4, EC-178182	25-35
Shaftal	SH-48	30-35
Sainfoin	IGFRIRRS-Sainfoin-17	30-45
White clover	PLP composite-1	25-35
Phalaris	IC-634850 to IC-634855	60-70
Temperate zone (altitude (1500-3500 m)		
Oat	JHO 2015-1, OS-424, SKO-225, SKO-90, SKO-96, SKO-20, Sabzar, JHO-99-1, JHO-99-2, Kent	35-45
Maize	African tall, J-1006, Pratap Makka, SFM-1	40-50
Sorghum	MP Chari, CSH-13-R Hybrid, CSH-20, Pant Chari 6, 7 and 8	40-100
Rye grass	Punjab Rye Grass-1,2, Grasslands Manawa, Palam Rye grass-1, IC-635997	25-35
Red Clover	Montgomery, PRC-3	25-35
White clover	PLP composite-1	25-35
Orchard grass	Currie, Comet, Howlong, IC-0615904	25-35
Tall fescue	Hima-1, Hima-14, Demeter, EC-178182	35-35
Phalaris	IC-634850 to IC-634855	50-70
Sainfoin	IGFRIRRS-Sainfoin-17	30-45
Berseem	BL-180, Wardan, BL-1, BL-2, UPB-110, JHB-17-1, 17-2	70-100
Shaftal	SH-48	30-35
Cowpea	GFC-2, GFC-3, UPC-287, UPC-622, Shalimar cowpea-1	20-30
Soybean	Shalimar soybean 1, 2	20-30

Seed rate and spacing

Seed rate is one of the important factors in attaining optimum level of plant density, as it results in efficient use of resources. A basic principle is that higher quantity of seed is required in forage crops with bold or bigger sized seeds like maize, cowpea, oat, sainfoin etc. and lower quantities are required in case of small seeded crops like timothy, berseem, clovers etc. Since maximizing biomass production is the primary goal for growing fodder crops, closer spacing is recommended. For instance, maize intended for grain production is typically spaced at 60-75 cm × 20 cm, but for fodder, it should be planted at 30 cm × 10 cm. Perennial forage crops, such as BN hybrid, are often transplanted at 75 cm × 30 cm, while temperate perennial forages are sown at 30 cm row spacing. Generally, perennial forages are planted with a spacing of 40 cm × 30 cm, whereas annual forage crops are grown with a spacing of 30 cm × 10 cm.

Fig. 2 Oat-berseem cropping system during Rabi season in Kashmir valley

Nutrient management

Nitrogen is the key nutrient that determines forage yield and quality through its effect on protein and chlorophyll formation and is typically the first limiting factor in forage production. Phosphorus plays an important role in both plant and animal growth and is especially critical for young developing seedlings. Insufficient phosphorus availability can impede ATP production, resulting in diminished photosynthetic activity, stunted plant growth and hence herbage losses. Potassium helps regulate water balance, nutrient and sugar movement, and starch and protein synthesis and stress tolerance. Potassium can improve palatability and digestibility of forages by regulating ion balance in plant tissues. In addition to NPK, calcium, magnesium and sulphur are important nutrients for enhancing forage yield and quality. In orchard grass, FYM at 15 t/ha should be mixed in soil 15-20 days before sowing. Besides, 60 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare should be applied at the time of sowing or planting. Berseem requires 20-25 kg N, 50-60 kg P_20_5 and 40 kg K_20 per hectare as basal dose at the time of sowing.

Micronutrients, which chiefly include boron, molybdenum, copper, zinc, manganese and iron, although required in extremely small quantities by crops and livestock, can cause serious problems in forages and health disorders in livestock, if found deficient. Micronutrient applications result in higher grain, stover and biological yields with single or combined application through seed treatment and soil or foliar applications.

Irrigation management

Different crops have varying water needs; for instance, alfalfa, a perennial crop, demands a high annual water supply, whereas maize, an annual crop, requires a more moderate amount of seasonal water. Factors such as geographic location, soil type, time of season, and the crop's water response all influence its water requirements. Increased water application can reduce water use efficiency due to losses from runoff or deep percolation. Forage maize typically needs 5-6 irrigations at 10-12 days intervals during summer and 1-2 irrigations during the rainy season. In areas with excessive rainfall, ensuring proper drainage is crucial. In case of berseem, on light soil, first irrigation may be given within 3-5 days after sowing whereas; on heavy soils it may be delayed for 8-10 days. Afterwards irrigations are given at intervals of 15-20 days depending upon weather conditions. Irrigation after each cut is essential for good re-growth of all the multi-cut crops. When temperature increases after February the frequency of irrigations also increases.

Weed management

Preventive weed control includes all measures taken to prevent or to arrest the introduction and spread of weeds like use of clean weed free seeds. Control methods include mechanical methods (hand weeding, hoeing, tilling, flooding etc.), cultural methods (crop rotations, growing of smothering crops like sorghum, fodder grasses, fodder legumes), biological methods by using a natural enemy of the plant which is harmless to desired plants and chemical methods by using herbicides. Spray of Imazethapyr @ 0.10 kg/ha as pre-plant incorporation has been found effective for control of chicory in berseem and weeds in cowpea. In oat, pre-emergence application of Linuron (0.5 kg/ha) and post-emergence application of 2,4- D sodium salt (0.75 kg/ha) is very effective. Application of Atrazine @ 1 kg a.i. in 500-600 l of water/ha as pre-emergence followed by Topramezone

(25 g a.i/ha) or Tembotrione (120 g a.i/ha) 30-35 DAS as post-emergence application gives effective weed control in maize and maize based systems.

Time of harvesting

The time of first cut after sowing is important to obtain maximum number of cuts as well as green forage yield at each cut. Quantity and quality of fodder follow opposite trends with the advancement in the crop development. At the vegetative growth stage, even grasses (like orchard grass) approach the feeding value of legumes (alfalfa) but results in lower yield. At full bloom, the grass may have about half the value of legume but produces high fodder quantities. The stage of harvesting also depends on the intended use of the forage. For example, for forage, maize crop may be harvested at 50 % silking stage and for silage making it may be harvested at milking stage (≈ 30 % DM) to ensure higher quantity and quality. In case of berseem and lucerne, the crops may be cut in the pre-blossom stage in order to prevent leaf fall and ensure conservation of protein and available energy to a great extent during hay making.

Adoption of cropping systems approach

Mixed cropping systems involving cereals/grasses and legumes enhance fodder yield and quality and soil sustainability by utilizing available resources more efficiently on a given land area. To meet the green fodder needs of livestock, the cultivation of both annual and perennial grasses within food-forage based cropping systems has gained popularity among dairy farmers in India, as it ensures a year-round supply of fodder. Intercropping of perennial forages (orchard grass, tall fescue etc.) with legumes (red and white clover, sainfoin) or perennial + annual crops for example, orchard grass + cowpea – oat/berseem will provide quality fodder during most parts of the year. In the subtropical conditions of Jammu, combinations such as maize + cowpea, berseem + mustard, and perennial fodders like Hybrid Napier and Para grass + annual legumes have proven to be highly productive and profitable.

Fig. 3 Fodder-based cereal-legume intercropping systems can substantially increase fodder production in the Himalayan region

Conclusion

The shortage of fodder forces farmers to resort to low-quality dry fodders or expensive concentrates resulting in lower milk and meat production. To address this issue, enhancing the productivity and quality of fodder crops through a well-defined agronomic package of practices is essential. This includes selecting suitable crop varieties, optimal sowing times and seeding densities, effective nutrient and irrigation management, adoption of mixed crop systems and strategic harvesting. By implementing these strategies, farmers can improve fodder availability, reduce deficits, and support sustainable growth of livestock industry.

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